

Pupa of *Batocera* sp. Ventral aspect

BRITISH MUSEUM  
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A MONOGRAPH OF THE  
IMMATURE STAGES OF BRITISH AND  
IMPORTED TIMBER BEETLES  
(*CERAMBYCIDAE*)

BY  
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## PREFACE

THE Beetles that form the subject of this monograph include some of the largest and most attractive to be found in the British Isles. One of the best known, the Musk Beetle (*Aromia moschata*) was illustrated and described by Thomas Mouffet in his *Insectorum sive Minimorum Animalium Theatrum* published in London in 1634. He referred to it as the Goatchafer, under which name the celebrated English naturalist John Ray also described it in his *Historia Insectorum*, 1710, together with a number of other species. Many years passed, however, before much was learned of the immature stages of the beetles, whose larvae burrow in the wood of trees. All that is known under this head, of both native and imported species, is summarised in the following pages and supplemented by a great deal of entirely new descriptive matter based on the author's own observation.

Most of the illustrations are from the author's own drawings. The Trustees are grateful, however, to the following for permission to borrow previously published figures, acknowledged in the text:

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N. D. RILEY

Keeper of Entomology.

16 September 1952.

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## INTRODUCTION

THE conservation of forests and timber increases in importance year by year, and the immense losses caused by insect damage alone become correspondingly more serious. Damage caused by insects can only be reduced by control measures based on accurate knowledge of the identity and biology of the insects concerned. Increased attention to conservation in this way creates a need for more information on the insect enemies of timber and for more easy access to this information.

Among the great variety of insects which are known to damage timber, the Cerambycidae or "Longhorn Beetles" have an important place. This family of beetles is of world-wide distribution and includes more than 20,000 species so far described.

The present work is designed to supply basic information on this economically important family. Accurate identification is an essential preliminary to any study of insects, for it is the key to all published work. In the Cerambycidae it is the larvae which are responsible for the damage, and as the larval stage is of two or more years' duration, it is in this stage that these insects are usually encountered.

Many tropical species fail to attain maturity unless they have already pupated at the time of importation, but a great number of species from sub-tropical and temperate regions are able to emerge successfully and, occasionally, to breed. Such establishment is, of course, most likely to occur when timber-yards and sawmills are situated near forest or park land.

For these reasons the first object of this work is to make possible the identification of Cerambycid larvae and pupae, both indigenous and imported.

The keys for the identification of larvae and pupae deal with 110 and 76 species respectively. Of these, 64 species are British while the remainder have been found in imported timber. Imported species have been included even when they have been found only once, for apart from the fact that further importations are possible, the more species included, the more reliable and useful are the results, especially with respect to the classification of tribes and genera.

In addition to keys, the work includes a correlated account of all the biological information on the immature stages and adults of Cerambycidae which is available, including original observations made during the past ten years. The literature on this aspect of the subject has until now been very scattered, and it is hoped that an organised source of information will be of assistance to workers who are in any way concerned with pests of timber.

The urgent need for an up-to-date correlation of existing information must be apparent to all who have attempted to identify Cerambycid larvae or pupae or to obtain information on the biology of any species. Control measures are dealt with only in so far as many of the more important works are mentioned, and in some cases (e.g. *Hylotrupes bajulus* (Linnaeus)) summarised.

Reference is made to approximately 200 British and imported species, many larvae

and pupae of which are described. The writer's entire collection of larvae and pupae, together with samples of infested timber, have been presented to the British Museum (Natural History).

As regards existing literature, mention must be made of the pioneering works of Schiödte (1863) and Perris (1877), which, although scarcely adequate by present-day standards, are nevertheless invaluable contributions to larval taxonomy; the more recent account by Craighead (1923b) of North American Cerambycid larvae and the numerous papers on Indian species by Gardner (1925-1948) have proved extremely useful. So far as the British fauna is concerned, it was not until the publication of van Emden's key (1939-1940) that the identification of Cerambycid larvae was at all possible. In the preparation of this original key, van Emden was greatly handicapped by lack of material and, to some extent, by wrongly named material through collectors having reared their specimens *en masse*. A larval key by Paulian and Villiers (1941) appeared soon after, but this was generic only, and has since been proved to make use of certain unreliable characters. It was as a result of the publication of these keys that the present writer's interest in this group was originally stimulated, and every effort has been made to fill in the numerous gaps in our knowledge.

With regard to the parasites listed, it should be pointed out that in many cases there appears to be no conclusive evidence as to the identity of their true hosts. Some of them have been found in old larval galleries, breeding cages, etc., and have not actually been known to emerge from their hosts. A number of them are probably parasitic exclusively on Lepidoptera. In the case of names of parasitic species extracted from Thompson's catalogue (1943), it has not been considered necessary always to quote the original reference.

References to literature have been obtained from numerous sources, particularly the *Coleopterorum Catalogus* of Junk and Schenkl (1912-1923), the *Review of Applied Entomology* and the *Zoological Record*. In a few instances when papers have been unobtainable, the relevant abstract in the *Review of Applied Entomology* has been relied upon. Although over 1,000 publications have been consulted, no claim is made to have seen every paper, but the writer is confident that few, if any, important papers prior to 1948 have been overlooked. It should be pointed out, however, that some of the very early papers have been intentionally omitted as they have been considered valueless.

Figures 49, 104, and 189 were kindly executed by Miss B. A. Read, to whom the writer is also indebted for the frontispiece. All other original figures of larvae and pupae have been prepared by the writer with the aid of a Bausch and Lomb binocular dissecting microscope and a Leitz monocular microscope, both in conjunction with a *camera lucida*. Acknowledgement is made in the legends of the comparatively few figures which have been copied or adapted from other publications. The photographic plates have also been prepared by the writer.

In conclusion, the writer wishes to express with pleasure and gratitude his indebtedness to all those who have so readily assisted in the preparation of this monograph from its inception to its publication. Firstly, appreciation is warmly tendered to Dr. H. E. Hinton, with whom consultation has been a valuable privilege. But for his continual interest and his helpful criticism, this work would never have

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Of these Mr. M. G. de C. Fraser deserves special mention. It is due to his untiring enthusiasm in the acquisition of desired imported material, and his critical biological observations that the scope of this work has been considerably enlarged.

Thanks are also expressed to the following persons for their kindness in lending material from their respective institutions: Dr. R. E. Blackwelder and Dr. E. A. Chapin (Smithsonian Institution, United States National Museum, Washington), Dr. R. C. Fisher (Forest Products Research Laboratory, Princes Risborough), Dr. H. E. Hinton (formerly of the British Museum (Natural History), London), Dr. Sv. G. Larsson (Universitetets Zoologiske Museum, Copenhagen), Dr. R. Paulian (formerly of the Museum National d'Histoire Naturelle, Paris) and Prof. U. Saalas (Universitetets Zoologiske Museum, Copenhagen).

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### ECONOMIC IMPORTANCE

Most Cerambycidae infest wood of various trees, some confining themselves to one host while others take a wider range and attack several hosts, often of widely diverse genera. Recently felled and stacked timber is generally the most vulnerable to attack, and the extent of damage caused by these insects is often apparent only when the logs are being cut up for conversion. The species of this family which are injurious to standing or felled timber are too numerous to discuss in this work, but the following examples will serve to demonstrate how considerable is their economic importance:

An outstanding example is *Hoplocerambyx spinicornis* Newman, which attacks

both standing and felled timber of Sal (*Shorea robusta*). According to Beeson & Bhatia (1939), even in a comparatively small epidemic affecting only eight square miles of forest in the United Provinces, 45,000 trees, amounting to nearly a million cubic feet of timber, were killed.

Another Indian species which is very destructive, especially to fig-trees, is *Batocera rufomaculata* Degeer. It is due to this insect that fig-growing is impossible in many areas (Husain & Khan, 1941). Considerable damage to Babul (*Acacia arabica*) by *Cleosterna scabrator* Fabricius has been experienced in past years (Beeson, 1931).

Another extremely destructive species is *Melanauster chinensis* Forster, which confines itself chiefly to orchard trees. Gressitt (1942) states that in one area in China about 90 per cent of all the *Citrus* trees were infested, and that many young trees are killed annually despite preventive measures.

In North America damage to a lesser degree is caused to fruit-trees by *Saperda* and *Parandra* species, and fig-trees are sometimes extensively attacked by *Neoptychodes trilineatus* (Linnaeus).

P. Audenarde has informed the writer that in East Africa, species of *Tragocephala* and *Phosphorus* have recently been responsible for serious damage to cacao plantations. In the case of one-year-old seedlings attack proves to be fatal, but older plants are more resistant.

According to Kalsoven (1936), *Nothopeus fasciatipennis* Waterhouse is a serious pest of clove-trees in Sumatra. Damage to standing and felled coniferous trees by species of *Monochamus* is often severe and widespread both in Europe and America. Chamberlin (1949) states that in 1908, after heavy gales in the South-eastern United States, the loss to timber owners through the depredations of *M. titillator* (Fabricius) was estimated at \$6,000,000.

In this country damage by Cerambycids to growing timber is comparatively negligible, such damage being confined chiefly to plantations of ornamental and shade trees. Even here the damage is generally superficial, for only the outer sapwood is usually affected, and as this is cut away in the process of squaring and dressing, the loss is not very serious.

The infestation of cut and seasoned timber usually occurs on a far greater scale, and the technical damage is often extremely serious. One of the few truly domestic species is *Hylotrupes bajulus* (Linnaeus), which is capable of completely destroying interior fittings, roofs and rafters of deal. During the past few decades, damage by this species has increased considerably, and many costly measures have been adopted in controlling this beetle on the Continent. For example, in 1935 over 1,000,000 marks were spent on control measures in Hamburg alone. Today this species has become established in several districts in this country, and the possibility of it spreading and causing extensive damage is by no means slight. Larvae of *Ergates* species also cause extensive damage—mainly to heartwood—and have been known to emerge long after the timber has been utilised for structural purposes.

Another species of domestic importance is *Stromatium barbatum* Fabricius, which readily oviposits on practically any kind of dry barkless wood, and is a notorious pest of plywood and wooden structures in general. Bamboo furniture is often found to be infested with larvae of *Chlorophorus annularis* (Fabricius). A species frequently

responsible for damaging oak furniture is *Eburia quadrigeminata* Say. The damage caused by this and similar species is twofold: in addition to the technical damage to the timber, there is the wasted labour to be considered, as it is usually not until the timber has been prepared and utilised that the insects appear, leaving conspicuous emergence holes.

Rustic garden work is often heavily attacked by *Callidium violaceum* (Linnaeus), and thus loses its ornamental appeal. Serious and extensive damage has been done in certain localities in the United States to telegraph poles by *Parandra brunnea* Fabricius. The poles were often so weakened that they collapsed. Considerable damage has been done in the past to wicker basketwork, particularly on the Continent, by *Leptideella brevipennis* (Mulsant) and *Gracilia minuta* (Fabricius).

Damage to crops by Cerambycids is comparatively rare. Plots of grass have been considerably damaged by larvae of *Homaesthis emarginatus* Say (Craighead, 1923b), and an unidentified Prionid has been reported causing considerable damage to corn-fields, killing the plants by eating off the roots (Craighead, 1915). Larvae of *Dorcadion* species have been known to damage fields of maize, and carrot crops have been attacked by *Phytoecia icterica* Schaller.

Even cacti, especially prickly pear, are often attacked by Cerambycids, notably of the genus *Moneilema*. As prickly pear is widely used as cattle fodder, these beetles are of decided economic importance. They are, however, to a certain extent beneficial, as they promote dissemination of the plants by gnawing off branches. Moreover, they were used effectively in the control of the prickly pear in Australia (Sweetman, 1936) as has also *Lagochirus funestus* Thomson. Orchids are not infrequently infested with larvae of *Diaxenes* and *Chreonoma* species, and owing to the relatively high commercial value of these plants, these are of no little importance.

Certain species, however, are decidedly beneficial either directly or indirectly to forestry. For example, larvae of *Rhagium*, *Arhopalus* and *Asemum* speedily break down stumps and discarded logs in coniferous plantations, thus greatly enriching the soil and clearing the ground. The appearance of certain Cerambycids such as *Tetropium gabrieli* Weise and *Prionus coriarius* (Linnaeus) in plantations is useful in that they indicate to the forester that his trees are unhealthy and are perhaps the victims of more serious foes such as fungus rot.

# GENERAL ACCOUNT OF THE BIOLOGY OF CERAMBYCIDAE

## THE DURATION OF THE EGG STAGE

LITTLE need be said regarding the incubation period of Cerambycid eggs since no great discrepancies are evident. The incubation periods of many species have been tabulated by Butovitsch (1939). To these may be added the present writer's observations, as follows: *Prionus coriarius* (Linnaeus) (30–37 days); *Rhagium mordax* (Degeer) (15 days); *Stenocorus meridianus* (Linnaeus) (14 days); *Alosterna tabacicola* (Degeer) (15 days); *Aromia moschata* (Linnaeus) (14–20 days); and *Pogonocherus hispidus* (Linnaeus) (20 days).

The average period of incubation appears to be about fourteen days, although such factors as temperature and humidity may accelerate or arrest development considerably, as has been shown by Steiner (1937) in the case of *Hylotrupes bajulus* (Linnaeus).

It is of interest to note that, according to Ritchie (1920), although the incubation period for *Saperda carcharias* (Linnaeus) is only about four weeks, the first-instar larva remains inside the egg-shell for about nine and a half months before attempting to emerge (see also p. 283).

## THE EMERGENCE OF THE LARVA

As pointed out below (p. 60), it was recently discovered that the first-instar larva of *Aromia moschata* (Linnaeus) is equipped with egg-bursting spines (fig. 184) which are clearly visible through the chorion several days before the larva is due to emerge. It was later found that, with the exception of *Prionus coriarius* (Linnaeus), egg-bursting spines were present in all the British species examined.

In the case of *Aromia moschata*, it was observed (Duffy, 1949b) that the larva, which at this stage lies extended in a horizontal position, ruptures the chorion with its dorso-lateral spines by performing backward peristaltic movements with its abdominal segments. As a result of these operations, a longitudinal jagged cut along one side of the shell is made. The first-instar larva of *Stenocorus meridianus* (Linnaeus) was also observed to adopt a similar mode of emergence: the chorion, which is extremely thin and soft, is split longitudinally for a distance of about two-thirds the length of the elongate egg by means of the abdominal spines. The abdominal segments then become distended to about one and a half times their original girth, an action which serves to widen the jagged split, thus facilitating the larva's egress. In the specimens under observation, the head was the last part to be extricated.

As regards the emergence of *Lamia textor* (Linnaeus) (which also possesses abdominal spines), Pavan (1948a) maintains that the rupturing of the chorion is facilitated by the use of the median teeth on the outer surface of the mandibles

(fig. 217) and the denticulate structure of the front margin of the frons and hypostoma (fig. 218); and that the so-called egg-bursting spines only fulfil the function of aiding the larva to gain sufficient purchase while actually emerging from the egg and excavating its gallery. This is at variance with the present writer's views, at least in so far as *Aromia moschata* and *Stenocorus meridianus* are concerned. The emergence of these species was carefully observed with the aid of a binocular dissecting microscope. Through the transparent chorion, the spines were clearly seen to be brought into action, and the chorion ruptured.<sup>1</sup> However, it is not suggested that these spines do not provide purchase for the larva during its rather helpless condition, nor that the processes on the mandibles and mouthframe do not assist in the rupturing of the egg. But it must be pointed out that these processes are apparently confined to a few Lamiinae, whereas abdominal spines are present in many, if not most, species of the family.

The first-instar larva of *Prionus coriarius*, although not possessing egg-bursting spines, has some very long, slender, slightly curved setae (fig. 40) on all segments, which appear to assist it in emerging from the egg. By convulsive peristaltic movements, the larva was seen to force itself through the oval orifice (which had been made with its mandibles), and as it emerged, the freed setae (previously recumbent) sprang to a more or less erect position, thus preventing the larva from going backwards while performing its peristaltic motions (Duffy, 1946a).

Another species which apparently relies entirely on its mandibles for rupturing the chorion is *Stromatium barbatum* Fabricius (Beeson & Bhatia, 1939). In this case the larva cuts out a conical cap (fig. 143).

Upon emergence from the shell, the first-instar larva quickly increases in girth, its gut having become distended with air, and within a few hours the head capsule becomes hardened and pigmented.

#### THE DURATION OF THE LIFE-CYCLE, LONGEVITY, AND RETARDED DEVELOPMENT

In literature there are many contradictory statements and conflicting reports concerning the duration of the life-cycle in Cerambycids. This, no doubt, may be attributed mainly to the difficulty of close and continuous observation of the larvae due to their concealed mode of life. Perris (1877) disagrees with the claims of Goureau (1844) and Ratzeburg (1838) that the average life-cycle is of at least two years' duration. He maintains that it is much shorter, and to support his contention he enumerates his own observations which may briefly be summarised as follows: *Acanthocinus aedilis* (Linnaeus) (7-11 months); *Monochamus* spp. (12 months); *Arhopalus* spp. (12 months); *Saperda scalaris* (Linnaeus) (12 months); *Ergates faber* (Linnaeus) (24 months).

In conclusion, he says, "Il faut donc reconnaître que la vie des larves de Longicornes n'est pas aussi longue que quelques-uns le pensent, et il faut admettre que, pour les petites et les moyennes, une année suffit à toutes leur évolutions et que les plus grosses ont assez de deux années. Mais il y a, je l'ai déjà dit, des exceptions, elles sont même assez nombreuses, et ce sont ces exceptions qui ont causé l'erreur que je combats."

<sup>1</sup> See also Duffy (1951).

The inaccuracy of other observers he attributes to the fact that when either adults or mature larvae have been found with very small larvae, it has been presumed that two or more generations were represented: he attributes discrepancy in size to (1) the eggs not all hatching at the same time, (2) eggs laid late in the year not hatching until the following spring, (3) oviposition occurring on wood already infested, and (4) the presence of sickly individuals.

Smith (1928), on the other hand, maintains that, in general, the average life-cycle is several years, and that species such as *Strangalia aurulenta* (Fabricius), *Leptura sanguinolenta* Linnaeus and *Arhopalus* require six or seven years in which to attain maturity. Such species as these, he asserts, undergo ecdysis only once a year and, as the head capsule is hardly larger than that of the exuviae, these larvae must necessarily require several years to become full-grown. He further states that *Prionus coriarius* (Linnaeus) requires well over twenty, if not thirty years, and this he substantiates by referring to a larva which he has kept alive for ten years and which was apparently full-grown when found.

As regards ecdysis, the present writer is unable to accept Smith's statement that it is only of annual occurrence. The following species have been reared from the egg for at least as far as their third instar, and the period between these ecdyses varied from about six weeks to nine days: *Rhagium bifasciatum* Fabricius, *R. mordax* (Degeer), *Stenocorus meridianus* (Linnaeus), *Tetropium gabrieli* Weise, *Asemum striatum* (Linnaeus), *Arhopalus ferus* (Mulsant), *Molorchus minor* (Linnaeus), *Phymatodes testaceus* (Linnaeus), *Anaglyptus mysticus* (Linnaeus), *Saperda populnea* (Linnaeus), *Phytoecia cylindrica* (Linnaeus), *Prionus coriarius* (Linnaeus) and *Aromia moschata* (Linnaeus).

Crawshay (1907) arrived at similar conclusions in the case of *Tetropium gabrieli* Weise, as shown in his chart (see p. 156).

*Phytoecia cylindrica* (Linnaeus) appears to have the shortest larval period of any known British species, pupation occurring within three months of oviposition, but there are records of certain exotic species with a life-cycle of approximately two months. That unusually high temperatures accelerate larval growth is admirably demonstrated by Crawshay (see fig. 119), and this would account for the fact that in India, for example, large species such as *Batocera* and *Macrotoma* attain maturity within a year. It is of interest to note that Stark (1926b) has observed in the case of *Saperda scalaris* (Linnaeus) and *Pyrrhidium sanguineum* (Linnaeus), that larvae of females tunnel more deeply and feed for a longer period than do those of the males.

The following data are based on the writer's field and laboratory observations for the past ten years:

| Species   | Duration of<br>Life-cycle |
|---|---------------------------|
| <i>Prionus coriarius</i> (Linnaeus) . . . . .         | 3-4 years                 |
| <i>Acmaeops collaris</i> (Linnaeus) . . . . .         | 2 "                       |
| <i>Rhagium bifasciatum</i> Fabricius . . . . .        | 2-3 "                     |
| <i>Rhagium mordax</i> (Degeer) . . . . .              | 2-3 "                     |
| <i>Stenocorus meridianus</i> (Linnaeus) . . . . .     | 2-3 "                     |
| <i>Grammoptera ruficornis</i> (Fabricius) . . . . .   | 1 year                    |
| <i>Strangalia quadrifasciata</i> (Linnaeus) . . . . . | 2-3 years                 |

| Species  | Duration of Life-cycle |
|--|------------------------|
| <i>Strangalia maculata</i> (Poda)                      | 2-3 years              |
| <i>Leptura scutellata</i> Fabricius                    | 2-3 "                  |
| <i>Judolia cerambyciformis</i> (Schrank)               | 2 "                    |
| <i>Arhopalus fesus</i> (Mulsant)                       | 3-4 "                  |
| <i>Asemum striatum</i> (Linnaeus)                      | 2-3 "                  |
| <i>Tetropium gabrieli</i> Weise                        | 0.25-1 year            |
| <i>Molorchus umbellatarum</i> (von Schreber)           | 2 years                |
| <i>Gracilia minuta</i> (Fabricius)                     | 1 year                 |
| <i>Aromia moschata</i> (Linnaeus)                      | 3-7 years              |
| <i>Hylotrupes bajulus</i> (Linnaeus)                   | 3-? "                  |
| <i>Callidium violaceum</i> (Linnaeus)                  | 2-3 "                  |
| <i>Phymatodes testaceus</i> (Linnaeus)                 | 2-3 "                  |
| <i>Poecilium alni</i> (Linnaeus)                       | 2 "                    |
| <i>Clytus arietis</i> (Linnaeus)                       | 2-3 "                  |
| <i>Anaglyptus mysticus</i> (Linnaeus)                  | 2-3 "                  |
| <i>Mesosa nebulosa</i> (Fabricius)                     | 2-3 "                  |
| <i>Pogonocherus hispidus</i> (Linnaeus)                | 1-2 "                  |
| <i>Pogonocherus hispidulus</i> (Piller & Mitterpacher) | 1-2 "                  |
| <i>Agapanthia villosoviridescens</i> (Degeer)          | 1-2 "                  |
| <i>Saperda populnea</i> (Linnaeus)                     | 2 "                    |
| <i>Saperda scalaris</i> (Linnaeus)                     | 2 "                    |
| <i>Stenostola ferrea</i> (Schrank)                     | 1-2 "                  |
| <i>Phytoecia cylindrica</i> (Linnaeus)                 | 1 year                 |

From the above data it is evident that, generally speaking, the average life-cycle under normal conditions is from two to three years' duration, and that only a few of the smaller species complete their development in a shorter time.

That larval development may be retarded, and the life-cycle greatly prolonged as a consequence, is evident from the numerous statements and records in literature. This longevity is presumably induced through abnormal conditions such as excessive desiccation of the wood caused by felling and seasoning, and appears to be confined to certain groups. Under such conditions many species die or pupate prematurely.<sup>1</sup> Our knowledge, however, of the occurrence of longevity in Cerambycid larvae may be far from complete, since available records refer almost exclusively to infested wood which has been utilised for a known period. The following table is based on various records in the literature:

| Species                             | Host         | Structure   | Minimum (in years) | Authority               |
|-------------------------------------|--------------|-------------|--------------------|-------------------------|
| <i>Ergates spiculatus</i> Leconte   | <i>Pinus</i> | Pier-prop   | 20?                | Fraser (1948g)          |
| <i>Ergates faber</i> (Linnaeus)     | <i>Pinus</i> | ?           | 12                 | Becker (1942b)          |
| <i>Prionus coriarius</i> (Linnaeus) | ?            | —           | 10                 | Smith (1928)            |
| <i>Chion cinctus</i> Drury          | <i>Pyrus</i> | Table       | 20-28              | Fitch (1856)            |
| <i>Chion cinctus</i> Drury          | ?            | Wagon spoke | 8                  | Blackman & Stage (1924) |

<sup>1</sup> Becker (1919) succeeded in rearing larvae of *Saperda candida* Fabricius in apples. He maintains that the unfavourable environment of a rotten apple resulted in a shortening of the life-cycle, thus producing an under-sized adult, and suggests that the frequent replenishment of sound apples might result in lengthening the larval period, thus producing a normal-sized adult. The present writer hopes to record his own observations on the rearing of wood-feeding larvae in fruits and vegetables in a later publication.

| <i>Species</i>                         | <i>Host</i>     | <i>Structure</i> | <i>Minimum</i><br>(in years) | <i>Authority</i>                          |
|--|-----------------|------------------|------------------------------|---|
| <i>Eburia quadrigeminata</i> Say       | <i>Quercus</i>  | Bedstead         | 20                           | Troop (1915)                              |
| <i>Eburia quadrigeminata</i> Say       | <i>Acer</i>     | Floor            | 14                           | Webster (1888)                            |
| <i>Eburia quadrigeminata</i> Say       | <i>Betula</i>   | Bookcase         | 40                           | Jaques (1918)                             |
| <i>Eburia quadrigeminata</i> Say       | <i>Fraxinus</i> | Door-sill        | 19                           | Jaques (1918)                             |
| <i>Eburia quadrigeminata</i> Say       | <i>Quercus</i>  | Bedstead         | 5                            | Arrow (1936)                              |
| <i>Eburia quadrigeminata</i> Say       | <i>Quercus</i>  | Wardrobe         | 19-20                        | Hickin (1951)                             |
| <i>Eburia quadrigeminata</i> Say       | <i>Quercus</i>  | Bedstead         | 25                           | W. T. Harrison (larva still living)       |
| <i>Hesperophanes griseus</i> Fabricius | <i>Cytisus</i>  | —                | 6                            | Lucas (1848)                              |
| <i>Hesperophanes</i> sp.               | ?               | Chair            | 10                           | Laboulbène (1853)                         |
| <i>Stromatium fulvum</i> Villiers      | ?               | Bench            | 10-13                        | Linsley (1938)                            |
| <i>Stromatium fulvum</i> Villiers      | <i>Juglans</i>  | Staircase        | 15                           | (unpublished record; larva still living). |
| <i>Stromatium barbatum</i> Fabricius   | ?               | ?                | 10                           | Beeson & Bhatia (1939)                    |
| <i>Stenopterus mauritanicus</i> Lucas  | <i>Cytisus</i>  | —                | 6                            | Lucas (1848)                              |
| <i>Romaleum rufulum</i> Haldeman       | <i>Quercus</i>  | Sideboard        | 11                           | Fraser (unpublished)                      |
| <i>Callichromine</i> sp.               | <i>Juglans</i>  | Chair            | 20                           | Scott (1923)                              |
| <i>Callidium violaceum</i> (Linnaeus)  | <i>Pinus</i>    | Hut              | 15                           | Kessler (1927)                            |
| <i>Hylotropes bajulus</i> (Linnaeus)   | <i>Pinus</i>    | Cupboard         | 17                           | Bayford (1938)                            |
| <i>Anaglyptus mysticus</i> (Linnaeus)  | <i>Fagus</i> ?  | Drawer           | 13                           | Hickin (1947b)                            |
| <i>Chlorophorus pilosus</i> Forster    | ?               | Chair            | 20                           | Romand (1846)                             |
| <i>Monochamus notatus</i> Drury        | <i>Pinus</i>    | Bureau           | 15                           | Packard (1890)                            |
| Unknown species                        | ?               | Pencil box       | 25                           | Gahan (1918)                              |
| Unknown species                        | <i>Pinus</i>    | Porch            | 45                           | Packard (1890)                            |

### SYMBIOSIS AND THE DIGESTION OF WOOD

From the work of Heitz (1927) it has been known for some time that the larvae of certain Cerambycids such as *Rhagium bifasciatum* Fabricius, and *Leptura rubra* (Linnaeus) live in symbiosis with micro-organisms of various kinds (including bacteria, yeasts, and protozoa) which occur in and around the gut. Schomann (1936), after studying the development of these symbionts, found that although larvae of PRIONINAE and LAMIINAE were free from yeast-like symbionts, larvae of ASEMINAE and certain LEPTURINAE and CERAMBYCINAE were symbiont-carriers. Buchner (1928, 1930) and others who were under the impression that insects were unable to secrete cellulase, stressed the suspected importance of these organisms in the digestion of wood, namely that of breaking down cellulose into simpler carbohydrates which were then available to the host. Later, however, Müller (1934) and Mansour & Mansour-Bek (1934a) drew attention to the lack of evidence in support of the assumption that these organisms aid the digestion of wood, and pointed out that cellulase had since been detected in larvae of species which were not symbiont-carriers.

Before reviewing the important work that has been done on larval digestion of wood, a brief enumeration of the components of wood seems desirable. The major constituents are cellulose (40-62 per cent), lignin (18-38 per cent) and hemicelluloses. The minor constituents include pentosans (6-23 per cent), hexosans (2-14 per cent), starch (0-5-9 per cent), sugar (0-6-2 per cent) and protein (1-1-2-3 per cent), as well as various tannins, resins, dyes and gums (Mansour & Mansour-Bek 1934a).

In 1905 Seillière detected an enzyme hydrolysing xylan (xylanase) in the larval alimentary canal of *Phymatodes testaceus* (Linnaeus) which appreciably reduced the pentosan content of the beech wood in which the larva fed. Later, Falck (1930) found that the larva of *Hylotrupes bajulus* (Linnaeus) removed about 21 per cent of the total cellulose and hemicellulose content of seasoned coniferous wood, and Mansour (1934) came to the conclusion that larvae of this species are only able to digest seasoned wood through their ability to secrete cellulase, a cellulose-splitting enzyme (see also pp. 210 and 212). In the case of *Chlorophorus annularis* (Fabricius), Newman (1946) found that the enzymes acted on cellulose but, unexpectedly, not on the hemicellulose. Ripper (1930) has detected the presence of a true cellulase (producing glucose from filter paper) in the mid-gut of larvae of *Cerambyx cerdo* Linnaeus, *Rhagium bifasciatum* Fabricius and *Leptura* species; and the experiments of Müller (1934) have indicated the presence of cellulase in larvae of *Oxymirus cursor* Linnaeus, *Leptura rubra* (Linnaeus) and *Gracilia minuta* (Fabricius). In the case of the first species, the enzymes hemicellulase, xylanase, amylase, invertase, maltase, emulsin, lipase, trypsin and erepsin were also detected. Larvae of *Macrotoma palmata* Fabricius and *Stromatium fulvum* Villiers have been found to possess an enzyme hydrolysing cellulose by Mansour & Mansour-Bek (1934a, 1937). The same authors (1934a) made the interesting observation that the larva of *Xystrocera globosa* Olivier was unable to secrete a cellulose-splitting enzyme, and appeared to derive its food from minor carbohydrate constituents of the sapwood.

As a result of these observations, Mansour & Mansour-Bek (1934a, 1937) recognised two fundamental groups of larvae, namely those highly-specialised species which secrete cellulase which enables them to digest the cellulose in wood, and those which do not possess cellulose-splitting enzymes but which derive the necessary carbohydrates from soluble sugars and starch through the digestive action of saccharase and maltase. Hopf (1938) has suggested the recognition of three larval groups which he based on the complexity of the wood components which were hydrolysed during digestion.

From this it appears that larvae which make only superficial galleries in the outer sapwood are unable to secrete cellulase, and feed on the simpler carbohydrates obtainable, such as soluble sugars and starch; and that larvae which penetrate the inner sapwood and heartwood (e.g. *Prionus*, *Phryneta*) are able to digest the heartwood cellulose, a process which is apparently assisted by the presence of a proventriculus for grinding the coarse fibres.

Pochon (1939) has succeeded in isolating a cellulolytic bacterium from the digestive tract of *Rhagium sycophanta* Schrank which he suggests may be responsible for the ability of the larva to digest cellulose. Parkin (1940), however, regards this as far from convincing since such bacteria are likely to occur quite normally in decaying wood. He comes to the conclusion that there is no fundamental difference between the digestive powers of species feeding in bark, cambium, or solid wood, and that the majority of larvae are capable of digesting cellulose, hemicelluloses, starch, soluble sugars, and proteins in wood.

A number of experiments have recently been undertaken in the attempt to accelerate larval growth in Cerambycids, but as these mainly concern *Hylotrupes bajulus* (Linnaeus), a summary of them is given under the heading of that species (see p. 210).

## PROTECTIVE DEVICES OF LARVAE

This heading is mainly one of convenience under which are discussed various structures and habits, which may very probably afford the larva a certain degree of protection, but for which there is so far little substantial evidence.

## Structures and Appendages

Many larvae such as *Asemum* and *Arhopalus* possess vertical urogomphi on the ninth abdominal segment, but their position is such that it is difficult to regard them as protective devices since attack would normally come from behind. That they are used as a means of anchorage is perhaps more likely. In the case of *Rhagium*, however, a strongly produced terminal spine (fig. 61) is present, and it is quite conceivable that this could be used to discourage attack. On the other hand, it must be remembered that these structures are not present until the third larval instar at the earliest, which means that the young larva is unprotected during the most vulnerable part of its existence.



Fig. 1. *Phaula* sp. Mature larva. Posterior part of abdomen showing terminal spine and sclerotised dorsum of tenth segment. Lateral aspect.

In the larva of a species of *Phaula*, the ninth abdominal segment is curiously modified, being produced into a long, thick claw-like process which is apically bifid (fig. 1). This process can apparently be directed downward by movement of the ninth segment. In the case of *Phryneta leprosa* Fabricius, the ninth segment is equipped with a very stout, curved spine (fig. 247), the base of which is concealed beneath the posterior margin: it appears to be controlled through direct muscular movement by which it can be appreciably raised. In both these larvae the dorsum of the tenth segment is strongly sclerotised, presumably to prevent injury through contact with the spine or process.

Here again any explanation of the function of these processes must for the time being be merely hypothetical. Perhaps they afford the larvae anchorage in their galleries, or serve to ward off attack by predators. In the case of *Phaula*, the process may perhaps be used as a "ram-rod" for clearing away or compressing the frass in the gallery.

#### Stridulation

The recent examination of an undescribed South American Cerambycid larva (*Trachyderes* sp.) revealed the presence of sclerotised plates behind the ampullae of the fourth, fifth, and sixth abdominal sternites (fig. 149). Usually such structures occur only on the ninth or tenth dorsum, and this appears to be the first time that such relatively extensive sclerotised areas have been observed in larvae of this family. Each sclerotised plate is slightly convex and deeply longitudinally striate. It is conceivable that this slender larva could produce vibrations by bracing itself so that the middle ventral part of its body rubs against the roughened walls of its gallery. The larva of *Phrynetia*, too, may possibly be capable of stridulation through rubbing the ventral ridge of its caudal spine across the striate dorsum of the tenth segment (fig. 247). As both these larvae are heartwood feeders it is unlikely that the sound, if any, would be audible to the human ear, but this does not preclude the possibility of such behaviour discouraging parasites and predators.

#### Secretion

Larvae of many species of Cerambycini possess the ability to secrete calcium carbonate from the Malpighian tubules in the form of a milky suspension of amorphous granules. According to Mayet (1896), calcium is present in four of the six Malpighian tubules of *Cerambyx*, but in *Hoplocerambyx* and *Xystrocera* only two of the tubules secrete calcium carbonate (Beeson, 1919; Mansour & Mansour-Bek, 1934b). At a time several weeks before pupation, the larva starts to regurgitate through the mouth most of the calcium secreted during larval development together with a variable proportion of gum-like matter. During this period the calcium carbonate present in the gut is readily visible through the integument. As a result of this performance the larva becomes reduced to at least two-thirds of its original length and bulk. It also loses its former transparency and becomes opaque and yellowish. The secreted calcium carbonate is moulded by the larva into a cocoon or an operculum; in the latter, the design is constant and often characteristic of the genus or species. The protection possibly afforded by these deposits is discussed on p. 45.

Secretions of a different nature have also been observed by the writer in *Prionus coriarius* (Linnaeus) (1946a) and *Aromia moschata* (Linnaeus) (1949a). In the process of extracting a mature larva of *P. coriarius* from its burrow it was seen to eject forcibly, from between its mandibles, a stream of dark brown fluid to a distance of a few inches; this happened on two occasions. In the case of *A. moschata*, molestation caused the larva to extrude from between its mandibles a yellowish grey, viscous globule which a litmus test proved to be acid. Anal excretion has been observed by Fraser (1949c) in the larva of *Plocaederus*, which when molested ejects a comparatively large quantity of dark brown fluid, which is acid in nature.

### Defensive behaviour

Curious behaviour is exhibited by the larva of *Arhopalus ferus* (Mulsant) according to Smith (1905). He observed that near the exit hole of the pupal cell there was a short offshoot into which the larva pushed one of its discarded skins and carefully covered the entrance to it with wood dust, a procedure, he maintains, which places out of reach an object which would encourage the growth of fungi. The present writer is unable to confirm this behaviour.

### LARVAL RESISTANCE TO INJURY, DROWNING, AND FROST

It has been the writer's experience that Cerambycid larvae are extremely delicate and susceptible to bruising and other forms of injury. Even such relatively sturdy larvae as those of *Prionus*, if in any way bruised or injured, invariably died within a few days. Horton (1917), however, has shown experimentally that larvae of *Neoptychodes trilineatus* (Linnaeus) are unusually resistant to mechanical injuries such as knife wounds, and that specimens cut so severely as to cause the loss of a considerable quantity of body fluid, often recovered and attained maturity. In one instance a larva, which was cut almost in two, recovered and pupated at the normal time. In another larva which was chewed almost in two, the abdominal cavity became closed by a transparent membrane, and death did not occur until a month later.

As the type of habitat so often adopted by *Aromia* larvae (i.e. sallows partly submerged in swampy areas) suggested that they might to a certain extent be resistant to drowning (1949a), the writer decided to experiment with the root-feeding larvae of *Prionus coriarius* (Linnaeus). That the latter were extraordinarily resistant to such conditions was demonstrated by the following experiment. A mature larva was immersed in water at 16°C. (60.8°F.), and after a lapse of 2 hours it had ceased to move (except when prodded) and had become extremely flaccid; but when, after immersion for 168 hours, it was transferred to dry filter paper, it completely recovered within 15 minutes. Upon repeating the experiment with another larva, the revival period was reduced to almost one-third merely by immersing the larva in warm water (40°C. [104°F.]), which suggested that the flaccidity was due to the low temperature rather than to the water itself (Duffy, 1946a).

Apparently even immersion in salt water may not necessarily cause premature death, for, according to Bartlett (1918), some pit-props which had been floating in the sea and which were later washed up on shore, proved to be infested with living larvae and pupae of *Acanthocinus aedilis* (Linnaeus). Fraser (1948g) describes what appears to be a case of exceptional resistance to sea water: a larva of *Ergates spiculatus* Fabricius had apparently been feeding for a period of twenty years in a pier-prop which was regularly submerged at high tide.

Fraser (1948e) comments on the resistance of West African *Cordylomera* larvae to freezing conditions in this country during winter. Although these larvae had become limp and inert, they became fully active within 10 minutes after being placed near the fireside. That *Prionus* larvae are remarkably resistant to frost has recently been demonstrated by the writer (1946a). A larva was placed in a refrigerator and subjected to a temperature —6°C. (21.2°F.) for 12 hours, and when removed it remained frozen

solid for nearly an hour; it was then placed in an incubator at 40° C. (104° F.), where it recovered about 2 hours later. This resistance to drowning and frost indicates that some Cerambycid larvae are able to withstand severe weather conditions.

### LARVAL RESISTANCE TO POISONOUS PLANTS

According to Miller (1934) there are several species of Cerambycidae which have been found feeding in derris roots (*Derris robusta*), which are not only of poor nutritional value, but which contain a toxic substance (rotenone), and when used as an insecticide proves fatal to most insects. These species include *Perissus laetus* Lameere and *Pterolophia melanura* Pascoe. According to Brues (1946) rotenone is actually digested by the larvae, which is proved by the absence of any insecticidal properties in extracts made from their excreta.

The plant from which pyrethrum is extracted is attacked by *Phytoecia virgula* Charpentier, but apparently larvae are to be found only in stems of plants growing in impoverished soil where they do not contain the poison characteristic of healthy plants (Brues, 1946).

Blanchard (1945) reports damage to leaves of tobacco plants by adults of *Alcidion bicristatus* Bates, although it is not clear whether these plants are ever infested by larvae.

The writer (1946c) has on more than one occasion found both larvae and pupae of *Rhagium bifasciatum* Fabricius and *Strangalia maculata* (Poda) in living stems of laurel. (For species infesting *Rhus*, see Steyskal (1951) and Howden (1951).)

### PROTHETELY

Throughout the numerous breeding experiments undertaken by the writer during the past ten years only one case of prothetely was observed, namely in a larva of *Aromia moschata* (Linnaeus). This larva was found immersed in water; it had evidently fallen out of its pupal cell the previous night. When first retrieved it was extremely flaccid and inert but soon recovered its normal turgidity; it was then that its strange condition was noticed.

In prothetelic specimens the last larval instar shows certain transitions towards the pupal stage, particularly in the evagination of wing buds. In this specimen these were exceptionally well developed (fig. 3). Another conspicuous characteristic of this abnormality was the enlargement and peculiar structure of the antennae (fig. 2); these were at least twice as long as those of a normal specimen and gave the larva a quaint "ram"-like appearance. The number of segments was greatly increased and the penultimate segment bore a protuberance closely resembling the apical segment. The

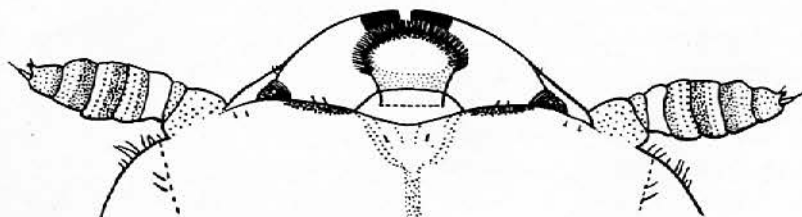


Fig. 2. *Aromia moschata* (Linnaeus). Prothetelic larva. Anterior part of head showing enlarged antennae. Dorsal aspect. (Duffy, 1949)

thoracic legs, which were of the pupal type, were twisted and swollen, those of the metathorax being more than three times the normal length. Ventrally, on the tenth segment, there were rudimentary sexual organs in the form of a pigmented, disc-shaped lobe. In the pupal stage this specimen proved to be even more deformed,

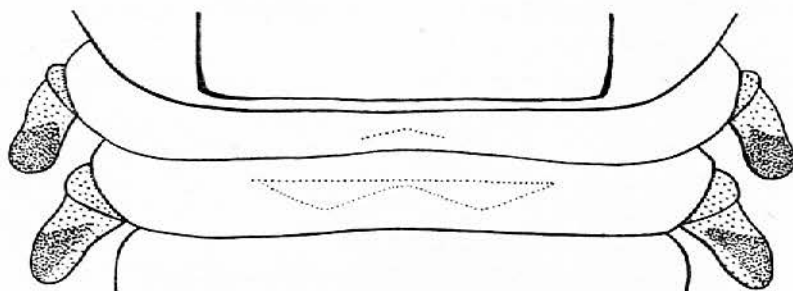


Fig. 3. *Aromia moschata* Linnaeus. Prothetelic larva. Meso- and metathoracic segments showing wing buds. Dorsal aspect. (Duffy, 1949)

the abdomen being strongly curved and the head twisted to one side. Though normal in size, the elytra were crumpled and the apices of the antennae and tarsi twisted and stunted. The pupa lived only a few days (Duffy, 1949a). (See also Becker (1950).)

#### CERAMBYCID LARVAE AS HUMAN FOOD

This is not an attempt on the part of the writer to promote the popularity of entomophagy but merely to present concisely the scattered records of the consumption of Cerambycid larvae.

*Stenodontes damicornis* Linnaeus. West Indies. Negroes carefully broil the larvae over a charcoal fire (Bequaert, 1921). Eaten in Surinam, West Indies, and America by both black and white people (Hope, 1842).

*Prionoplus reticularis* White. New Zealand. Known to the Maoris as the "Huhu" and eaten by them (Hudson, 1934).

*Mallodon downesi* Hope. West Africa. Natives eat the young larvae after roasting them on twigs (Distant, 1904).

*Agrianome fairmairei* Montrouzier. Queensland. Devoured in all stages (Distant, 1904).

*Hovotoma cinnamomea* Olivier. Madagascar. Cooked with rice (Distant, 1904).

*Bardistus cibarius* Newman. Australia. Eaten by aborigines and white people (Tillyard, 1926).

*Dorysthenes (Opisognathus) forficulatus* Fabricius. Morocco. Known to the natives as "Korta Hlima" and eaten by them (Villiers, 1946).

*Macrotoma edulis* Karsh. St. Thomé. Sold in the markets and eaten by natives (Karsh, 1887).

*Ergates faber* Linnaeus. Europe (Netolitzky, 1920).

*Cerambyx cerdo* Linnaeus. Europe (Netolitzky, 1920).

*Olithrius insularis* Fairmaire. Samoa (Netolitzky, 1920).

*Cnemoplites edulis* Newman. Australia (Netolitzky, 1920).

*Lamia textor* (Linnaeus). Europe (Netolitzky, 1920).

*Morimus* spp. Europe (Netolitzky, 1920).

*Ancylonotus tribulus* Fabricius. West Africa (Netolitzky, 1920).

*Batocera rubus* Linnaeus. Java (Netolitzky, 1920).

*Macrodontia cervicornis* Fabricius. Brazil (Netolitzky, 1920; Hope, 1842).

*Petrognatha gigas* Fabricius. West Africa (Netolitzky, 1920; Hope, 1842).

*Acanthophorus serraticornis* Olivier. India (Planet, 1889).

*Apriona germari* Hope. China. Known as "con sâu dâu", and eaten by peasants who extract them from trees with wires or barbs. Also used medicinally for children's maladies and for small-pox (Nguyễn-Cong-Tiêu, 1928).

*Eurynassa australis* Boisduval. Australia. According to Lumholtz (1889), the aborigines hack out these larvae from tree-trunks, and sometimes eat them alive. Usually they are placed on red-hot ashes where they at once become brown and crisp—"the fat fairly bubbled in them while they were being thus prepared". After being turned over once or twice they are ready for eating. "If a larva is broken in two", he continues, "it will be found to consist of a yellow and tolerably compact mass rather like an omelette. In taste it resembles an egg, but it seemed to me that the best kind (i.e. *Eurynassa*), which has the flavour of nuts, tasted even better than a European omelette. The natives always consumed the entire larva, while I usually bit off the head and threw aside the skin but my men always consumed my leavings with great gusto. They also ate the beetles as greedily as the larvae, simply removing the hard wings before roasting them."

*Prionus coriarius* (Linnaeus). Europe. An interesting account of the edibility of this species is given by Planet (1889). To prepare a larva for consumption, he says, "salez-la, faites-la mariner un peu, dans du vinaigre, pour rendre la peau moins dure, faites revenir dans du beurre et . . . bon appétit". As a precaution he advises that the larva's head first be removed lest it should cause "un sommeil exotique"!

Cerambycid larvae are also used for other purposes. For example, those of *Phryneta spinator* Fabricius are used as bait by West African fishermen (Distant, 1904). Even in this country many a larva has undoubtedly been impaled on the angler's hook, especially those of *Aromia* which are so often readily available at the water's edge. In China, twigs of mulberry infested with larvae of *Ceresium sinicum* White are sold as food for cage birds (Kojima, 1931).

## PUPATION

When a larva has become fully grown and has prepared its pupal chamber, it ceases to feed and remains quiescent often for several weeks. During this period of rest it becomes somewhat contracted, causing the intersegmental skin to wrinkle and the ampullae to lose their characteristic form. The head is gradually inclined downward, and the thoracic segments become swollen owing to the appendages beneath having become everted from their sacs. The insect at this period is usually known as a "pre-pupa" and the period as the "pre-pupal" instar. This is not, however, a true instar, and Hinton (1946c, 1948c) has proposed the term "pharate" to designate the phase of an instar which is enclosed within the cuticle of the previous instar. Hence the insect in this condition should be referred to as a pharate pupa.

Ecdysis ultimately takes place, and the old larval skin is cast off to reveal the pupa. The pupal period lasts on an average three to four weeks, although for certain species periods of up to six weeks have been recorded. Bugnion's statement (1937) that *Cerambyx cerdo* Linnaeus remains in the pupal stage for six months is obviously erroneous, and probably refers to the pharate adult.

#### THE RELATION OF CUTICULAR STRUCTURES TO THE RESTING POSITION OF PUPAE

Cerambycid larvae have been observed to adopt any one of three positions prior to pupation. They may be vertical with the head directed either upward or downward, or may be horizontal.

Most species so far investigated, both in the field and under laboratory conditions, pupated head upward. Comparatively few species have been observed normally to pupate either head upward or downward indiscriminately. The spines or setae on at least the first six abdominal tergites of all these pupae were inclined posteriorly.

Only a few species are known that invariably pupate head downward. *Aromia moschata* (Linnaeus) is apparently the only British species known to do so (Duffy, 1949a). Many pupae of this species have been observed in the field in various localities, and not a single exception to the rule was found. Several writers have since verified this observation. In *Aromia* pupae, the spines on the abdominal tergites are exceptional in that they are directed forward (fig. 187). A likely explanation of this would seem to be that the spines would offer little or no anchorage for the pupa if they were directed posteriorly; moreover, the forward-projecting spines are probably of some assistance to the imago in extricating itself from the pupal skin.

Another species known always to adopt a similar position is the Japanese *Cagosima sanguinolenta* Thomson (Kojima, 1929), but unfortunately this author makes no reference to the direction of the pupal spines.

Species which normally pupate horizontally do so, apparently without exception, on their backs in earthen cocoons. The known pupae of such species are always devoid of stout spines, and only occasionally bear fine setae (fig. 42). The absence of spines in these pupae may be attributed to the fact that anchorage is not required in such a position, rather than that they have been dispensed with because the earthen cocoon affords ample protection.

The only British species so far known to pupate in this manner are *Prionus coriarius* (Linnaeus), *Judolia cerambyciformis* (Schrank) and *Acmaeops collaris* (Linnaeus). According to Craighead (1915, 1923b) all known species of the genera *Prionus*, *Gaurotes* and *Pachyta* pupate horizontally in the soil, and the pupae are entirely devoid of spines.

#### THE PROBABLE FUNCTION OF PUPAL SPINES AND PROCESSES

From the foregoing observations it seems likely that the primary function of the pupal spines and setae on the abdominal tergites is to anchor the pupa, and, with few exceptions, the protection provided by them against predators and possible parasites

must be meagre and probably coincidental, since it is usually only the two extremities of the pupa that are readily accessible. Spines are, however, protective in so far as they prevent the delicate pupal integument from becoming bruised by contact with the comparatively rough walls of the cell.

In the case of *Agapanthia* the spines are highly specialised (figs. 269, 270), and not only provide anchorage for the pupa but also enable it to ascend and descend its vertical gallery with comparative speed. It is curious that this pupa should lead so active an existence when the vast majority of pupae are almost quiescent: a likely explanation for this behaviour would seem to be that it is in order to escape from unsuitable conditions (such as waterlogged roots or moulds) or from predators. The latter is perhaps the more likely (especially as movement is fast), for many of the dead stems examined have been occupied by centipedes, earwigs and other predacious arthropods. Other pupae are, of course, comparatively safe from such invasion, their thick solid cells and wads of frass providing adequate protection.

The chief function of the well-developed pupal urogomphi seems to be that of protecting the posterior part of the body (which bears all the weight) from bruising, since apparently they are present only in pupae the larvae of which pupate head upward. The fact that they are absent in all species of PRIONINAE and LEPTURINAE known to pupate horizontally, supports this view. It has been noticed that urogomphi are never present if the posterior abdominal tergites are equipped with stout, anteriorly directed spines. These processes obviously do not assist in providing anchorage, since even in the outwardly curved kind they are not long enough to come in contact with the walls of the cell. Perris (1877) contends that their function is to enable the pupa to turn at will. They can scarcely be of any great protective value against predators as the majority of pupae face the aperture of the cell through which invasion would normally come.

The most likely protective devices of Cerambycid pupae are the abdominal processes (fig. 47) present in certain PRIONINAE which have recently been termed "gin-traps" by Hinton (1946a), who was the first to suggest their significance.

## PUPAL MOVEMENTS

As already pointed out, pupae of *Agapanthia* are capable of ascending and descending their pupal gallery with ease and speed. These movements are fully as complicated and interesting as in the larvae. In mounting the stem, the stout bifurcated structure on the strongly protuberant seventh abdominal tergite (fig. 271) is firmly pressed against the wall of the stem; the body is then arched ventrally, and the curved spines on the first six tergites are brought forward and fixed in the wall. The process on the seventh tergite is then quickly disengaged by the spines on the ninth tergite through the pupa arching its body in the opposite direction, and pressing these spines against the wall, and with the curved spines on the first six tergites (fig. 269) acting as levers, the pupa is propelled up the stem; by executing these movements quickly it is able to move with comparative speed. The pupa can descend with even greater ease, for by releasing the process on the seventh tergite and the hooked spines alternately, it is lowered by gravity. When placed in a horizontal

position the pupa is able to progress forward only in slow jerky movements, and if removed from the stem and placed on a flat surface, it wriggles ineffectively in all directions. Pupae of the North American species *Hippopsis lemniscata* Fabricius and *Spalacopsis stolata* Newman, probably perform similar movements.

A strange observation concerning the pupal movements of *Tetropium gabrieli* Weise is that by Crawshay (1907) who states: "Immediately on the head and thorax being freed from the larval skin, the antennae curl forward somewhat after the fashion of a ram's horns, though not so much curled. When they are fully grown the pupa revolves first in one direction, and, with the help of the sides of the cell, rubs one antenna into its place behind the projecting femora; then, revolving in the other direction, similarly arranges the other and rests." The present writer cannot confirm this observation, although all pupae of ASEMINAE undoubtedly engage in gyratory movements (the abdomen describing an ellipse) first in one direction and then in the other. On the other hand, pupae of *Pogonocherus* and *Leiopus* appear to be incapable of any marked movement. Most pupae, however, appear to react to very slight vibrations.

Although some pupae such as those of *Aseum* and *Rhagium* are armed with long pointed spines, no instances have been observed of their propelling themselves right to the surface of the wood in the manner of certain lepidopterous pupae which are similarly armed, although, if their cell be slightly inclined, they will attempt to propel themselves upward.

*Agapanthia* and *Phytoecia* pupae often produce a rattling noise (especially when disturbed) by rubbing the spinose body against the dry parchment-like walls of the dead stems. Many other pupae, especially those of the ASEMINAE and LEPTURINAE, may be detected by the scratching noise produced when they wriggle, particularly when the wood is dry. No instances of stridulation have so far been observed.

### ECLOSION

A few days before the eclosion of the imago, the pupal cuticle becomes loosened from the epidermis of the imago. Although still covered with the pupal cuticle, the insect has now attained the imaginal stage, and is a pharate adult (Hinton, 1946c, 1948c). The eyes are always the first part of the pharate adult to become pigmented. By the time they have become completely black, other parts have become pigmented, usually in the following sequence: mandibles, apices of femora, bases of tibiae, claws, thorax, elytra, pygidium, and head. Sometimes in strongly marked species the pattern of the elytra and thorax can be seen before eclosion.

The process of eclosion varies considerably in duration but usually takes at least an hour. By convulsive movements of its appendages and body the imago eventually succeeds in rupturing the pupal cuticle. The first rupture occurs at the front of the head, and gradually extends longitudinally along the thorax, the head being freed almost immediately. This is accompanied by similar tears in the cuticle in the region of the tarsi. At the same time the elytra begin to expand and assume a dorsal position. In the process of being pushed back over the body, the pupal cuticle often constricts the thoracic appendages, and the adult is forced to free them by tearing at the skin with its mandibles.

Eventually the skin is cleared from the pygidium with the aid of the hind legs. The hind wings are expanded, and when they have become hardened they are folded beneath the elytra. Within about twenty-four hours the adult has usually become fully pigmented, although the sclerites often take considerably longer to harden completely. A period of at least a week elapses before the adult starts to gnaw its way out of the pupal cell or cocoon.

### OVERWINTERING

Strictly speaking, Cerambycids do not hibernate. Species which pupate and eclose in the late summer or autumn (e.g. *Rhagium*, *Cerambyx*, *Pogonocherus*, *Mesosa*, *Phytoecia*) usually remain in their pupal cells until the following spring before emerging. This cannot be regarded as true hibernation but rather as overwintering. Should adults emerge prematurely in autumn owing to exceptionally warm weather (as sometimes happens in the case of *Pogonocherus*), they are apparently incapable of surviving the winter; presumably because they have already experienced an active existence, and also because they lose the shelter and protection of a pupal cell.

Species which overwinter appear to be provided with an unusually large supply of fat-body. This is particularly noticeable in the distended abdomens of *Rhagium* species.

### LENGTH OF ADULT LIFE

The duration of adult existence in the Cerambycidae appears to vary from a few weeks to several months. In literature there are numerous references to the adult life-span of various species, many of which have already been listed by Butovitsch (1939). The majority of these, however, are probably far from reliable as they mostly concern adults which have been kept in captivity, owing to the obvious difficulty of keeping individuals under prolonged observation in their natural environment. Furthermore, most records evidently refer only to the active period of adult existence, and it should be remembered that many of the Palaearctic species referred to pass a considerable time resting in their pupal chambers.

An approximate estimate of the adult life-span can be made, providing it is known at what time of the year pupation normally occurs. For example, species of *Rhagium*, *Cerambyx*, *Pogonocherus*, *Mesosa*, *Phytoecia* and many other genera pupate in the late summer: adults eclose during the autumn, and overwinter in their pupal chambers until the following spring, when they emerge. In such cases the life-span must necessarily be at least seven months. On the other hand, species which pupate in the spring emerge soon after eclosion and seldom live for more than a month or six weeks. Males usually eclose and emerge before females, and their life-span is often several days shorter.

### FLIGHT

As would be expected, the flight of most Cerambycids is comparatively slow, deliberate and heavy, though by no means ungraceful. Large species such as *Aromia moschata* (Linnaeus) and *Stenocorus meridianus* (Linnaeus) wheeling in the sunlight,

with their bodies tilted, and their antennae gracefully extended, make an impressive sight. Some of the smaller species, however, such as *Gracilia minuta* (Fabricius) make only short spasmodic flights. *Judolia cerambyciformis* (Schrank) has the curious habit of hovering up and down over flowers after the manner of a Hymenopteron, whereas females of *Ulochaetes leoninus* Leconte, which fly like a *Bombus*, carry the ovipositor over the back (Hardy & Preece, 1926).

In this country the majority of Cerambycids are diurnal, many flying readily only in brilliant sunshine (e.g. *Aromia moschata* (Linnaeus), *Callidium violaceum* (Linnaeus) and *Leptura* species), but in the tropics a large percentage of species are essentially crepuscular or nocturnal, particularly those of the PRIONINAE and LAMIINAE. The eyes of nocturnal species are noticeably larger or possess a greater number of facets than those of diurnal species. There are only a few British species which are known to fly at night; these include *Prionus coriarius* (Linnaeus), *Asemum striatum* (Linnaeus) and *Arhopalus ferus* (Mulsant).

As regards the first species, adults (particularly males) sometimes indulge in large-scale flights which appear to take place on warm, sultry, or even wet evenings during the peak period of emergence. E. W. Classey informs the writer that on one occasion he saw thirty to forty adults flying between dusk and midnight. In early publications are to be found vivid descriptions of enormous swarms of these beetles which "obscure the twilight sky". Although chiefly crepuscular, this species has been seen on the wing in the early hours of the morning (Duffy, 1946a).

Many nocturnal species appear to be readily attracted to artificial light, and in this country, adults of *Prionus coriarius*, *Asemum striatum* and *Arhopalus ferus* have been observed at light-traps and to enter lighted rooms.

### STRIDULATION

The usual type of stridulating organ consists of a strongly sclerotised striate plate occupying the median area of the produced mesonotum, which is set in vibration when scraped by one or more sharp ridges on the posterior margin of the pronotum, whenever the latter is raised or lowered. There are thus two interacting parts, the *pars stridens* (a striated plate) and a *plectrum* (or file).

The transverse ridges or striae of the *pars stridens* are, as a rule, extremely fine (except in large species such as *Batocera*), regularly separated, and not sexually dimorphic; but according to Gahan (1900) in the Madagascan genera *Ranova*, *Leucographis* and *Lasiocerus*, the striae are coarser in the male, and in both sexes become gradually more widely separated anteriorly. Very often the *pars stridens* is bisected longitudinally by a smooth channel, although in the LAMIINAE it is apparently always undivided. The interspecific variation in the LEPTURINAE has been carefully investigated by Kaszab (1938).

According to Sharp (1918) species of *Plagithmysus* not only stridulate in the above manner (the *pars stridens* being exceptionally well developed), but also by rubbing the hind femora against the elytra, the former bearing more or less distinct tubercles. Moreover, in a few species of this genus there are highly developed striate areas on the mid and hind coxae.

In a recent work by Paulian (1943) the author states: "Chez les Cérambycides adultes, la stridulation se fait par friction des fémurs postérieurs contre le bord postérieur du pronotum." Such a contortionist feat is, of course, impossible.

Dudich (1920, 1921) has suggested suitable terminology for the different types of stridulation in Coleoptera, four of which are applicable to the Cerambycidae. These are:

- Org. strid. mesoscuto-pronotale (the majority of species).
- „ „ mesocoxa-sternale (*Plagithmysus*, pars).
- „ „ metafemore-elytrale (*Plagithmysus*, pars).
- „ „ elytro-metatibiale (*Prionus*, *Ctenoscelis*).

As regards the last type, Marcu (1930, 1932b) has pointed out that it should have been designated "Org. strid. elytro-metapemorale", since in the genera *Prionus* and *Ctenoscelis* the plectrum is situated on the femur, not the tibia.

The act of stridulation is accompanied by the emission of a rasping or squeaking noise, which in some species is audible at a distance of several yards. The function of stridulation has long been debated, but so far as the Cerambycidae are concerned the present writer has never heard any adult stridulate except when it has either been molested, or about to engage in or to cease copulation. As the latter usually involves a certain amount of active resistance or compulsion, it appears that stridulation occurs only as a result of tactile interference by another animal.

### SCENT EMISSION

The faculty of scent emission is apparently common to all Callichromine species, including those of *Callichroma*, *Aromia*, *Pachyteria*, *Litopus*, *Promeces* and *Polyzonus*. In this country there is only one sweet-scented species, namely *Aromia moschata* (Linnaeus), although adults of *Agapanthia villosoviridescens* (Degeer) emit a powerful, but much less agreeable scent which resembles the smell of snuffed candles.

The earliest reference to scent emission by *A. moschata* appears to be that in a letter of John Ray's (1671) in which he says: "I can at present call to mind but two sorts of Insects that I have seen, which smell of Musk. The *one* is like the common *Capricornus* or *Goat-chaffer*, which is mention'd by all Naturalists that write of Insects, and which smells so strong of that perfume, that you may scent it a good distance as it flies by, or sits near you—". Another allusion to the scent of this insect is that by Planet (1890) which runs thus:

"Il embaume, dit un naturaliste connu, tous  
les alentours des saules qu'il habite,  
et ses émanations le trahissent fatalement  
au collectionneur qui le poursuit."

Whether the scent emitted by *A. moschata* is really like that of musk cannot, of course, be decided as that scent has long been lost in this country; but to the writer it seems to bear a strong resemblance to attar of roses, and although rather penetrating it is nevertheless very pleasant. Although the above quotations are undoubtedly rather colourful and exaggerated, it has been the writer's experience that the presence of this

insect may be detected merely by the scented air surrounding it; in fact, at the height of emergence of a large colony, the air was so heavily scented that it became almost overpowering. Neither is there any doubt that the scent may be detected several yards away from the colony.

The healthy beetle appears to be in full control of this faculty, and can emit or retain its scent at will; but when dying it is unable to retain it. This was shown by a belated specimen (taken in September) in which the scent was exceptionally powerful; this specimen was severely injured and dying. Specimens killed and mounted for the cabinet soon lose their agreeable perfume, but it was noticed that in

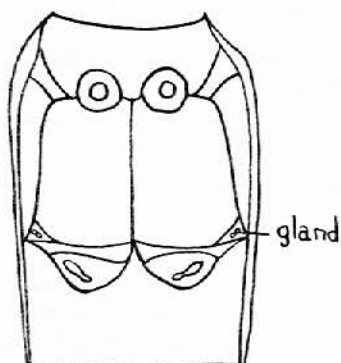


Fig. 4. *Aromia moschata* (Linnaeus). Adult. Metasternum, showing scent glands. (Smirnov, 1911)

specimens subjected to a humid atmosphere the perfume was partially restored. The injection of glycerin also had this effect.

Willoughby Ellis (1926) states: "... A large number of both sexes of *A. moschata* L. were present on old willows, many pairs being *in cop*. Around these paired beetles several species of Diptera had gathered and become torpid and stupefied to such a degree that they could be caught easily with the hand, making no effort to escape. These torpid flies were only to be found around the paired beetles and did not occur near single beetles of either sex." No other reports of insects being stupefied by *Aromia* could be found in literature, and no stupefied insects have been seen by the writer.

The nature and location of the scent organs in *A. moschata* were originally described by Schiödte (1863). He states that on the metasternum are a pair of small, narrow, spout-shaped slits, which are the apertures of the scent glands. The latter are large, flat and bilobate, and contain clusters of glandular cells, the ducts from all the cells of each cluster being collected in a bundle. These glands have been more carefully investigated by Smirnov (1911), who points out that the apertures are placed near the base of the coxae (fig. 4). According to Hollande (1909), the secretion contains a salicylic ester.

D. J. Atkinson has recently found that the prosternum of certain species of Calli-chromini (including *A. moschata*), bears two oval poriferous areas, which he suspects as being connected with scent emission. According to G. Arnold (Rhodesia), adults of *Xystrocera nyassae* Gahan possess a fetid stench.

## ADULT FEEDING HABITS

Our knowledge of the feeding habits of the adult Cerambycidae is far from complete, and the extent to which feeding is necessary either for survival or for the attainment of sexual maturity is a problem yet to be solved by the observation of individuals, not only in captivity but in their natural environment. This aspect of the adult biology was recently discussed by Trägårdh (1930), and comprehensively reviewed by Butovitsch (1939). The latter author has provisionally divided the adult feeding habits into the following groups:

- |                                  |                    |
|----------------------------------|--------------------|
| 1. Blossom feeders.              | 5. Sap feeders.    |
| 2. Bark and stem feeders.        | 6. Fruit feeders.  |
| 3. Leaf feeders.                 | 7. Root feeders.   |
| 4. Pine needle and cone feeders. | 8. Fungus feeders. |

## 1. Blossom Feeders

All the British and apparently most of the North American LEPTURINAE are known to frequent or assemble on flower-heads where feeding, and often copulation, take place. The writer has found that a diet of pollen or sweetened water is essential when breeding many Lepturids, especially such species as *Acmaeops collaris* (Linnaeus), *Judolia cerambyciformis* (Schrank), *Alosterna tabacicola* (Degeer), *Strangalia melamura* (Linnaeus) and *Leptura livida* Fabricius. Conflicting views, however, have been expressed in the past as to whether adults of *Rhagium mordax* (Degeer) and *R. bifasciatum* Fabricius frequent flowers or not. In areas where these two species have been particularly abundant, the writer has only very rarely noticed them on blossom, which suggests that it is by no means necessary. Moreover, many adults have been reared in captivity and have oviposited successfully without the provision of flowers. Another Lepturid which is not a regular visitor to blossom is *Stenocorus meridianus* (Linnaeus). Adults of this species in captivity were not attracted to the wide variety of blossom provided, although they readily sipped at sweetened water sprayed on the bark. Heintze (1925) has observed a similar indifference to blossom in the case of *Leptura rubra* (Linnaeus). This author has discussed the structural adaptation of the head and prothorax of the LEPTURINAE to the pollen-feeding habit. Butovitsch (loc. cit.) includes in this category various species of CERAMBYCINAE and LAMIINAE, including the following British species: *Molorchus minor* (Linnaeus), *M. umbellatarum* (von Schreber), *Obrium cantharinum* (Linnaeus), *O. brunneum* (Fabricius), *Gracilia minuta* (Fabricius), *Cerambyx scopoli* Füssly, *Poecilium alni* (Linnaeus), *Aromia moschata* (Linnaeus), *Clytus arietis* (Linnaeus), *Anaglyptus mysticus* (Linnaeus), *Tetrops praeusta* (Linnaeus) and *Phytoecia cylindrica* (Linnaeus). He also includes *Callidium violaceum* (Linnaeus), *Saperda scalaris* (Linnaeus) and *Stenostola ferrea* (Schrank), which is at variance with the present writer's experience with these species.

Dusham (1921) has observed that in order to breed *Cyllene caryae* Gahan, a diet of pollen is absolutely essential. *Aromia moschata* (Linnaeus) is sometimes readily attracted to flowers (Duffy, 1949a), but there is no evidence that it is a true pollen-feeder, and oviposition is possible without access to flowers.

## 2. Bark and Stem Feeders

This habit is confined almost exclusively to the LAMIINAE. Some species feed only on bark while others may feed also or only on stems, twigs and even buds. The following British and imported species have been recorded by Butovitsch (loc. cit.) as being true bark feeders: *Lamia textor* (Linnaeus), *Monochamus sutor* (Linnaeus), *M. galloprovincialis* (Olivier), *M. rosenmülleri* (Cederhjelms), *M. scutellatus* Say, *M. notatus* Drury, *Neoptychodes trilineatus* (Linnaeus), *Saperda carcharias* (Linnaeus), *S. populnea* (Linnaeus) and *Phryneta leprosa* Fabricius. To these may be added *Oberea oculata* (Linnaeus), *Saperda scalaris* (Linnaeus), *Acanthocinus aedilis* (Linnaeus) and *Niphona hookeri* Gahan. Species which feed extensively on stems, although often on leaves, include *Moneilema* spp., *Agapanthia villosoviridescens* (Degeer) and *Phytoecia cylindrica* (Linnaeus).

## 3. Leaf Feeders

The following indigenous or imported species are known to feed on leaves: *Lamia textor* (Linnaeus), *Neoptychodes trilineatus* (Linnaeus), *Saperda carcharias* (Linnaeus), *S. populnea* (Linnaeus), *S. scalaris* (Linnaeus), *S. candida* Brooks, *Oberea oculata* (Linnaeus), and *Batocera* spp. (Butovitsch, loc. cit.).

The writer has seen foliage extensively damaged by adults of *Agapanthia villosoviridescens* (Degeer), *Stenostola ferrea* (Schrank), *Phytoecia cylindrica* (Linnaeus) and *Chreonomia* sp. *Diaxenes dendrobii* Gahan has been recorded feeding on both leaves and flowers of orchids. In the case of *Saperda carcharias* (Linnaeus) the bites are usually made well away from the edge of the leaf (fig. 276), and are enlarged into holes of various shapes with serrated edges; sometimes the leaf veins and leaf stems are also attacked. The characteristic damage to leaves by *Saperda scalaris* (Linnaeus) is shown in fig. 278.

## 4. Pine Needle and Cone Feeders

This habit is almost exclusively characteristic of the genus *Monochamus*. According to Craighead (1923b), adults of *M. titillator* (Fabricius) feed extensively on pine needles, as do also the European *M. sutor* (Linnaeus) and *M. rosenmülleri* (Cederhjelms). *M. sartor* (Fabricius) and *M. galloprovincialis* (Olivier), however, have also been reported to feed on green cones as well as needles (Gusseff, 1932).

## 5 & 6. Sap Feeders and Fruit Feeders

These two categories are here dealt with together, since little or no discrimination is shown between either form of nourishment. Species which are the most readily attracted to fruit appear to be those of the genus *Cerambyx*, which often invade orchards in the south of France. They apparently seek fallen, bruised, or slightly rotten fruit; and hanging unripe fruit is seldom attractive. These species are also readily attracted to trees which are exuding sap. According to Horton (1917) adults of *Neoptychodes trilineatus* (Linnaeus) often feed on ripe figs. On the other hand, *Phryneta spinator* Fabricius is attracted only to unripe figs (Butovitsch, loc. cit.). According to Beeson & Bhatia (1939), adults of *Hoplocerambyx spinicornis* Newman often become so gorged and distended through feeding on sap that they are unable to stand or fly;

moreover, they are able to detect fresh exudations of sap at a distance of a quarter of a mile. Adults of *Moneilema* species are known to feed on cactus fruit (Psota, 1930). Also included in this category by Butovitsch (loc. cit.) are *Aromia moschata* (Linnaeus) and *Saperda carcharias* (Linnaeus). The same author also refers to interesting records concerning *Clytus arietis* (Linnaeus) and *Strangalia quadrifasciata* (Linnaeus), which were observed to consume aphids on plants—presumably on account of their sugar content.

A most unusual record is that by Bittenfeld (1948) who maintains that he repeatedly observed that adults of *Aromia moschata* (Linnaeus) hunted young cross spiders and devoured them. This is indeed extraordinary behaviour for a Cerambycid, and it is unfortunate that Bittenfeld's account is not more detailed. There can surely be no grounds for regarding *A. moschata*—or any Cerambycid for that matter—as essentially predacious. The only possible explanation would seem to be that the spiders were "attacked" merely and solely for their water content, for *A. moschata* is undoubtedly a thirsty insect. But whether this beetle would deliberately hunt young spiders is a matter for experiment.

Two other species which appear to have adopted a somewhat specialised feeding habit are the American *Dendrobias mandibularis* Serville (Schwarz, 1904) and *Megaderus bifasciatus* Dupont (Dimmock, 1884). According to Schwarz (1904), adults were especially fond of printer's ink, and sometimes obliterated the large letters on posters of theatrical performances which were pasted on walls and fences. It would be interesting to know whether there have been any more recent observations of this curious behaviour, and whether it really is the ink and not the moisture in the paste which is the attraction.

With the exception of many LEPTURINAE and ASEMINAE it seems probable that the majority of Longicorns are to some extent attracted to sap or sugary exudations. Champion & Kirk (1926), and Champion & Knull (1932) have demonstrated in their experiments with bait-pan traps (containing brown sugar and water) that many Cerambycids may be attracted in this way. Their captures included *Chion cinctus* Drury, *Eburia quadrigeminata* Say, *Elaphidion mucronatum* Fabricius, *Cyllene robiniae* Forster and species of *Phymatodes*, *Xylotrechus*, *Neoclytus* and *Purpuricenus*. A preponderance of males was noticed.

It has been the present writer's experience that, with the exception of the ASEMINAE, all species which were reared in captivity took frequent or prolonged sips of drops of sweetened water or diluted jam. This also applied to Lepturine species, which paired and oviposited satisfactorily in the absence of blossom, providing that sweetened water was available.

### 7. Root Feeders

The only reference to this particular feeding habit appears to be that of Reitter (1916), in which he states that adults of *Dorcadion* feed, like their larvae, on the roots of grasses.

### 8. Fungus Feeders

According to Craighead (1923b), nearly all the species of *Leiopus* and allied genera feed on the fruiting pustules of bark fungi, a procedure which usually accompanies

oviposition. It is not yet proved that this habit is adopted by the British *L. nebulosus* (Linnaeus). Kinnmark (1924), however, has observed that *Leptura rubra* (Linnaeus) feeds on fungus, and Butovitsch (loc. cit.) presumes this to be physiologically necessary.

Although the probability is that the vast majority of adult Cerambycids require food in some form or other, there are a few species which do not appear to feed either in captivity or in their natural environment. As a result of careful investigation, Silantjev (1908) has proved conclusively that *Stromatium fulvum* Villiers requires no nourishment at all in the adult stage. *Hylotrupes bajulus* (Linnaeus) may also apparently be regarded as a non-feeder, although Määr (1933a) states that he found adults under bark, the inner surface of which had been chewed and Schwarz (1935) succeeded in feeding some captive adults on pieces of banana.

In the course of field observations and breeding experiments, the writer has observed that adults of *Asemum striatum* (Linnaeus), *Tetropium gabrieli* Weise and *Arhopalus fesus* (Mulsant) showed no interest in drops of sweetened water, nor were there ever an indications that they fed on bark.

Although Craighead (1923b) is of the opinion that the North American PRIONINAE do not feed, this does not apply to the British *Prionus coriarius* (Linnaeus), for there are several records of this species being attracted to lepidopterists' sugaring posts (Duffy, 1946a). On the other hand, the European *Ergates faber* Linnaeus could not be induced to feed, at least in captivity (Mjöberg, 1905). Polozhentzev (1929) maintains that *Spondylis buprestoides* Linnaeus will not accept any form of food in the adult stage. Further information concerning this aspect of the adult biology is to be found in the comprehensive paper by Butovitsch (loc. cit.).

### COPULATION

From the comparatively few accounts in literature of the attitude adopted by Cerambycids during copulation, it appears that with slight variations the position is more or less constant throughout the family. When about to copulate, the male approaches from behind, mounts the back of the female, sits astride her, clasping her elytral shoulders with his front tarsi, depressing his head so that his mandibles press on to the vertex of the female's head. The middle legs are often used to grasp the hind legs of the female. In *Prionus coriarius* (Linnaeus) (Duffy, 1946a) the male embraces its mate's abdomen with its front legs which are crossed beneath or a little in front of the posterior femora, its middle legs crossing behind them. Its hind legs are extended posteriorly to hold the sides of the female's pygidium, the tarsi being supported by the female's abdomen. It is in this position that the male attempts coitus by bending the pygidium downwards to meet the protruding ovipositor, and quickly extruding the genital tube which is inserted into the vagina. In some species it is not until such connection has been affected that the female's ovipositor is visible, having been jerked out by the male's flexible organ, but in some species (e.g. *Stenocorus*, *Acanthocinus*) the ovipositor is partly extruded in readiness to receive the male. Throughout the act, jerky movements are usually performed at regular intervals.

It has been noticed that during actual copulation the males perform secondary sexual movements, presumably to stimulate the female: thus in *Prionus coriarius* (Linnaeus) (Duffy, 1946a) and *Molorchus minor* (Linnaeus) the male continuously rubs the female's thorax with its palps, whereas in *Aromia moschata* (Linnaeus) (Duffy, 1949a) the male frequently strokes the base of his mate's elytra with his mandibles. The position assumed by the antennae during copulation seems to be somewhat variable; for instance, the male antennae in *Aromia moschata* are usually directed backward, whereas in *Prionus coriarius* they point forward. In *Molorchus minor*, however, they are held at right angles to the body while those of the female point forward.

Copulation may be performed either while the female remains stationary or while she is crawling about with the male on her back. The observation of Barbey (1915) that *Cerambyx cerdo* Linnaeus copulates during flight seems very remarkable, particularly as such behaviour has apparently not been observed in any other species. During copulation certain species such as *Prionus coriarius* stridulate loudly, although in the majority of species the act is apparently performed in silence.

When *in copula* a couple will rapidly disengage at the slightest molestation, but only very rarely will they separate completely. The males are extremely tenacious and any attempt on the part of the female to evade the male is usually overcome. However fast the female runs, the male usually manages to cling on, and often attempts to pacify his mate by repeated titillations on the thorax. The female's only means of discouraging the male is that of raising her hind legs and moving him to one side, but this is usually unsuccessful. Males frequently attempt to mate even while the female is in the act of oviposition, and both males and females have been observed to copulate with several different mates.

Scarcely anything is known of the means whereby the males are able to detect and recognise their prospective mates, beyond the fact that it is partly with the aid of sensory organs in the antennae. In the case of *Aromia moschata* and other Callichromini, scent emission very probably aids detection (see also p. 23).

Plavil'shchikov (1932) gives an account of how he succeeded in assembling some flying males to a captive female of *Mallasia* species; and the present writer has noticed the continual efforts of several males of *Stenocorus meridianus* (Linnaeus) to bite through a perforated zinc tin in which a female was confined. That the antennae are instrumental in the recognition of the female has been shown by the experiments of Heintze (1925). He states that in the case of males of *Strangalia melanura* (Linnaeus) and *Leptura rubra* (Linnaeus), when both antennae were amputated, pairing did not take place, but the removal of one antenna only did not incapacitate them unduly. In *Molorchus minor* (Linnaeus) the male does not appear to recognise his mate until he accidentally happens to touch her, but when once antennal contact has taken place he is able to keep track of her. Many species, however, apparently do not have to rely upon direct contact for recognition (e.g. *Aromia moschata*, *Hylotrupes bajulus*), and are able to track down or pursue their mates from a distance of a foot or more.

Rather unusual behaviour has been reported in the case of *Hoplocerambyx*

*spiniornis* Newman (Beeson & Bhatia, 1939). Large-sized males were observed to monopolise several females, driving off smaller males after the manner of a stag or boar. Neander (1928) describes how, when a pair of *Acanthocinus aedilis* (Linnaeus) were disturbed by another male, the first male released the female and chased its rival; the males then rushed each other with lowered heads and pushed each other like he-goats. The males of many species are ferocious fighters, and with their exceptionally well-developed mandibles are able to inflict severe injuries upon one another, sometimes biting off legs or antennae. Such behaviour was observed in a colony of *Arhopalus ferus* (Mulsant) recently kept under observation. Rival males fought ferociously, and the clicking noise which accompanied the amputation of antennae and legs was audible some yards away. Under the relatively confined conditions of the insectary, mutilation was so severe that several specimens were found lying on their backs at the bottom of the cage with scarcely a single appendage intact. In this species too, self dismemberment was observed on several occasions when an adult had been isolated from the rest of the colony; in such cases the beetles seemed so intent at biting anything they could get a grip on that it mattered not whether the appendages were their own or those of some other individual.

Curious behaviour on the part of the females has been observed in *Saperda candida* Fabricius (Brooks, 1919), *Xylotrechus rusticus* Linnaeus (Butovitsch, 1939), and by the writer in *Stenocorus meridianus* (Linnaeus) and *Acanthocinus aedilis* (Linnaeus). While at rest they stretch out their ovipositors and twist them backwards and forwards, a procedure which may last for an hour or more. Brooks (1919) suspected that these movements were aimed at enticing the males.

Copulation usually takes place a day or two after the emergence of the adults from their pupal cells; this, of course, may not necessarily coincide with eclosion (see p. 20). There are, however, numerous exceptions: for example, *Cerambyx dux* Faldermann pairs immediately after emergence (Bodenheimer, 1930), whereas certain Lamiids under observation (*Phytoecia*, *Saperda*) appeared to need a week or more (in which to attain sexual maturity?).

The duration of copulation appears to be extremely variable in the Cerambycidae. According to Butovitsch (1939), *Xylotrechus rusticus* Linnaeus requires only about one and one-half minutes in which to complete the act, but in *Cyllene caryae* Gahan (Dusham, 1921) and *Hoplocerambyx spinicornis* Newman (Beeson & Bhatia, 1939) copulation lasts only a few seconds. *Hylotrupes bajulus* (Linnaeus) usually requires about five and one-half to six minutes (Schwarz, 1926), and *Stromatium fulvum* Villiers about ten minutes (Picard, 1929). Adults of *Stenocorus meridianus* (Linnaeus), *Aromia moschata* (Linnaeus) and *Saperda carcharias* (Linnaeus) have been observed by the present writer to remain in copulation for at least an hour at a time. Schimitschek (1929) has shown that in the case of *Tetropium*, repeated copulation is necessary before all eggs can be deposited, since at a single act only a small proportion of the eggs may be fertilised. This is probably true of most, if not all, species. In various species under observation, including *Stenocorus meridianus* and *Aromia moschata*, females were inseminated by the same or by different males at more or less regular intervals throughout the oviposition period.

Copulation may occur in one or two distinctly different habitats. In the majority of wood-infesting species it takes place on the branches of main stems of the host trees, but species of many Lepturine genera (e.g. *Judolia*, *Alosterna*) copulate usually on the flower-heads of plants which are often growing some distance away from the site of oviposition. According to Lucas (1854) adults of *Acanthophorus serraticornis* Olivier copulate in the earth.

### OVIPOSITION

The period that elapses between copulation and the commencement of oviposition appears to vary considerably in different species, although there are numerous records of approximately six days. Butovitsch (1939), however, believes that in most cases oviposition begins immediately after the first copulation. It seems very probable that many former records may be misleading, for, as pointed out by Butovitsch (*loc. cit.*)

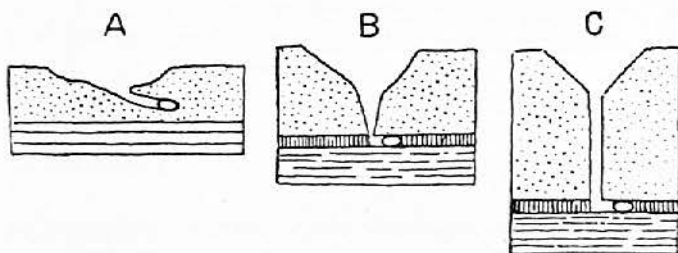


Fig. 5. Three different types of oviposition: A, no slits gnawed, but the egg is laid in a crevice in the bark with the aid of the ovipositor; B, a funnel-shaped slit is gnawed through the bark to the cambium by the mandibles only; C, a funnel is excavated through the bark, partly with the mandibles and partly with the pygidium, which is used as a drill. (Trägårdh, 1930)

and verified by the present writer, more than one act of copulation is necessary for the fertilisation of all the eggs. In many cases it seems doubtful whether the observers concerned could have been certain that the copulation they witnessed was the first or, indeed, whether they were even aware that more than one copulation usually takes place.

Attention to the various methods of oviposition (fig. 5) was first given by Trägårdh (1930), but these have since been much more thoroughly investigated by Butovitsch (*loc. cit.*), who recognises the following kinds:

#### A. Oviposition by means of ovipositor only.

- (a) On bark or outer surface of host.
- (b) In cracks or under scales of bark.
- (c) In cracks or crevices in wood.
- (d) In emergence holes of other insects.
- (e) In the ground.
- (f) On the surface of various objects (stones, etc.).

**B. Oviposition by means of ovipositor and mandibles.****I. In egg cavities, without special preparation of the substrate.**

(a) In egg cavities prepared by the mandibles.

(b) In egg cavities prepared by mandibles and ovipositor.

**II. In egg cavities gnawed out by mandibles or bored by ovipositor, with special preparation of the substrate.****Oviposition by means of Ovipositor only**

Very few species are in the habit of depositing their eggs in an exposed position on the outer surface of the wood: they include *Gracilia minuta* (Fabricius), *Chion cinctus* Drury, and sometimes *Stromatium fulvum* Villiers, *Hesperophanes griseus* Fabricius, *Chlorophorus faldermanni* Faldermann and *Spondylis buprestoides* Linnaeus (Butovitsch, loc. cit.). Nicolas (1891) and Xambeu (1902) give an interesting account of the way in which eggs are deposited by *Leptideella brevipennis* (Mulsant): the eggs are first laid on the surface of the wood, and are then covered with a glutinous coating mixed with fine particles of earth or dust gathered previously by means of a pubescent "brush" situated ventrally on the female's abdomen; thus the eggs are not only secured but camouflaged. Perris (1877) has discussed similar habits in *Clytanthus pilosus* Förster, but in this species particles of wood are used as a protective covering. According to Butovitsch (loc. cit.), similar brushes are present in species of *Callimus*, *Cartallum* and *Obrium*.

The eggs are normally deposited deep in cracks or fissures, often in compact batches of half a dozen or more. Ovipositing adults often spend a considerable period of time exploring the surface of the wood in an effort to find suitable sites which are inaccessible to would-be predators. The same site is often explored several times with the ovipositor before the eggs are inserted. Species of the subfamily LAMINAE which adopt this method of oviposition are apparently very few, the only ones observed by the writer being those of the genus *Pogonocherus*. *Acanthocinus aedilis* (Linnaeus) and *Saperda carcharias* (Linnaeus) may sometimes adopt this method, depending on the thickness of the bark.

Certain species are known to oviposit between the scales of pine cones: these include *Chlorophorus strobilicola* Champion (Champion 1919), *Paratima conicola* Fisher (Craighead, 1923b) and *Stenidea* sp. (Wollaston, 1862). The number of species known to oviposit on seed-pods is very small, and includes *Ataxia sulcata* Fallén; *Leptostylus terraecolor* Horn; *Lepturges spermophagus* Fisher (Craighead 1923b); *Baryssinus leguminicola* Linell (Fisher, 1917); and *Lophopoeum timbouvae* Lameere (Bruch, 1940).

As regards species said to oviposit either in cracks in wood or in the emergence holes of other insects, it is felt that Butovitsch's distinction between these two situations is scarcely justified, for it is very doubtful whether any species would be so discriminating. It is the writer's opinion that emergence holes are used when no other suitable crevices are present, and no preference is shown for the former. No species observed by the writer oviposited in emergence holes only, although several species made use of both crevices and emergence holes. These included *Hylotrupes bajulus* (Linnaeus),

*Aromia moschata* (Linnaeus), *Arhopalus ferus* (Mulsant), *Clytus arietis* (Linnaeus), *Gracilia minuta* (Fabricius), *Molorchus minor* (Linnaeus), *Rhagium mordax* (Degeer), *R. bifasciatum* Fabricius, *Stenocorus meridianus* (Linnaeus), *Strangalia quadrifasciata* (Linnaeus), *S. maculata* (Poda), *S. melanura* (Linnaeus) and *Alosterna tabacicola* (Degeer).

The number of species which normally oviposit in the cracks and crevices of barkless wood is very small and includes *Hylotrupes bajulus* (Linnaeus) and species of *Stromatium* and *Arhopalus*. Butovitsch (loc. cit.) draws attention to the fact that some species, such as *Parandra brunnea* Fabricius, do not necessarily rely upon cracks and crevices but force their eggs into soft punky wood with their powerful ovipositors. He suggests that this method may be adopted by certain LEPTURINAE, and this has since proved to be the case in a number of species including *Stenocorus meridianus* (Linnaeus) and *Strangalia melanura* (Linnaeus), but only when the wood was decidedly soft.

The habit of ovipositing in soil appears to be characteristic mainly of the PRIONINAE, especially desert species such as *Prionus (Polyarthron) komarovi* Dohrn. According to Schaufuss (1916), the gravid female of this species is so heavy with eggs that she is unable to fly and is forced to crawl laboriously over the sand: when she arrives at a suitable spot, the ovipositor (which is of body length) is stuck deep in the sand. Also belonging to this group are *Prionus turkestanicus* Semenov, *P. imbricornis* Linnaeus, *Homaesthis emarginatus* Say, *Lophosternus hugelii* Redtenbacher and the Lepturid genus *Apatophysis* (Butovitsch, loc. cit.); to these may probably be added *Prionus (Polyarthron) pectinicornis* Fabricius, *P. aegyptiacum* Guérin-Ménéville, *P. banghaasi* Pic, *P. brachypterus* Gebler (Pl. VIII, fig. 37), and *P. bienerti* Heyden.

Villiers (1946) describes how the Prionid *Dorysthenes (Opisognathus) forficulatus* Fabricius lays its eggs in a pit about 4 cm. deep in the soil prepared with the aid of its mandibles and legs; after oviposition the pit is filled up again. All species which have adopted this habit are similarly adapted, that is to say, they all have the abdomen attenuated posteriorly and equipped with a long ovipositor, and have sturdy hind legs and shortened elytra. It is unlikely, however, that many of the non-desert species, such as *Ergates*, oviposit in this manner. So far as is known, the only Lamiid species which have adopted this habit are those of the genus *Dorcadion*, the larvae of which are terricolous.

The unusual habit of ovipositing on the surface of various objects such as stones is apparently characteristic only of those species which undergo hypermetamorphosis, namely those of the genus *Vesperus*. Upon hatching, the slender active first-instar larvae burrow into the soil, where they moult and are then short and fat. In their second instar they start to feed on the roots of plants.

Another unusual habit is that described by Lucas (1854), who states that females of *Acanthophorus serraticornis* Olivier copulate in the soil and oviposit in the empty pupal cocoons alongside roots.

#### Oviposition by means of the Ovipositor and the Mandibles

With very few exceptions (e.g. *Parandra brunnea* Fabricius), this method of oviposition appears to be confined to the LAMIINAE, although certain species such as

*Acanthocinus aedilis* (Linnaeus) and *Saperda carcharias* (Linnaeus) are known to be influenced by the nature of the bark and as a consequence do not always adopt this method.

The majority of species of this group oviposit without specially preparing the substrate for the reception of the eggs. The egg-cavities in the bark or in the walls of herbaceous plants are deep, extending usually to the inner bark or inner wall of the plant; generally only one egg is inserted in each cavity. Many species such as those of *Saperda* provide additional protection for the eggs by secreting from the ovipositor a viscous fluid, which on drying seals up the cavity. After oviposition, the adult of *Plectrodera scalator* Fabricius (which lays its eggs in wood just above ground-level) seals the cavity with a secretion, pats into place with its abdomen the adhering wood-fibres, and then fills in the cavity with earth scraped up by means of the tip of the abdomen (Milliken, 1916).

According to Neander (1928), *Acanthocinus aedilis* (Linnaeus) before oviposition first gnaws a deep funnel-shaped cavity in the bark, which is then deepened by the extremity of the abdomen which is used as a drill. This procedure, which takes two or more hours to complete, has also been witnessed by the present writer, although it appears that other methods are adopted when the bark is unusually thick or thin.

Some Lamiids, however, which attack only living trees and plants, take considerable care in suitably preparing the substrate for the reception of their eggs, and Butovitsch (loc. cit.) regards this as the most highly specialised method of oviposition in the Cerambycidae. A typical example of this group is *Saperda populnea* (Linnaeus) which, prior to oviposition, makes a horseshoe-shaped abrasion on the bark, in the middle of which is a minute puncture; eggs are laid singly in the inner walls of the bark in a vertical position. In the case of *Saperda scalaris* (Linnaeus), the ovipositing female sinks her mandibles deep into the bark, thereby making two small but deep incisions; the beetle then turns round and inserts an egg in one or both of them. Plant-feeding species such as *Phytoecia cylindrica* (Linnaeus) and *Agapanthia villosa-viridescens* (Degeer) insert their eggs singly in a horizontal position deep in the walls of stems (see also p. 294). Quentin (1951) gives an interesting account of *Dorcadion fuliginator* Linnaeus which he has observed to oviposit in grasses. Perhaps the most unusual method of oviposition is that adopted by species of such genera as *Tragocephala*, adults of which girdle the stem (in which the egg is laid) with their mandibles, apparently to arrest the flow of sap or to cause the stem eventually to break off, thus affording suitable conditions for metamorphosis.

#### THE FERTILITY OF THE CERAMBYCIDAE

Little need be said about this aspect since it is clear that the majority of estimates given in literature must be misleading. This is mainly due to the almost impossible task of keeping adults continually under observation in their natural habitat. In many cases where individual adults have been kept under observation in the laboratory, it has not been definitely known whether oviposition had already started before capture. Moreover, the writer has dissected a number of dead females which had apparently

completed oviposition, only to find that their ovarioles contained sometimes a considerable number of partly developed eggs. Beeson & Bhatia (1939) have shown that in *Hoplocerambyx spinicornis* Newman fertility was considerably affected by humidity. As has already been shown, elaborate precautions are taken for the concealment of eggs in most Lamiid species, and this may account for the fact that the average number of eggs in this subfamily is generally far smaller than that of other subfamilies. As an illustration of the considerable diversity in the maximum number of eggs, the following will serve as examples:

*Melanauster chinensis* Forster, 20 (Lieu, 1945); *Prionus imbricornis* Linnaeus, 200 (Craighead, 1915); *Hoplocerambyx spinicornis* Newman, 468; *Epepeotes luscus* Fabricius, 1,400 (Beeson & Bhatia, 1939); and *Prionus californicus* Motschulsky, 1,200 (Hardy & Preece, 1927).

### POLYPHAGY AND HOST-SELECTION

Various accounts in literature have tended to give the impression that the choice of host plants in the Cerambycidae is strictly limited. In the course of recent field work, however, the writer has noticed that the larvae of a number of British species infest a wide range of hosts, both coniferous and deciduous. The following are examples:

*Prionus coriarius* (Linnaeus). *Quercus*, *Fagus*, *Betula*, *Aesculus*, *Castanea*, *Fraxinus*, *Prunus*, *Ulmus*, *Carpinus*, *Platanus*, *Alnus*, *Salix*, *Ilex*, *Abies*, *Pinus*, *Picea*, *Larix*.

*Grammoptera ruficornis* (Fabricius). *Crataegus*, *Hedera*, *Populus*, *Ilex*, *Pyrus malus*, *Aesculus*, *Prunus cerasus*, *Fraxinus*, *Ulmus*, *Quercus*, *Pyrus aucuparia*, *Salix*, *Acer pseudoplatanus*, *Prunus spinosa*, *Corylus*, *Sambucus nigra*, *Rhamnus*.

*Rhagium bifasciatum* Fabricius. *Castanea*, *Quercus*, *Betula*, *Fagus*, *Laurus*, *Pyrus aucuparia*, *Prunus cerasus*, *Sambucus nigra*, *Crataegus*, *Pinus*, *Picea*, *Abies*, *Larix*.

*Clytus arietis* (Linnaeus). *Quercus*, *Castanea*, *Rubus*, *Acer pseudoplatanus*, *Pyrus malus*, *Ficus*, *Prunus cerasus*, *Corylus*, *Fagus*, *Salix*, *Betula*, *Laurus nobilis*.

Many exotic species are now known to have a far greater range of hosts than was originally supposed: an outstanding example is *Stromatium barbatum* Fabricius, which is known to have over three hundred host plants (Beeson & Bhatia, 1939).

Several instances have recently been observed by the writer of species hitherto exclusively associated with deciduous trees feeding in conifers and vice versa. For example, both *Quercus* and *Pinus* have been found to be infested with larvae of *Callidium violaceum* (Linnaeus), *Rhagium bifasciatum* Fabricius, *R. mordax* (Degeer), *Alosterna tabacicola* (Degeer), *Strangalia quadrifasciata* (Linnaeus) and *S. maculata* (Poda). *Molorchus minor* (Linnaeus) has recently been found in both *Picea* and *Betula*.

The wide range of hosts selected by certain primitive groups of Cerambycids seems to suggest that polyphagy is phylogenetically a primitive habit. The term "polyphagous", however, as applied to Cerambycids and other wood-feeding insects is rather too vague a term. With comparatively few exceptions there is a sharp division between species which feed in deciduous trees (Gymnosperms) and those which feed in conifers (Angiosperms), but the term "polyphagous" does not indicate whether the

range of hosts may be included in one or both of these groups; and so the following terms are suggested:

Gymnospermophagous (feeding in various Gymnosperms).

Angiospermophagous (feeding in various Angiosperms).

Amphixylophagous (feeding in both Gymnosperms and Angiosperms).

According to the "host-selection principle" as defined by Hopkins (1916) and originally recognised by Walsh (1864), any insect species which breeds in two or more hosts will, under normal conditions prefer to continue to breed in the host to which it has become adapted. The host concerned predetermines selection by a gravid adult of the same host species for oviposition. Thus special physiological races may evolve which do not appear to differ morphologically although they have particular host preferences.

Craighead has investigated this problem with regard to several species of Cerambycidae, and has published the results of his experiments (1921, 1923a), which he has summarised as follows:

- "(1) In practically all the species experimented with the adults show a marked predilection for the host in which they have fed as larvae, provided they are not deterred by other factors such as the unfavourable condition or the small quantity of the host.
- "(2) There is a considerable variation in the degree of preference for the original host, as between different species. Thus—
  - (a) Certain species are capable of living in only one genus or species of plant, which consequently they select.
  - (b) Certain species, chiefly those living in nature in several hosts, can be forced to adopt a new host.
  - (c) Certain species, chiefly those feeding in nature in a great variety of plants, show little discrimination in the selection of hosts.
  - (d) Certain species feeding in nature in a great variety of hosts often show a preference for a few of these.
- "(3) In forced transference of individual adults of a species to a new host, a high mortality of the broods usually occurs, especially in the case of eggs laid by beetles emerging from the original host, in which case the mortality is often total. One-half to full-grown larvae, however, usually can be successfully transferred to a new host and live and transform to adults.
- "(4) With some species that can be reared in a secondary (new) host by the larvae feeding one or part of one year, preference for that host is shown by the resulting adults.
- "(5) In general, the fewer the hosts in nature, the more marked the predilection for a particular host, and *vice versa*.
- "(6) Continued breeding in a given host intensifies the preference for that host.
- "(7) The condition of the host has a great influence on host selection, in that every species prefers an optimum condition of the host which it selects and will

choose a new host in the optimum condition in preference to an old host in which the conditions are unfavourable.

- "(8) The quantity of wood at the disposal of the ovipositing adults may influence the insects in their choice between different kinds of host wood, in that, if there are many adults to a limited amount of the primary host, some species will select a secondary host if such is available. If this is done, however, the resulting brood is weakened."

It is the present writer's opinion that the seventh observation is of by far the greatest significance. Breeding experiments and field work undertaken throughout the past ten years with the majority of British species permit the following observations to be made:

- (1) Ovipositing adults are influenced to a greater degree by the nature and condition of the host (i.e. thickness of bark, stage of decay, moisture content) than by the identity of the host species.

Adults of known origin including such species as *Stenocorus meridianus* (Linnaeus), *Judolia cerambyciformis* (Schrank), *Rhagium bifasciatum* Fabricius, *R. mordax* (Degeer), *Strangalia maculata* (Poda), *S. quadrifasciata* (Linnaeus) and *Alosterna tabacicola* (Degeer) were on different occasions enclosed in a large out-door breeding cage in which were placed sections of branches, roots, twigs and stumps; these included several sections of *Populus*, *Alnus*, *Fagus*, *Betula*, *Quercus*, *Pyrus* and *Pinus* of various degrees of moisture content and decay. Adults of the above species oviposited in all sections of wood which were slightly moist, slightly decayed, and which had relatively thick bark. Sections which were either dry, sound, very rotten or with thin loose bark were ignored. In another experiment with adults of *Gracilia minuta* (Fabricius) (reared from *Rubus*) both freshly-cut and old dry stems of *Rubus* and *Rosa* were provided. In this case oviposition occurred on both hosts, but only on the old dry stems.

- (2) Ovipositing adults (at least under laboratory conditions) are influenced by the amount and variety of hosts, irrespective of species. Thus, in a species known to feed in either *Quercus* or *Pinus* (e.g. *Rhagium*), there was a tendency for oviposition to take place on whichever host was the more abundant, provided conditions were reasonably similar. When there was a paucity of suitable wood, or when only unsuitable wood was present, many adults oviposited on it before dying.
- (3) The successful development of larvae depends to a far greater extent upon the nature and condition of the wood than upon the host species concerned. The high mortality (later overcome by improved technique) of most species was due either to desiccation or to moulds, particularly during the early instars.
- (4) Many species showed a marked preference for a particular part of a tree, such as exposed roots (*Judolia*, *Prionus*), twigs (*Molorchus*, *Pogonocherus*), or the bole (*Tetropium*, *Phymatodes*) (see also p. 39). One notable exception was *Poecilium alni* (Linnaeus) which thrived in both very slender twigs and stout branches.

- (5) The range of hosts is, in general, greatest in species which oviposit on freshly-cut, slightly injured, or decaying wood; whereas the hosts of species which oviposit only on healthy living wood or plant tissue are considerably restricted, often to a single genus, i.e. *Salix* (e.g. *Aromia*, *Saperda*, *Phytoecia*).

As pointed out by Parkin (1940), there seems to be no reason why some species should not be capable of deriving nourishment from wood which is apparently unsuitable. The larva of *Hylotrupes bajulus* (Linnaeus), for example, although angiospermophagous, possesses enzymes which would apparently enable it to digest either kind of wood with equal facility.

In a recent examination of an infestation of *Callidium violaceum* (Linnaeus) (which is regarded as strictly angiospermophagous), it was noticed that the posts supporting the coniferous rustic work were of oak, and these were just as heavily infested as were the coniferous cross-pieces. It appears that in this instance the infestation was so great that the adults were forced to oviposit on the oak supports, there being no other suitable wood near by. That the resulting larvae successfully completed their development was evident from the damage.

#### DAMAGE TO METALS BY CERAMBYCIDAE

After reading some of the early accounts in literature, one is rather left with the impression that certain Cerambycids have a decided liking for chewing their way through metal sheeting. The probability is, however, that both adults and larvae of all the larger species attempt and often succeed in gnawing their way through soft metal sheeting, when it forms a barrier to their freedom or food-supply. Such damage can only be caused by species which are able to withstand dry conditions, and are able to mature in timber used for structural purposes such as rafters, telephone poles and underground ducts. The following table is based on records available to the writer. For additional references the reader is referred to the papers by Burke, Hartmann & Snyder (1922), and Horn (1933):

*Hylotrupes bajulus* (Linnaeus). There are numerous reports of damage to metal by this species. Munford (1846) states that larvae often perforate the sheet-lead covering spouts and roofs, and that the examination of their stomach contents has revealed particles of lead. Adults have been known to chew through sheet-lead  $\frac{1}{8}$  in. thick (Kirby & Spence, 1822). Other references to damage by both larvae and adults are given by Horn (1933, 1934), Laing (1919, 1920), Rathvon (1862) and Westwood (1839).

*Eburia quadrigeminata* Say. A curious incident has been anonymously recorded (1927) concerning this species. About thirty telephones were put out of order as a result of an adult boring through a lead cable  $\frac{3}{32}$  in. thick, attached to a pole.

*Pyrrhidium sanguineum* (Linnaeus). Adults bored through metal sheeting (Houlbert, 1912). It has been proved experimentally that adults are capable of boring through lead crucibles (Laing, 1920).

*Megaderus stigma* Linnaeus. Damaged lead cables (Moreira, 1930; Rendell, 1930). Eggs were deposited on the cables as well as the cross-arms, poles, etc. Larvae had

excavated numerous holes, but lead was not ingested, and they eventually died from starvation.

*Ergates faber* Linnaeus. Boring through lead (Horn, 1933).

*Arhopalus rusticus* (Linnaeus). Adults emerged through zinc plating and even solder (Houlbert, 1912).

*Tetropium gabrieli* Weise. Adults perforated the lead lining of wooden vats (Laing, 1919).

*Spondylis buprestoides* Linnaeus. Boring through lead (Horn, 1933).

*Monochamus sutor* (Linnaeus). Adults bored through lead pipe (White, 1850).

*Monochamus notatus* Drury. A larva perforated a lead pipe  $2\frac{1}{2}$  in. thick (Cook, 1891).

Other materials are, of course, subject to similar damage. The writer was recently shown a bale of silk which had been ruined by an adult of *Phymatodes testaceus* (Linnaeus) chewing its way through the middle of it. The bale had been stored on top of a shelf in which the beetle had evidently matured. Léveillé (1897) gives an account of *Pyrrhidium sanguineum* (Linnaeus) feeding on gelatin.

### LARVAL GALLERIES

Cerambycid larvae attain maturity in a great variety of hosts, ranging from trees of considerable age and girth down to young slender saplings and herbaceous plants. The conditions under which these larvae live are extremely varied. Breeding experiments have clearly indicated that, generally, their successful development depends to a far greater extent on the nature and condition of the wood, including such factors as thickness of bark, presence of sap, moisture content and so forth, than on the species of tree itself (see also p. 277).

Many larvae exhibit a decided preference for a particular part of a tree. Several species prefer slender twigs (*Tetrops*, *Pogonocherus*), or dry, scaly bark (*Elaphidion nanum* Fabricius), but the majority are to be found in the stouter branches (Mesosini, Callidini, Clytini). Numerous species of great economic importance are bole feeders, and tunnel deep into the sapwood and often into the heartwood (*Monochamus*, *Batocera*, *Aromia*, *Ergates*), whereas certain species are essentially root feeders (*Judolia*, *Prionus*, *Dorcadion*).

Very often a distinct preference is shown for wood in a particular condition. Healthy trees are attacked mainly by species of LAMIINAE (*Oberea*, *Saperda*) and CERAMBYCINAE. The majority of species of Callidini, Clytini, ASEMINEAE, however, prefer injured, sickly trees or freshly cut timber. Many Lepturine and Prionine larvae (*Rhagium*, *Strangalia*, *Mallodon*) are able to mature successfully only in rotten, moist wood. On the other hand, very dry or seasoned timber is preferred by *Clytus*, *Stromatium* and *Hylotrupes*.

Many species of LAMIINAE (*Phytoecia*, *Moneilema*) feed only in herbaceous plants such as Umbelliferae and Cactaceae, and even grasses. Here again preference is sometimes shown for roots or tubers. Bamboo furniture and osier wickerwork are often heavily infested with some species (*Chlorophorus*, *Gracilia*), and even seeds and cones of certain plants and trees are occasionally attacked.

The galleries themselves are in general broad, shallow excavations which are nearly always oval in cross-section. When subcortical they are very often rather broad and meandering, whereas those in wood are more inclined to be relatively straight and more clearly defined. There are, of course, many galleries in wood made by larvae of other lignicolous insects including those of Hymenoptera, Diptera, and Lepidoptera, as well as of other families of Coleoptera. In general, galleries of Cerambycidae may be recognised by the fact that they are oval (seldom round) in cross-section, and by the presence in them of excreta and gnawed particles of wood (frass) which are usually rather coarsely shredded (but powdery in some CERAMBYCINAE), and are never spun together with silken threads as in the case of Lepidoptera. Galleries of Hymenoptera and most Diptera are round in cross-section and are tightly packed with fine powdery frass. Nevertheless, the galleries of other wood-feeding coleopterous larvae and even those of certain Diptera are very similar to those of Cerambycids, and only after considerable field experience is one able to distinguish between them with certainty.

Owing to this great diversity of habitat, the preparation of even a provisional classification of larval galleries is very difficult: inevitable exceptions arise, which are themselves inconsistent because of the strong influence of prevailing conditions. It seems evident, however, that from the point of view of identification it is the location of the gallery rather than its nature which is of the greater significance, and it is mainly from this aspect that the following classification is suggested.

### 1. Galleries in Trees

Under this heading are included species which cause widespread and often serious destruction in forests, plantations, parks, and in many cases to felled and stacked timber.

#### 1.1. Galleries in trees and felled timber with bark intact.

##### 1.1.1. Superficial galleries.

1.1.1.1. Gallery entirely in or under the bark (Pl. I, fig. 2; Pl. VI, fig. 29). Examples: *Elaphidion nanum* Fabricius, *Grammoptera ruficornis* (Fabricius), *Rhagium inquisitor* (Linnaeus), *Leiopus nebulosus* (Linnaeus).

1.1.1.2. Gallery subcortical for the greater part but later penetrating the outer sapwood where pupation takes place. Examples: *Rhagium*, *Plagionotus*, *Callidium*, *Phymatodes testaceus* (Linnaeus), *Plocaederus*, *Molorchus*, *Pogonocherus*.

These two types of gallery are not always strictly adhered to by the respective larvae concerned, as the location is influenced by various factors which are discussed later.

The damage caused through the excavation of both these types of gallery is superficial, and although of little or no economic importance so far as felled timber is concerned, it often causes or hastens the death of healthy trees either directly or indirectly through encouraging the invasion of other borers or fungi.

1.1.2. Internal galleries (Pl. II, figs 8, 9). Here are included all galleries which, although subcortical at first, very soon penetrate the sapwood, and often extend deep into the heartwood. Usually this concerns only the larger species, many of which are

of considerable economic importance. Examples: *Monochamus*, *Batocera*, *Ergates*, *Phrynetta*, *Aromia*, *Cerambyx*.

1.2. *Galleries in dead or seasoned timber with bark removed* (Pl. III, figs. 12, 13). Under this heading can be included comparatively few species, but they are all of considerable economic importance so far as building structures, plywood and furniture are concerned. Eggs of these species are deposited in cracks and crevices in the barkless sapwood, and the young larvae bore straight into the wood where they excavate meandering galleries. These larvae often require several years in which to mature, but they are able to withstand extremely dry conditions and to obtain sufficient nourishment even from timber that has been felled fifty years or more before infestation. Examples: *Hylotrupes bajulus* (Linnaeus), *Stromatium* spp.

## 2. Galleries in Herbaceous Plants and Seedlings (Pl. VI, fig. 26)

Under this heading may be included a large number of genera belonging almost exclusively to the LAMIINAE. In general these larvae are of little economic importance, although there are a few notable exceptions. The gallery in most cases is a simple longitudinal excavation of the pith channel, but occasionally it is confined to roots or tubers. Examples: *Phytoecia cylindrica* (Linnaeus) (in *Carrota*), *Agapanthia villosoviridescens* (Degeer) (in *Carduus*), *Moneilema*, *Coenopoeus* (in cacti), *Diaxenes* (in orchids), and *Neoclytarlus euphorbiae* Bridwell and *Lagocheirus obsoletus* Thomson (in *Euphorbia*).

## 3. Galleries in Soil

Galleries of this kind are made by certain root-feeding species of PRIONINAE and LAMIINAE.

3.1. *Galleries partly in soil but mainly in wood* (Pl. IV, fig. 17). When their limited food-supply is exhausted, species which feed *internally* on roots of trees are capable of tunnelling through the soil to nearby roots which they enter to continue their lignicolous existence. Here the galleries in the soil are merely a connecting link between the true larval galleries in the wood. Examples: *Prionus coriarius* (Linnaeus) (Duffy, 1946a), *Judolia cerambyciformis* (Schrank), *Acanthophorus serraticornis* Olivier, *Lophosternus hugelli* Redtenbacher (Beeson & Bahtia, 1939).

3.2. *Galleries entirely in the soil*. A few species which feed *externally* at roots of grasses and herbaceous plants are continually forced to tunnel through the soil from root to root in order to feed; here the galleries are extensive and the larvae can be regarded as truly terricolous. Examples: *Tetraopes tetraophthalmus* Forster, *Homaethesis* spp. (Craighead, 1923b).

## 4. Galleries in Seeds and Seed-pods

The majority of the comparatively few species belonging to this group are to be found in dead fallen cones of Coniferae, the pith scales and seeds of which are attacked. They include such species as *Paratimia conicola* Fisher (Craighead, 1923b) and *Stenidea* sp. (Wollaston, 1862). In the case of *Chlorophorus strobilicola* Champion (Champion, 1919), only healthy green cones are attacked, and the larvae feed on the internal woody tissue, chiefly in the cellular parts of the scales and central axes.

Apparently other species are capable of attaining maturity in cones: Bargagli (1882) records the discovery of a larva of *Strangalia maculata* (Poda) in a pine cone from which it was successfully reared. The present writer recently found several fallen cones which when split open revealed galleries similar to those of *Molorchus* spp., but no larvae were present.

According to Craighead (1923b) the seeds of mangrove (*Rhizophora mangle*) are bored by larvae of *Ataxia sulcata* Fallén and *Leptostylus terraecolor* Horn. The unripened seeds of cowpeas (*Vigna*) are sometimes riddled by larvae of *Lepturges spermophagus* Fisher, and adults of *Baryssinus leguminicola* Linell have been obtained from pods of *Enterolobium* from Paraguay (Fisher, 1917). Bruch (1940) gives an account of *Lophopoeum timbouvae* Lameere, larvae of which infest seed-pods of *Prosopis alba*.

### 5. Specialised Galleries

5.1. *Galls and cankers.* Sometimes the activity of a larva within a growing branch or twig gives rise to a swelling or gall. These galls are most conspicuous in the case of slender twigs, where presumably the tissues are more readily affected. Usually the gall is surmounted by a dark brown roughened area of partly decayed bark. The gallery itself consists of a simple longitudinal excavation (packed with fibrous frass) in the centre of the stem, and seldom extends more than an inch or so beyond the swollen portion. Sometimes several galls are to be found on a single stem, and may be less than an inch apart as is often the case with *Saperda populnea* (Linnaeus). Other gall-making species are *Apriona swainsoni* Hope, *Nupserha variabilis* Gahan (Beeson & Bhatia, 1939), *Xylotrechus aceris* Fisher and *Desmocerus piperi* Webb (Craighead, 1923b); the latter produces galls up to 10 in. in diameter. The larva of *Mallodon melanopus* Linnaeus is said to produce a large gall in the roots of *Quercus* (Craighead, 1915).

In the case of *Dihammus cervinus* Hope (a pest of teak) there is partial girdling and injury to the cambium, which causes an increased growth of wood around the wound (fig. 6): this overgrowth in the callus eventually produces a bulging canker, the diameter of which may be twice that of the stem. Owing to the activity of ants, termites and even woodpeckers, this canker is prevented from healing over, with the result that the stem breaks in two (Beeson & Bhatia, 1939).

5.2. *Girdled galleries.* The girdling of twigs and stems in which eggs are deposited may be carried out either by the adult (as in *Oncideres*) or by the larva. Craighead (1923b) considers that the purpose of this girdling is either to provide dead wood (through arresting the flow of sap) for the larva in which to feed, or to cause the stem eventually to break off and fall to the ground; thus affording conditions suitable for pupation. In the case of *Oberea* the larva tunnels down a slender stem and periodically cuts off from the inside that portion of the stem through which it has bored (see also "Perforated galleries").

5.3. *Perforated galleries* (fig. 7). The slender stems of living trees and plants which are infested with Cerambycid larvae often have a series of small but distinct holes arranged in a straight row in the bark. These perforations connect with the main larval gallery, and have been referred to in literature as "aeration holes" and "frass-ejection holes". As to whether these holes really function in aeration or are

merely for the ejection of frass is debatable although the latter would seem the more likely.

In some cases this habit is associated with that of girdling, as in *Oberea*. It is clearly demonstrated in the case of *Tragocephala anelli* Bates, a Lamiid which recently has been causing severe damage to young cacao seedlings. The stem is first girdled by the adult at the time of oviposition. On hatching, the young larva tunnels downward, excavating a series of holes at more or less regular intervals. There may be as many as twelve holes in a single gallery through which the frass is periodically ejected.<sup>1</sup>



Fig. 6

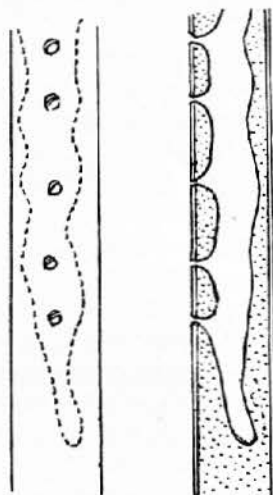


Fig. 7

Fig. 6. *Dihammus cervinus* Hope. Canker produced in the stem of a sapling of *Tectona grandis*, showing exit-hole of beetle; vertical scale line represents one inch. Small figure shows a sapling broken off at the canker from which a subsequent coppice-shoot is growing. (Beeson & Bhatia, 1939)

Fig. 7. *Tragocephala anelli* Bates. Larval galleries showing (left) external and (right) internal damage.

5.4. *Temporary galleries.* In very rare instances larvae have been known to transfer themselves from one gallery into another of a distinctly different kind. In the case of *Apriona swainsoni* Hope the young larva tunnels in the living stem of a large climber (*Butea superba*), in which a gall is formed. When nearly mature, the larva then passes from the climber into the tree, at a point where both are in close contact. Other species exhibiting similar behaviour are *Nupserha variabilis* Gahan and *Sphallenum setosum* Germar. This curious behaviour of the adoption of a secondary host was first observed by Atkinson (1931).

The only larva so far known which apparently does not excavate its own gallery but which occupies deserted galleries of other species is that of *Acmaeops collaris* (Linnaeus) (see p. 120).

<sup>1</sup> For field observations of this species, the writer is indebted to P. Audenarde.

## PUPAL CHAMBERS

As in the case of larval galleries, pupal chambers are extremely diverse both in nature and in location. They may be formed in the bark, under the bark, in the sapwood, in the heartwood, in the stems of trees and herbaceous plants, or in the soil.

The most usual form of chamber is simply an oval enlargement of the larval gallery. If frass has been closely packed behind the larva, no special barrier is erected, but if the gallery has been kept clear, then a suitable barrier in the form of one or two plugs of compressed fibres is constructed to seal off the pupal chamber from the larval gallery.

### 1. Cells

These consist of an enlargement of the terminal end of the larval gallery, the pupa being in direct contact with the surface of the surrounding wood. They may be divided into two main types.

1.1. *Superficial cells.* These may be either in the bark or between the bark and the cambium, superficially grazing the outer sapwood. Usually they take the form of a shallow elliptical cavity packed at one or both ends with wooden fibres (*Leiopus*, *Poecilium*, *Grammoptera*). An elaborate variation of this type of cell is made by some species of *Rhagium*, and consists of a shallow concavity (usually in the inner wall of the bark) which is surrounded by a barrier of interlaced wood fibres, giving it the appearance of a bird's nest in miniature (Pl. IV, fig. 16; and fig. 73).

1.2. *Internal cells.* These are formed either in the sapwood or occasionally in the heartwood. They may be conveniently divided into three distinct kinds.

1.2.1. *Direct cell* (figs. 173, 194). A cell of this kind consists of a prepupal gallery into the sapwood (seldom heartwood), which may be transverse, oblique, curved or straight, and which terminates in an elongate pupal cell. Larvae which construct this kind of cell always turn round to face the orifice before pupating. Examples: *Callidium*, *Molorchus*, *Aromia*, *Saperda*.

In the case of many Cerambycini, cells of this kind are plugged at the entrance with a calcareous operculum in the form of a thick stopping or bung of calcium carbonate, which is secreted by the larva (see p. 13). Species so far known to construct these opercula belong to the following genera: *Cerambyx*, *Pachydissus*, *Massicus*, *Aeolesthes*, *Hoplocerambyx*, *Nadezhdiella*, *Chelidonium* and *Philematium*.

1.2.2. *Indirect cells* (fig. 231). Larvae which construct this kind of cell all enter the sapwood, tunnel into the heartwood (where they usually overwinter), and continue to tunnel towards the surface of either the same or the opposite side to that which they entered, making their cell in the sapwood just beneath the surface. Such larvae pupate without turning round: consequently the adult has to gnaw through part of the sapwood as well as the bark in order to escape; thus there is a hole at each end of the gallery. Examples: *Monochamus*, *Batocera*, *Goes*, *Apriona*.

1.2.3. *Simple cells* (Pl. VI, fig. 26). This kind of cell is to be found in dead stems of herbaceous plants and slender stems of trees which have been hollowed out by the larva. It consists simply of the original longitudinal larval gallery which has been partitioned off with one or, more often, two plugs of fibrous shreds. In order to

escape, the adult has only to gnaw through the thin fragile walls of the dead stem. Examples: *Oberea*, *Agapanthia*, *Phytoecia*.

## 2. Cocoons

These consist of an excavated chamber either in wood or in soil, the pupa being enclosed by and in contact with an internal lining formed from a gum-like or calcareous secretion of the larva. There are two distinct kinds of cocoon, namely (1) earthen and (2) calcareous; the latter is formed only in wood.

2.1. *Earthen cocoons* (Pl. IV, fig. 14). These are constructed by various species of PRIONINAE and LEPTURINAE. In the case of the former, the larvae are usually root feeders, which when mature hollow out a large roomy cavity in the surrounding soil (often alongside a root). The particles of earth comprising the inner surface of the cocoon are cemented together with a shiny, gum-like secretion of the larva. Sometimes, as in *Prionus coriarius* (Linnaeus) (Duffy, 1946a), the cocoon may consist of small particles of gnawed wooden fibres; this probably only occurs when the surrounding soil is too light or too heavy. Examples: *Judolia*, *Prionus* (Duffy, 1946a), *Homaesthis*, *Tetraopes* (Craighead, 1923b), *Acanthophorus*, *Lophosternus* (Beeson & Bhatia, 1939). Certain Lepturine species, which feed above ground, fall to the ground when mature, and construct an earthen cocoon just below the surface (*Acmaeops*, *Anthrophilax*, *Gaurotos*, *Pachyta*).

2.2. *Calcareous cocoons*<sup>1</sup> (Pl. IV, fig. 15). These egg-like cocoons, which resemble large sugared almonds, are constructed by certain species of Cerambycini, notably by *Plocaederus* species. The larva first thickly pads the terminal part of the gallery with coarse wooden fibres, which are interwoven and compressed to form a chamber in which the larva leaves room enough to assume a slightly coiled position. The larva then coats the inner surface with a deposit of calcium carbonate (see also p. 13). Species so far known to construct calcareous cocoons belong to the following genera: *Plocaederus*, *Diorthus*, *Dialeges* and *Xystrocera*. The latter, which belongs to the tribe Oemini, is the only known genus, outside the Cerambycini, the larvae of which construct calcareous cocoons.

There are apparently three main sources of danger from which calcareous cocoons and opercula could afford protection, namely insect parasites and predators, parasitic or saprophytic fungi, and excessive variation in the humidity of the chamber. As regards the first of these, Cerambycid larvae are subject to parasitism long before the preparation of the pupal chamber, and a calcium barrier would seem no more effective against invasion than is a thick plug of wooden fibres. According to Beeson (1919a) the calcium deposit has been found to be completely impervious to fungal hyphae, and therefore affords efficient protection, although, as he points out, this is rather discounted by the fact that other species of Cerambycidae are not generally appreciably harmed by the intrusion of moulds. He suggests that the calcareous operculum serves to prevent excessive loss of moisture through the open prepupal gallery, and that the calcareous cocoon serves to prevent desiccation and to maintain

<sup>1</sup> It should be realised that, in the case of damaged or infested timber, the presence of calcareous opercula or cocoons or even remains of them, afford a very useful and reliable clue to the identity of the insect.

a constant degree of humidity inside the cocoon. Later, however (Beeson & Bhatia, 1939), the conclusion is reached that these calcareous deposits are not devices for regulating humidity, because some species of this group emerge in the dry season and others in the wet. No instances have been observed in which a Cerambycid pupa has dispensed with the primitive method of protection such as cells or cocoons afford.

### EMERGENCE HOLES

Emergence holes in wood are nearly always broadly elliptical, the ellipse often lying parallel or slightly obliquely to the grain of the wood. They are prepared by the larvae prior to pupation, and are with few exceptions plugged at the entrance with wooden fibres. In the case of larvae which construct the "indirect" or "simple" type of cell (e.g. *Monochamus*, *Agapanthia*), the emergence hole is nearly always excavated entirely by the adult, and if the species be cylindrical in form, as are most Cerambycids in this category, then the emergence hole is round.

### FACTORS INFLUENCING THE SHAPE AND NATURE OF GALLERIES AND CHAMBERS

1. *Thickness of bark.* This is perhaps the most important factor determining the position of the larval gallery and pupal chamber. Larvae which are normally sub-cortical feeders for their entire existence will, if the bark be unusually thin, tunnel into the sapwood long before maturity; consequently pupation will take place in an elongate cell in the sapwood instead of in a cavity beneath or in the bark. This is clearly demonstrated in the case of *Leiopus nebulosus* (Linnaeus) (see p. 277). On the other hand, species which normally pupate in the outer sapwood will, if the bark be exceptionally thick, pupate under, or even in the bark (*Acanthocinus*, *Clytus*).

2. *Girth of tree.* An interesting observation regarding the influence of this factor upon the larval habits of *Monochamus sutor* (Linnaeus) has been made by Trägårdh (1930). It appears that if the diameter of the trunk does not exceed twice the distance tunnelled by the larva prior to overwintering (i.e. about 7 cm.), the gallery will be continued in more or less the same direction, and emergence will occur at a point on the opposite side of the trunk (fig. 231A), but if the diameter of the trunk appreciably exceeds twice the distance travelled by the larva prior to overwintering, then the gallery will be continued in the form of a "U", so that emergence occurs on the same side of the trunk as the entrance hole (fig. 231B). Among other contributing factors may be included the feeling or derangement of the original position of the host, and in the case of root-feeders, the nature of the surrounding soil.

### CERAMBYCID EGGS

The form of Cerambycid eggs is variable, but is in general slender and either cylindrical, fusiform, or elongate-ovoid with rounded ends (figs. 49, 130). Intra-specific variations of form are common, especially among eggs laid in batches. In *Aromia moschata* (Linnaeus), for example, some eggs were observed to be straight with the middle enlarged, whereas others were slightly curved and parallel-sided; the

degree of flattening also varied (Duffy, 1949a). Owing to the softness of the chorion, the form of the egg appears to be readily modified by the shape of the crevice in which it has been deposited. According to Weidner (1936b), those of *Hylotrupes bajulus* (Linnaeus) which are laid at the beginning of the oviposition period are much more slender than those laid later. Eggs of some species (e.g. *Parandra brunnea* Fabricius) have a protuberant micropylar area.

The chorion may be smooth and slightly shining, or rugose and dull. It varies appreciably in thickness, and is occasionally thin and transparent as in *Stenocorus meridianus* (Linnaeus), or even soft and viscous as in *Phoracantha*. Often it exhibits externally some form of elaborate sculpture, being covered with pits, granules, spicules and even carinae and other processes. Usually the surface, especially near the poles, is covered with a vein-like reticulation comprising minute hexagonal areas which correspond with the overlying follicular cells. In some species, such as *Ergates faber* Linnaeus, the reticulation is very conspicuous and of a contrasting colour.

The usual colour of Cerambycid eggs is white but often with a yellowish or greenish tint, although that of many species is light brown or buff. The eggs of *Phytoecia cylindrica* (Linnaeus) are bright orange, whereas those of *Saperda populnea* (Linnaeus) are often tinted pink. Infertile eggs soon become dark brown or black.

Eggs of some species, such as *Prionus coriarius* (Linnaeus), although dull, are covered wholly or partly with a shining secretion, giving them a varnished appearance (Duffy, 1946a). Occasionally, as in *Leptideella brevipennis* (Mulsant), they are covered with a glutinous coating mixed with particles of earth or dust (see p. 197).

Butovitsch (1939) in his comprehensive review of the length-breadth ratio in Cerambycid eggs has tabulated the measurements of many species.<sup>1</sup> He has shown that, in general, Cerambycid eggs are about twice as long as broad, except in the LAMIINAE, where they are usually appreciably longer. It should be pointed out, however, that eggs of many LEPTURINAE and ASEMINAE are also strongly elongate as in *Stenocorus meridianus* (Linnaeus) (3.4 mm. by 1.75 mm.) and *Tetropium gabrieli* Weise (1.25 mm. by 0.25 mm.). The length of Cerambycid eggs, as would be expected, varies considerably, ranging from about half a millimetre to as much as a centimetre (*Titanus giganteus* (Linnaeus)). Contrary to previous accounts, the egg length does not necessarily, and in fact seldom does, increase directly in proportion to the length of the adult beetle. For example, the length of the egg of *Phytoecia cylindrica* (Linnaeus) is about one-fourth that of the length of the adult (8 mm.), whereas in *Titanus giganteus* (Linnaeus) it is only about one-twelfth that of the adult's length (130 mm.). In general, eggs of the LAMIINAE are larger than those of other subfamilies. This is probably due to the fact that species of this subfamily lay fewer eggs (see also p. 35).

<sup>1</sup> Egg-measurements of other species are given in the present work under the species headings.

# GENERAL MORPHOLOGY OF CERAMBYCID LARVAE

## LATER INSTARS

CERAMBYCID larvae are, in general, recognisable by their subcylindrical, elongate, tapering form; the pale pubescent cuticle, the comparatively short legs, the protracted mouthparts, the presence of abdominal ampullae, the gouge-shaped or wedge-shaped mandibles and the absence of segmented urogomphi.

Although remarkably constant in general form, there are numerous exceptions, ranging from the cylindrical, curved type (*Agapanthia*, fig. 266), to the straight, extremely depressed type (*Hargium*, *Apiocephalus*); and from the thick, robust type (*Moneilema*), to the extremely slender form of the Graciliini. Diversity in form is most evident in the LAMIINAE.

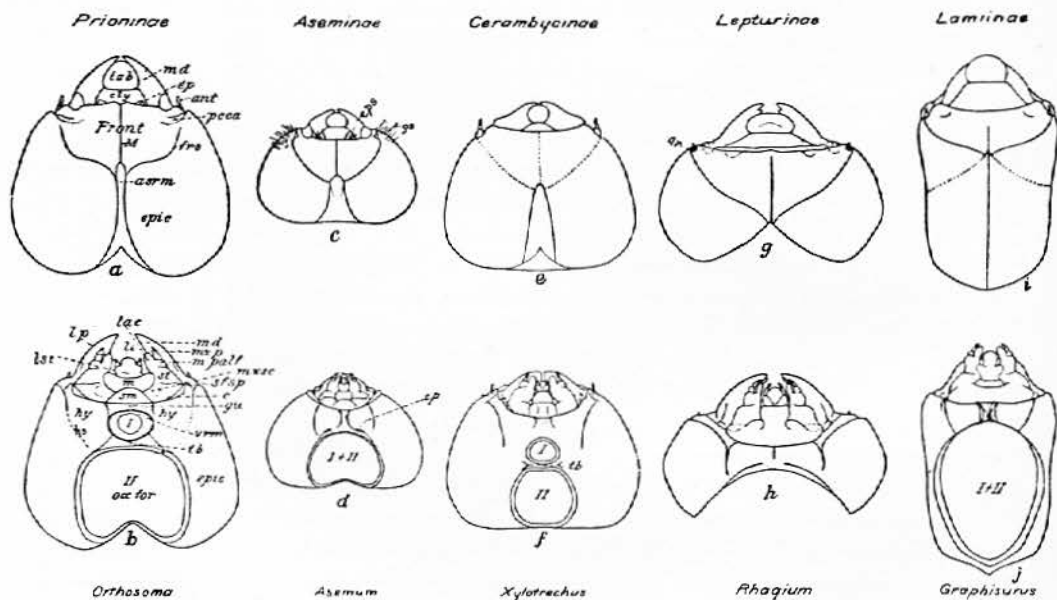


Fig. 8. Diagrammatic illustration of head types of various subfamilies of Cerambycidae. (Craighead, 1923)

### The Head<sup>1</sup> (figs. 8, 10, 11)

The head is large and strongly sclerotised anteriorly, and is deeply retracted in the prothorax. There are two fundamental types of head capsule: (1) head with the occipital foramen consisting of a single large orifice (LEPTURINAE, ASEMINAE, LAMIINAE);

<sup>1</sup> No attempt has been made here to establish the homologies of the cranial areas of the insect head. The terminology adopted is merely provisional, but agrees in general with that of Craighead (1923b), particularly as concerns the terms "frons", "clypeus", "gula" and "hypostoma".

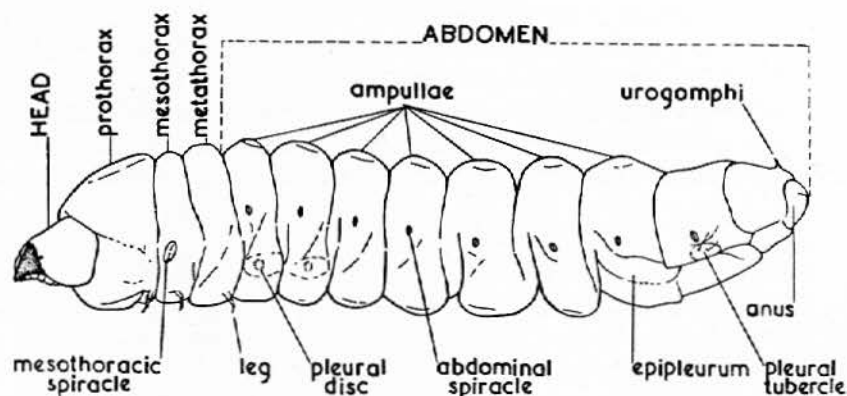


Fig. 9. Diagrammatic figure of a Cerambycid larva. Lateral aspect.

and (2) head with the occipital foramen divided into a small anterior, and a large posterior portion by the tentorial bridge (PARANDRINAE, PRIONINAE, CERAMBYCINAE). The first type of head capsule may be subdivided into two distinct forms, namely (a) head with sides parallel or converging posteriorly (LAMIINAE only), and (b) head with sides rounded and divergent posteriorly (LEPTURINAE, ASEMINAE). In the second type of head capsule the sides are always rounded and divergent posteriorly (fig. 10).

The head is usually slightly depressed, sometimes strongly so as in *Rhagium* and *Acanthocinus*; only occasionally is it thick and subcircular in cross-section

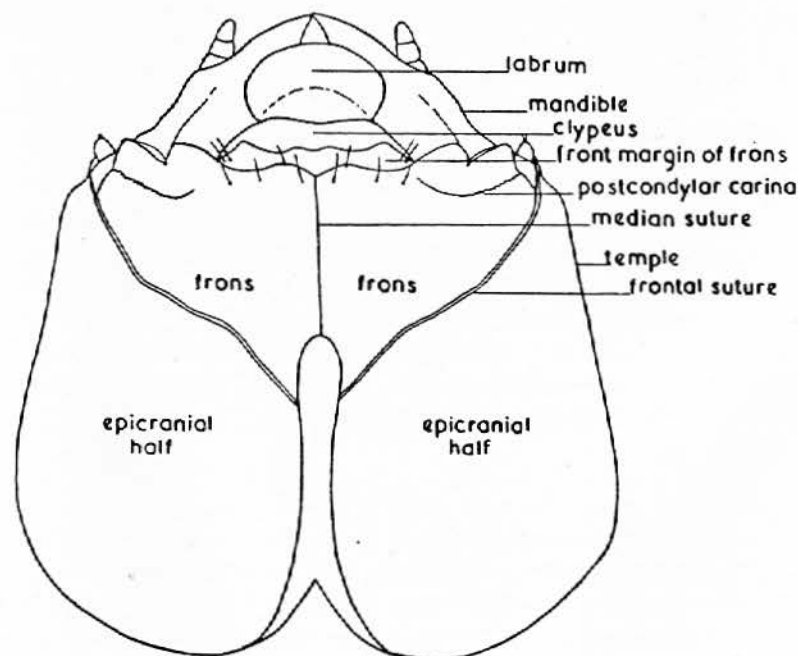


Fig. 10. Diagrammatic figure of larval head. Dorsal aspect.

(*Agapanthia*). Usually it is deeply retracted in the prothorax to which it is attached by a membranous collar, which enables it to be extended or retracted. In a few species the head is salient, as in those of *Agapanthia* and *Tetraglenes* (figs. 266, 19).

The dorsal surface of the head comprises two *epicranial halves* which are separated anteriorly by the more or less triangular frontal region (the hind margins being strongly divergent as in LEPTURINAE), or partly fused (PARANDRINAE, PRIONINAE, ASEMINAE,

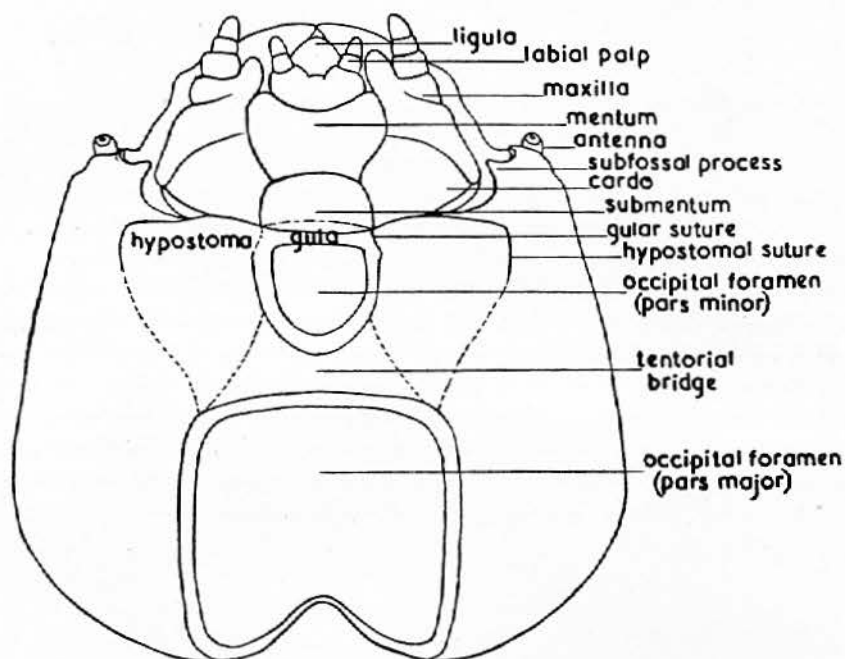


Fig. 11. Diagrammatic figure of larval head. Ventral aspect.

CERAMBYCINAE), or even fused for the entire dorsal length (LAMIINAE). Considerable uncertainty exists as to the exact extent of the frontal region or *frons*, but for the present purposes it should be regarded as the region bounded by the *frontal sutures* or dorsal cleavage lines. These sutures extend forward to the *antennal ring*, which they sometimes bisect and open behind; they are most distinct in the LEPTURINAE. The *frons* is bisected either partly or completely by the *median adfrontal suture*. In certain LEPTURINAE a distinct *transverse line* is present near the front margin, whereas in the PRIONINAE, behind the dorsal articulations of the mandible, is a curved carina, the *postcondylar carina*.

A morphological study of the *front margin of the frons* (named the epistoma by Craighead) may show that this region is actually the postclypeus. It varies considerably in form and is most elaborate in the PRIONINAE, in which the upper boundary may be keel-shaped or may project in four blunt teeth, and the lower boundary may project forward laterally in a pair of large lobes (fig. 46). In the remaining subfamilies, with few exceptions, it is more or less declivous. A transverse row of setae is always present: they have been called "*epistomal*" setae by Craighead, and it seems convenient to

adopt the term here pending further morphological study. In the CERAMBYCINAE there are four, in the PARANDRINAE and PRIONINAE six, but in the ASEMINAE and in certain LEPTURINAE and LAMIINAE there are ten to twenty or more setae.

Ventrally the epicranial halves are bridged anteriorly by the hypostoma and gula, and posteriorly by the tentorial structures. The *hypostoma* consists of two plate-like areas which are fused medially with the gula to form a broad ridge immediately behind the maxillae; these are delimited laterally by the *hypostomal sutures*. The gular region is usually delimited by a pair of reddish-brown curved lines which are often raised; these have been termed "*gular-sutures*", although they actually appear to be lines of strengthening. In certain genera of the LEPTURINAE and LAMIINAE these "sutures" are obsolete, in which case a pale median line<sup>1</sup> is present, the "*gular-line*" of Craighead; in this work it will be referred to as the *ventral cleavage line*. Although the gular region is usually glabrous, one or two pairs of setae sometimes occur, while in the Acanthocinini the setae are more numerous. In the ASEMINAE, LAMIINAE, and LEPTURINAE the origin of the posterior tentorial arms is indicated externally by a pair of pits, one at the posterior inner angle of each hypostomal plate. From each pit the tentorial arms extend internally to the frontal sutures as rods of pale cuticle; these are connected by the short tentorial cross-arm. In the PARANDRINAE, PRIONINAE, and CERAMBYCINAE the cross-arm lies in the same plane as the hypostoma, forming a bridge behind it, the *tentorial bridge*. Thus the occipital foramen is divided into a small anterior portion (*pars minor*<sup>2</sup>) and a larger posterior portion (*pars major*).

The lateral region of the epicranium between the dorsal articulations of the mandible and the antenna is known as the *gena*: it is either shouldered as in *Phoracantha* or gradually narrowed up to the base of the mandible as in *Molorchus* (fig. 161); usually it is rather strongly sclerotised anteriorly and bears several setae, the genal setae, which are sometimes characteristically curved as in *Molorchus* (fig. 161). The lateral region behind the antenna, *the temple*, is usually glabrous and pale. Behind the ventral articulation of the mandible in the PRIONINAE, and occasionally in the CERAMBYCINAE, there is to be seen a conical tubercle, the *subfossal process*. The *ocelli* or simple eyes are situated on the gena, usually laterad or ventrad of the antenna. Each ocellus consists of a black or grey pigmented spot (often deep beneath the cuticle) and a biconvex lens (or cornea) which is a small transparent round or oval area in the cuticle; the latter may vary from being almost flat, to being strongly convex and protuberant. In the majority of larvae there is only a single ocellus on each side, but sometimes there may be three small, subcontiguous ocelli in a row, as in *Cerambyx* and *Grammoptera*, or, more rarely, two as in certain Phoracanthini. In *Hylotrupes*, besides the three subcontiguous ocelli, there are two widely separated vestigial ocelli (the lens being absent); whereas in *Oberea*, which has one large ocellus, there are from one to three vestigial ocelli behind it, each consisting of a greyish pigmented spot without a distinct lens. The larva of *Acmaeops collaris* (Linnaeus) is apparently unique in having six pairs of conspicuous ocelli. Only in comparatively few species are the ocelli absent.

<sup>1</sup> Hinton (1948a) points out that paired or single cleavage lines (often confused with gular sutures) occur in the ventral surface of the head of Coleopterous larvae.

<sup>2</sup> The nervous system and the cephalic retractor muscles extend through the *pars minor* (Heller, 1904; Paulian & Villiers, 1941).

Anterior to the front margin of the frons is the membranous *clypeus*<sup>1</sup> to which is attached the labrum. The former is usually trapezoidal, widest posteriorly, and completely occupies the space between the dorsal articulation of the mandibles, with the exception of the CERAMBYCINAE, in which it is unusually narrow. It was previously supposed always to be glabrous, but in *Phryneta* and *Saperda* distinct groups of lateral setae are present.

The *labrum* is fringed anteriorly with numerous setae which may be short and bristly, or long and fine; sometimes a median depression or furrow is present as in *Batocera*. In form it varies between strongly transverse and slightly elongate, and it is usually more or less semicircular, orbicular or cordate.

The *antenna* has usually been presumed to consist of three strongly sclerotised segments, and little use has been made of its diagnostic value, probably owing to its small size. In all species described in the present work the antenna has been critically examined, and it is now apparent that there are many genera in which it is apparently only two-segmented, the "third segment" being minute, hyaline, tapering and devoid of setae, and probably merely a supplementary process. This diversity is of tribal and generic significance. The antenna is attached to the head capsule by a large *basal membrane* which has often in the past been erroneously regarded as the basal segment; in some CERAMBYCINAE it is strongly elongate as in *Stromatium* (fig. 139). The basal segment is always very elongate and is either totally, or for the greater part, concealed beneath the basal membrane. The second segment may be transverse, quadrate, or elongate, and except in certain LAMIINAE bears in addition to, and beneath the third segment (when present), a minute, tapering, glabrous, hyaline process referred to here as the *supplementary process*: the shape of this process is sometimes of specific value as in *Molorchus* (figs. 162, 170). But it is the presence or absence of the third segment which is of by far the greatest diagnostic importance. This segment is, apparently without exception, cylindrical, strongly sclerotised and apically setose, and is thus quite distinct from the accompanying supplementary process which is usually much shorter, and is always tapering, hyaline and devoid of setae (figs. 13a, 13b). It is now evident that the third antennal segment is absent in certain tribes of the PRIONINAE, ASEMINAE, LEPTURINAE and LAMIINAE, but no reduction in segmentation has yet been found in the PARANDRINAE and CERAMBYCINAE.

The *mandibles* are of two distinct types. In the CERAMBYCINAE they are comparatively short, stout, and with rounded gouge-like cutting edges (fig. 123). This type of mandible is often divided by a transverse ridge into a pale basal part and a dark apical part, a distinct longitudinal impression generally being present on the outer surface of the latter. In the remaining subfamilies they are wedge-shaped, much more slender, sometimes extremely so as in many LAMIINAE, and the cutting edge is always oblique (fig. 67). Sometimes the dorsal angle of the cutting edge is toothed or flattened into a striated plate as in some LEPTURINAE. Both types of mandible bear at least two setae on the basal half of the outer face; in many ASEMINAE and LAMIINAE there are numerous setae.

The *maxillae* (fig. 12) are large, fleshy and protracted, and are attached to

<sup>1</sup> A study of the cibarial muscles may show this to be only the anteclypeus, and the posterior part to be fused with the frontal region.

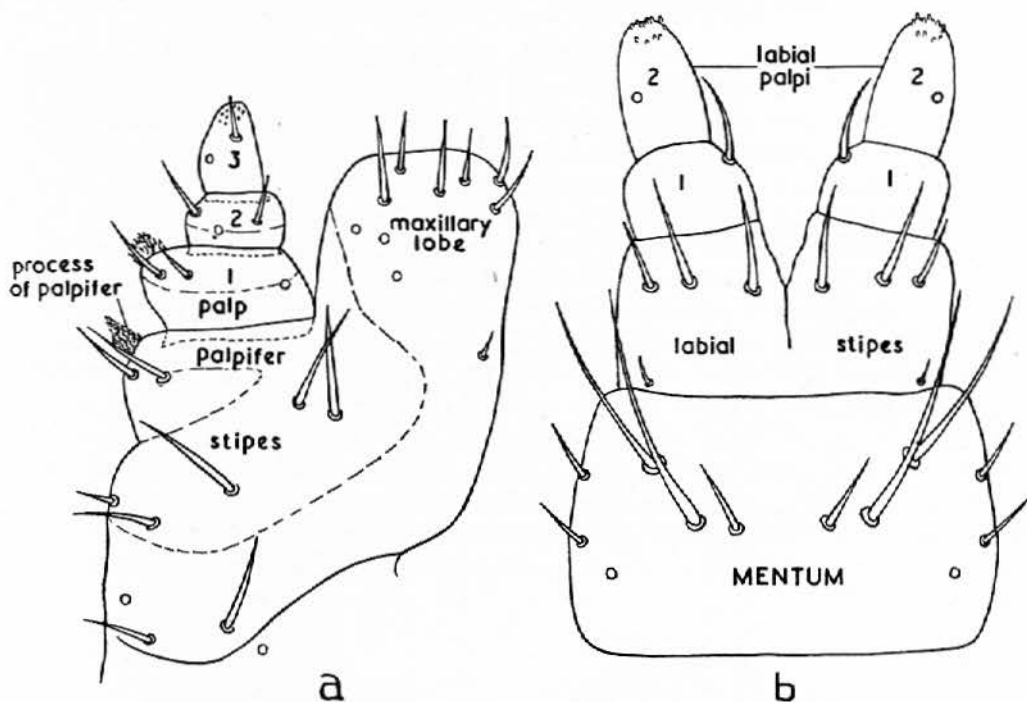


Fig. 12. Diagrammatic figure of ventral mouthparts of larva. Ventral aspect.

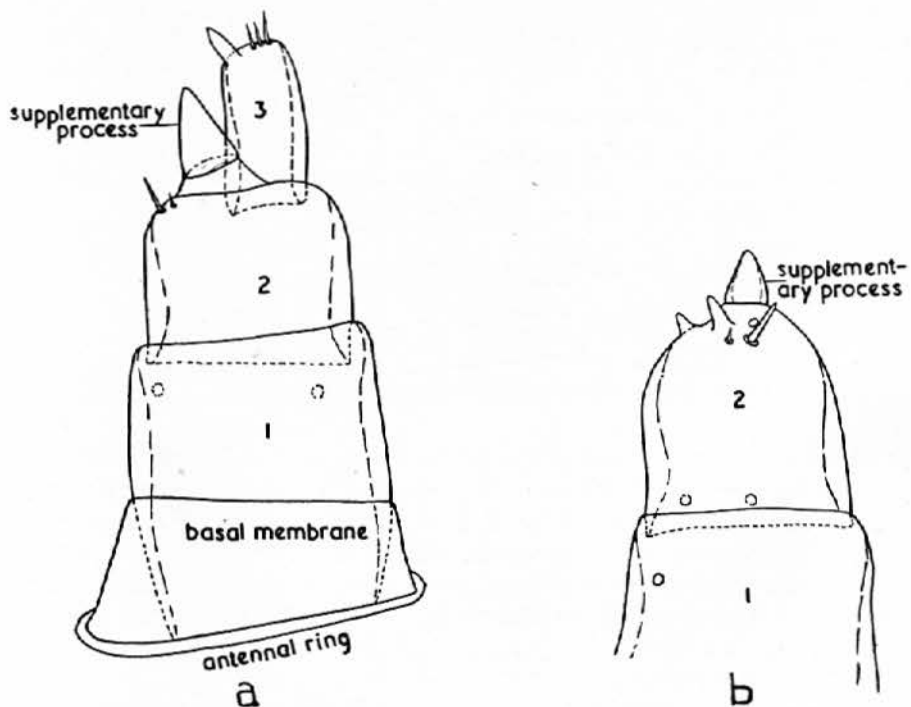


Fig. 13. Diagrammatic figure of larval antenna.

the front margin of the hypostoma and gula by the *submentum*. The latter may either distinctly be delimited from the *mentum* by a transverse impression, or fused with it. Attached to the *mentum* is the *ligula* and the paired *labial stipes*, each of which bears a two-segmented *labial palp*. On each side of the *mentum* lies the *maxilla*; each consists of the *maxillary articulating area* (with which it is attached to the *submentum*), the *cardo*, the *stipes* and the *palpifer*, which bears the *maxillary lobe* and the *maxillary palp*. Sometimes the *palpifer* bears on its outer face a small teat-like lobe known as the *process of the palpifer* which is very conspicuous in the Callidini. A similar but smaller process is occasionally present on the first palpal segment. The maxillary palp is nearly always three-segmented: the few exceptions include *Pogonocherus hispidus* (Linnaeus) and *Tetrops praeusta* (Linnaeus). The maxillary lobe in the CERAMBYCINAE is broad, flat, sparsely setose or glabrous on the inner margin, and curved upward apically against the ventral surface of the mandible. In the remaining subfamilies it is usually slender, subcylindrical and setose on the inner margin. The *cardo* and maxillary sclerite are distinctly defined and movable except in the LAMIINAE. The maxillae may be attached to the hypostoma only by little more than the width of the gula (CERAMBYCINAE) or for the entire distance between the articulation of the mandibles as in the LAMIINAE.

#### The Thorax (figs. 14, 15)

The *prothorax* is, without exception, the largest of the thoracic segments, being about equal in size to the meso- and metathorax combined, and it is the most important segment from the taxonomic point of view, particularly with regard to its sculpture and chaetotaxy. The dorsal surface consists mainly of a large rectangular, sclerotised plate, the *pronotum*. With the exception of certain LEPTURINAE, this is generally

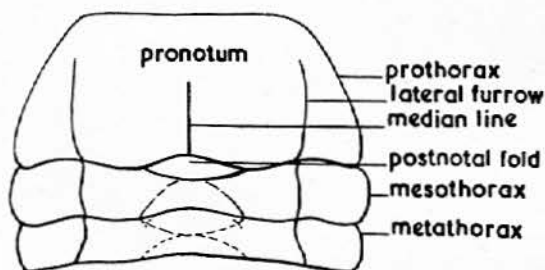


Fig. 14. Diagrammatic figure of larval pro-, meso- and metathorax. Dorsal view.

delimited by a distinct longitudinal furrow, the *lateral furrow*. Usually the pronotum is bisected by a longitudinal, median *cleavage line* which may be impressed or slightly raised, and often indistinct anteriorly. It is the posterior half of the pronotum which usually provides the most useful taxonomic characters, varying in sculpture, armature, etc. In the PARANDRINAE, ASEMINAE, and many LAMIINAE, it is asperate or spiculate, whereas in the PRIONINAE and CERAMBYCINAE it is generally longitudinally rugose or striate. In certain *Monochamus* species it is finely pubescent.

Posterior to the pronotum in the PARANDRINAE, PRIONINAE and many CERAMBYCINAE is a transverse fold, the *postnotal fold*. The ventral region of the prothorax

(*prosternum*) consists of an anterior, more or less triangular area, the *presternum* and a posterior region which is divided into the *eusternum* and the *sternellum*. The *eusternum*, although often undefined, is usually semicircular or triangular, and may be setose, asperate, pubescent, rugose or glabrous; its diagnostic value is greatest in the

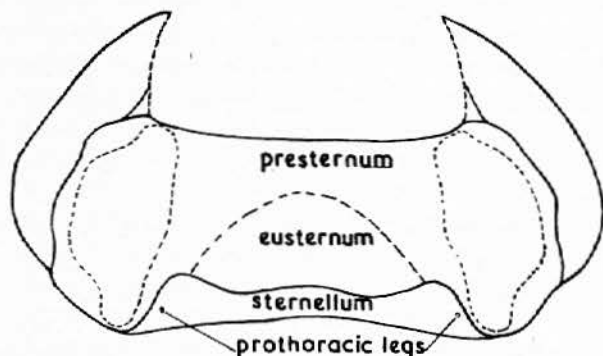


Fig. 15. Diagrammatic figure of larval pro-, meso- and metathorax. Ventral view.

LEPTURINAE where it is always well defined. Dividing it from the posterior sternellum is a transverse furrow extending between the front pair of legs (when present). With the exception of certain LAMINAE, the dorsal surface of the meso- and metathorax (i.e. the mesotergum and metatergum) is usually divided by X-shaped sutures into an anterior *prescutum* and a posterior *scutellum*, although the metatergum may have only a single transverse suture. The mesosternum and metasternum are each divided into the *eusternum* and *sternellum* by a transverse furrow.

#### The Legs (fig. 16)

The *legs* are never strongly developed in the Cerambycidae. They are most conspicuous in the LEPTURINAE: in the present material they appear to be longest in *Judolia* in which they protrude laterally beneath the thorax and are visible from above. In all the other subfamilies they are considerably smaller and in many of the CERAMBYCINAE and all the LAMIINAE they are either vestigial (in the form of a minute spine or setose tubercle) or absent. They are always widely separated, more or less conical, with a spine-like *unguiculus* or

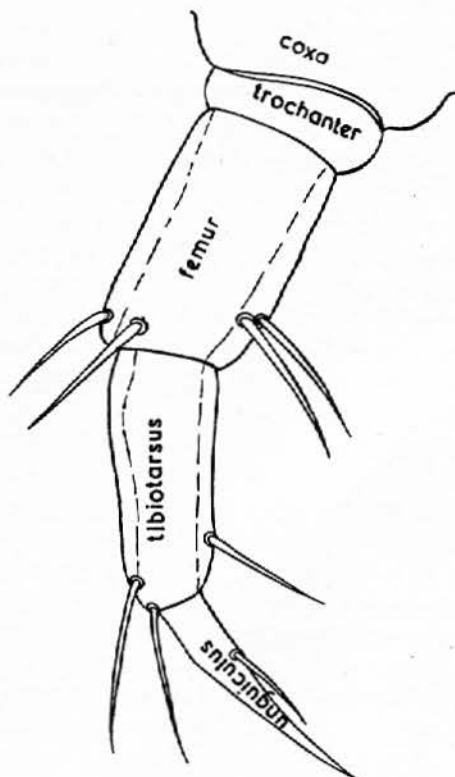


Fig. 16. Diagrammatic figure of larval leg.

claw; the latter may be straight or stout (fig. 39), flagelliform (fig. 152), or with a conspicuous basal seta (fig. 62), and is often imbricately spinose. Except when vestigial, the legs are two- to four-segmented. The basal segment or *coxa* is a fleshy lobe surrounded by the hypopleurum, eusternum, and sternellum. In most PRIONINAE and LEPTURINAE the coxae are strongly transverse, so that they almost meet medially. Between this segment and the unguiculus (which is here regarded as an appendage—not a segment) lie the *trochanter*, *femur* and *tibiotarsus* (see Emden, 1934). The relative proportions of the femur and tibiotarsus are of taxonomic importance in the LEPTURINAE.

#### The Abdomen (fig. 9)

The abdomen is ten-segmented. The tergal and sternal areas of the first six or seven segments are very similar in structure, being developed into large, fleshy, oval protuberances known as *ambulatory ampullae*, which assist the larva in moving along its gallery. The dorsal ampullae bear one to three transverse impressions (the ventral never more than one), and are delimited by a pair of *lateral furrows*; usually a median, longitudinal furrow is also present. In the PARANDRINAE and PRIONINAE the two transverse impressions are very distinct, but in most species of the CERAMBYCINAE the posterior one is indistinct or absent. The surface texture of the ampulla varies considerably, and is of great diagnostic value. It is asperate or spiculate in certain groups of all subfamilies, though rarely so in the CERAMBYCINAE. In the LEPTURINAE, and in some CERAMBYCINAE and many LAMIINAE, there are conspicuous rows of moniliform tubercles present. Occasionally the ampulla is deeply bilobed and strongly protuberant as in *Obrium* (fig. 175) and *Agapanthia* (fig. 266).

With the exception of the tenth, each abdominal segment is divided into a dorsal and ventral region by a protuberant fold, the *epipleurum*. It is often marked only on segments seven to nine, but in the LEPTURINAE and many LAMIINAE it is raised on all segments. In many species the epipleurum bears a conspicuous though small protuberance, the *pleural tubercle*, which is particularly well defined in the LAMIINAE and LEPTURINAE. The number of setae present is of diagnostic importance. In most LAMIINAE two conspicuous setae are present, but in the Pogonocherini there is only one, while in the Monochamini there are several. Moreover, in this subfamily many species have a small sclerotised pit at both the postero-dorsal and antero-ventral ends, that on the latter usually being less distinct (fig. 227). In the PRIONINAE and CERAMBYCINAE, however, the first six abdominal segments (when the epipleurum is not protuberant) instead of bearing a pleural tubercle, usually have a small round or triangular area of contrasting texture known as the *pleural disc*. These are often conspicuous on the first three segments only, especially in certain PRIONINAE, although in some species they are discernible on segments one to eight. Each disc has a median pore-like depression from which a minute sclerotised cap usually projects; the area surrounding this depression may be radially striate as in *Prionus* (fig. 37), finely rugose, granulate, or reticulate. These discs (fig. 17), like the paired pits in certain LAMIINAE, have been carefully studied by Hess (1917), who regards them as the external parts of chordotonal organs.

The ninth abdominal segment is frequently of greater taxonomic importance than

are the other segments. In the PARANDRINAE and PRIONINAE it is always elongate, swollen and extended, whereas in most other larvae it is more or less telescoped into the eighth segment. In *Agapanthia* and allied genera of the LAMIINAE, this segment is of a characteristic form, being swollen, as wide and high as the eighth, and truncate apically. Occasionally it is strongly sclerotised. It often bears on the tergum paired, sclerotised, spine-like protuberances, the *urogomphi*, as in the ASEMINAE (figs. 109, 121). In some LAMIINAE this segment is equipped with a median spine or sclerotised plate at or near the posterior margin. In *Phrynetia* (fig. 247), for example, there is a stout, curved spine, the base of which is concealed beneath the posterior margin, whereas

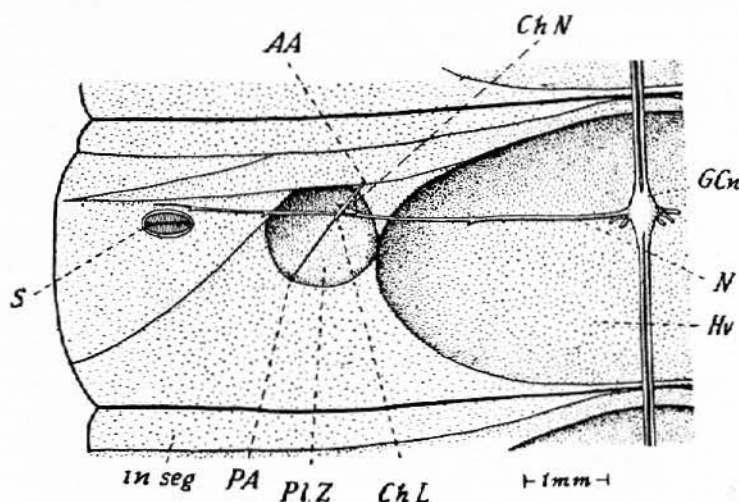


Fig. 17. *Ergates spiculatus* Leconte. Left side of third abdominal segment opened from the dorsal side. AA, anterior attachment of chordotonal ligament; Ch L, chordotonal ligament; Ch N, chordotonal nerve; G Cn, ganglion of central nervous system; Hy P, hypopleurum; in seg., intersegmental area; N, nerve; P A, posterior attachment of chordotonal ligament; Pl Z, pleural zone; S, spiracle. (Hess, 1917)

a small, vertical spine is present in the Mesosini (fig. 240). The sclerotised process in *Pogonocherus* may be in the form of a flat, striated plate, the centre of which may or may not be produced into a vertical spine or a longitudinal keel (figs. 251, 255, 256). In *Rhagium* the spine is caudal and horizontal (fig. 61). The tenth abdominal segment comprises the lobes surrounding the anus. The latter is usually trilobate, sparsely setose and strongly protuberant as in the PRIONINAE and certain LAMIINAE; occasionally there are only two lobes present, one above and one below the anal cleft, which is transverse as in *Lamia* and *Phrynetia*; in the latter the dorsal lobe is strongly sclerotised medially (fig. 247). Only very rarely does this segment bear a spine or process. In a few LEPTURINAE (*Acmaeops*, *Apioccephalus*) the anus is ventral instead of terminal and is used as a pseudopod (fig. 52).

### Spiracles

The term "spiracle" includes not only the external aperture and surrounding sclerite, the peritreme, but also the atrium and closing apparatus. In mature larvae

the spiracle is apparently without exception of the bilabiate type, each lip being fringed with complicated, branched processes. The number of paired spiracles appears to be constant, that is, one mesothoracic, one metathoracic, and eight abdominal; no instances of reduction have been observed.

The largest and most conspicuous spiracle is that of the mesothorax. Its exact position on the pleurum varies slightly: in the PRIONINAE and LAMIINAE it protrudes into the prothorax, but in the remaining subfamilies it does not extend beyond the mesothorax. Unlike those of certain other coleopterous larvae, it appears to be essentially the same as those of the abdomen, differing from them only in size. The metathoracic spiracle is vestigial and non-functional. The abdominal spiracle is situated on the epipleurum: with the exception of the LEPTURINAE and LAMIINAE this region bears a slightly raised elliptic area in the centre of which the spiracle is situated. The first abdominal spiracle is always the largest, the succeeding ones decreasing in size as far as the fourth or fifth, and then gradually becoming larger so that the eighth is at least almost as large as the first.

The shape and structure of the peritreme has proved to be of the greatest significance in the present study. In general shape the peritreme varies considerably: it may be round as in *Pogonocherus* and *Agapanthia* (fig. 268), broadly oval as in *Monochamus* (fig. 227) and *Rhagium* (fig. 60), narrowly oval as in *Saperda*, or slot-like as in *Oberea* (fig. 285). The thickness and degree of sclerotisation seems to vary more or less directly with the size of the species: in small species such as *Molorchus* it is thin and feebly sclerotised, whereas in *Prionus* and *Cerambyx* it is usually extremely thick and ferruginous.

An interesting modification in the structure of the peritreme was apparently first described by Steinke (1920), who noticed the presence of a series of small marginal "air-chambers" in the peritreme of *Rhagium* larvae. Later, Gardner, in a series of papers on Indian Cerambycid larvae (1942-1944), draws attention to the fact that the peritreme of mature larvae of the LEPTURINAE has multiple marginal "air-chambers", while in the ASEMINAE two or more subcontiguous marginal "air-chambers" are present. Further study undertaken by the present writer has shown that not only does this modification occur without exception in all the known British species of LEPTURINAE and ASEMINAE, but also that similar marginal chambers are present in various tribes and genera of the remaining subfamilies. In the present work the term "air-chamber" will be replaced by the non-committal "chamber", since it is difficult to conjecture what part, if any, these chambers play in respiration, for there appears to be no connection with the tracheae.

In the PARANDRINAE (*Parandra*) these chambers are conspicuous, and rather elaborate in form, the posterior half of the peritreme having from ten to twelve elongate chambers which give it a crescentic appearance (fig. 29). Larvae of the PARANDRINAE may apparently be distinguished from those of the PRIONINAE by this character alone, for in the latter, the chambers, when present, are very small and do not extend as far as the outer margin of the peritreme. The peritreme in Lepturine larvae has from eight to twenty distinct marginal chambers which appear to be most strongly developed in *Judolia* (fig. 100) and *Acmaeops*, where they form a conspicuous and characteristic crescent.

The chambers in the ASEMINAE are either two, or six to twelve in number. In the case of the former, which is characteristic only of *Tetropium* (fig. 117), they are large, conspicuous, and protrude from the outer posterior margin of the peritreme, but in *Arhopalus* and *Asemum* they are small and confined to the inner margin. In the CERAMBYCINAE this modification has so far been found to occur only in the Phoracanthini (*Elaphidion* only) and the Cerambycini; in the latter they are most evident in *Pachydissus* (fig. 133) and *Plocaederus*, where there are about nine small but distinct chambers on the inner margin. Gardner (1931) records the presence of "air-chambers" in the Molorchini (*Epania*), but such chambers are not found in the British species of *Molorchus*. In the LAMIINAE, chambers have been found in nine genera. In *Moneilema*, *Acanthocinus*, *Leiopus*, *Mesosa* and *Pogonocherus* there are from five to eight subcontiguous chambers on the inner margin of the peritreme, whereas in *Coptops* (fig. 243) there are about twenty-four. *Agapanthia* appears to be unique in having about thirty subcontiguous chambers, which occupy the entire inner margin of the peritreme (fig. 268). In the Tetraopini there appears to be unusual diversity in the structure of the peritreme: Gardner (1944) draws attention to the presence of a pair of conspicuous "air-tubes" which extend from the peritreme in *Chreonoma* larvae (fig. 289); in *Tetrops*, however, the present writer has found that the inner margin is produced into several digitiform processes which are inclined upward to support (?) a crescentic membrane, which covers about half the surface area within the peritreme (fig. 288). No doubt a more comprehensive study of the larval spiracle will reveal many more instances of similar modifications, and perhaps of greater diversity.

### FIRST INSTAR

In Cerambycid larvae there are considerable differences between the first and succeeding instars. For example, the first-instar larva of *Rhagium bifasciatum* Fabricius has no terminal spine (so characteristic of the mature larva) and possesses five pairs of ocelli. The following are the chief characters peculiar to first-instar larvae:

(i) *Antenna*. Generally speaking, the antenna differs from that of the mature larva only in the proportionate length of the hyaline supplementary process, and the apical setae (when present) of the third segment. A curious exception to this is to be found in the ASEMINAE, where the apical antennal segment is tapering, hyaline and devoid of setae instead of being strongly sclerotised and setose as in the mature larva.

(ii) *Mandible*. Attention has recently been drawn (Pavan, 1948a) to the presence of an anteriorly directed, tooth-like process near the middle of the outer face of the first-instar larval mandible of *Lamia textor* (Linnaeus) (fig. 218), and *Morimus asper* Sulzer. Pavan regards them as true egg-bursters (see p. 60). It would seem probable that this mandibular process is confined to the Lamiini, for the present writer has been unable to find any indication of such a process in other first-instar larvae.

(iii) *Mouthframe*. Diversity in this structure was apparently first noticed in the case of *Prionus coriarius* (Linnaeus) (Duffy, 1946a): in this species the front margin of the frons of the first-instar larva is produced into a conspicuous median lobe (fig. 41), which in later instars is gradually replaced by two paramedian lobes (see also p. 109).

Pavan (1948a) records the presence of similar protuberances on the front margin of both the frons and hypostoma of *Lamia textor* (Linnaeus) (fig. 217) and *Morimus asper* Sulzer; these he regards as being instrumental in the rupturing of the chorion (see also p. 6).

(iv) *Ocelli*. So far, with only two exceptions, the number of ocelli appears to be constant throughout all the larval stages of each species. The exceptions are the genera *Rhagium* and *Stenocorus*, larvae of which possess five distinct pairs of ocelli in the first instar. Generally speaking, the pigmented spot is very conspicuous in the first-instar larva, and becomes less distinct as the larva matures, and especially shortly before pupation.

(v) *Legs*. These always seem to be proportionately longer in the first instar than in the succeeding stages, especially the unguiculus, which in many species, particularly the ASEMINAE, is strongly attenuated (fig. 112). This prolongation no doubt affords the larva extra purchase during the precarious operation of excavating its gallery.

(vi) *Ninth abdominal segment*. One of the chief larval characteristics of the PRIONINAE is the elongate, extended ninth segment. In the case of *Prionus coriarius* (Linnaeus), this segment (fig. 40) is transverse in the first instar, but it yet remains to be seen whether this condition prevails throughout the subfamily.

(vii) *Caudal armature*. Another striking characteristic of first-instar larvae is the absence of caudal armature. In all the British species of the ASEMINAE, the urogomphi are indiscernible at this stage, while the caudal sclerotised process of *Rhagium* and *Pogonocherus* larvae appears to be totally absent. These processes are apparently not evident until after the second or third ecdysis.

(viii) *Setae*. All the cephalic, thoracic, and abdominal setae of first-instar larvae are considerably longer in proportion to those of later instars. This is clearly shown in *Prionus coriarius* (Linnaeus).

(ix) *Egg-bursting spines*. The most characteristic feature of first-instar Cerambycid larvae appears to be the presence of egg-bursting spines. According to Emden (1946) there are three types of egg-bursters in the Arthropoda, those of the Coleoptera Polyphaga being designated by him as "persistent thoraco-abdominal egg-bursters". In 1944, while investigating the biology of *Aromia moschata* (Linnaeus) (Duffy, 1949a), the present writer discovered that the first-instar *Aromia* larva was equipped with stout, ferruginous spines (fig. 184) which were situated in pairs dorso-laterally on the third, fourth, fifth, and sometimes the sixth abdominal segments: they were conspicuous and visible through the chorion some days before the larva was due to emerge. Up to this time egg-bursting spines were apparently unknown in Cerambycid larvae, the nearest approach to this condition being in *Crioceris* (CHRYSOMELIDAE), the larva of which bears a pair of curved spines on the first abdominal segment only (Emden, 1925). Gardner (1927) referred to the presence of "a blunt, chitinous tooth" above each abdominal spiracle in the first-instar larva of *Dihammus cervinus* Hope; these were evidently egg-bursters, although he made no comment on their function or significance. Later, Husain & Khan (1941) recorded the presence of a "thick spine directed backwards" behind each abdominal spiracle in the first-instar larva of *Batocera rufomaculata* Degeer (fig. 235). Pavan (1948a) has recently recorded the presence of similar spines in *Morimus asper* Sulzer and *Lamia textor* (Linnaeus) (fig. 217) which

are present in both cases on the first eight abdominal segments: he does not, however, agree that they fulfil the function of egg-bursters (see p. 6).

In the present work, the writer has found egg-bursting spines to be present in a number of species, including the following: *Rhagium bifasciatum* Fabricius (fig. 63), *R. mordax* Degeer (fig. 68), *Stenocorus meridianus* (Linnaeus), *Tetropium gabrieli* Weise, *Asemum striatum* (Linnaeus), *Arhopalus ferus* (Mulsant), *Molorchus minor* (Linnaeus), *Phymatodes testaceus* (Linnaeus), *Anaglyptus mysticus* (Linnaeus), *Saperda populnea* (Linnaeus), and *Phytoecia cylindrica* (Linnaeus). In all cases they occurred on the first eight abdominal segments, but in the species of ASEMINAE and LEPTURINAE examined they were also present, though appreciably smaller, on the meso- and metathorax. *Aromia moschata* (Linnaeus) thus appears to be unique in having the spines confined to segments three to five or six. So far the only species in which the spines are definitely known to be absent is *Prionus coriarius* (Linnaeus) (Duffy, 1946a); it will be interesting to see whether this is applicable to the entire subfamily. In the remaining subfamilies, however, the occurrence of these spines is widespread and it should be safe to assume that there will be comparatively few, if any, exceptions. These solidly sclerotised spines are shed at the first larval ecdysis and no traces of them are to be found in the succeeding instars.

(x) *Spiracles*. Although the number and position of the first-instar spiracles appear to be the same as in the later instars, there exists a very marked difference in structure. The diversity was first recorded by Gardner (1925), who observed that the first-instar larval spiracles of *Hoplocerambyx*, *Xylotrechus*, and *Dihammus* were biforous. Subsequently (1927, 1931) he found that this also applied to other groups and encountered only one exception—an unidentified Callichromine larva which had the bilabiate type of spiracle characteristic of the mature larva.

The examination by the present writer of all the British material available has shown, without exception, a similar diversity, all the spiracles of the first-instar larvae being of the bicameral, biforous type. Although apparently essentially the same, the contiguous finger-like lobes, which constitute the external apertures in this type of spiracle, vary considerably in form. In *Lamia textor* (Linnaeus) (fig. 219) they are large, slipper-shaped, and extend obliquely down to the atrium, whereas in *Rhagium mordax* Degeer (fig. 69) they are small, less elongate, with strongly corrugated margins, and are placed almost horizontally. In *Prionus coriarius* (Linnaeus) the two lobes are scarcely larger than the circumference of the atrium, and in *Arhopalus ferus* (Mulsant) one lobe is distinctly shorter than the other. In the second instar the spiracles are apparently always bilabiate and open directly into the atrium, the bicameral structure having disappeared.

### SOME EXCEPTIONAL FORMS OF CERAMBYCID LARVAE

In general, Cerambycid larvae are remarkably constant in appearance and form, hence it may be of interest to draw attention to a few unusual or abnormal exceptions, despite the fact that most of the species concerned scarcely come within the province of the present work and that there is little likelihood of their ever being imported into this country.

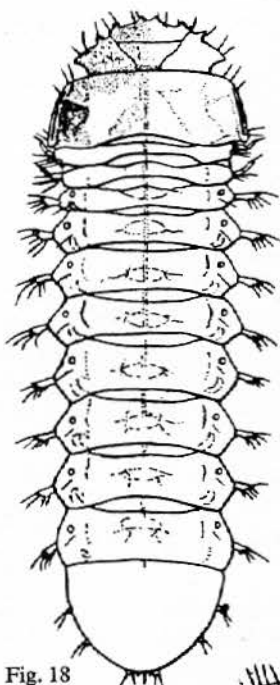


Fig. 18

Perhaps the most remarkable Cerambycid larvae yet discovered are those of the Indian Lepturine genus *Apiocephalus* (fig. 18). These larvae are extremely depressed, with the head strongly produced and angulate laterally, and the first eight abdominal segments each bearing a pair of large, rigid, lateral projections, which resemble legs (see also p. 119). In these respects these larvae are totally unlike any other known species. According to Gardner (1931) these larvae, as would be expected, feed entirely subcortically. Striking affinities towards this larva are exhibited in the British Lepturid *Acmaeops collaris* (Linnaeus), especially in the form of the head capsule, the ninth and tenth segments and the ventral ocelli.

Another curious larva described by Gardner (1931) is the Indian Lamiid *Tetraglenes insignis* Newman (fig. 19). In this species the head is salient, a most unusual feature in Cerambycid larvae. The nearest approach to this condition in European species is to be found in *Agapanthia* larvae.

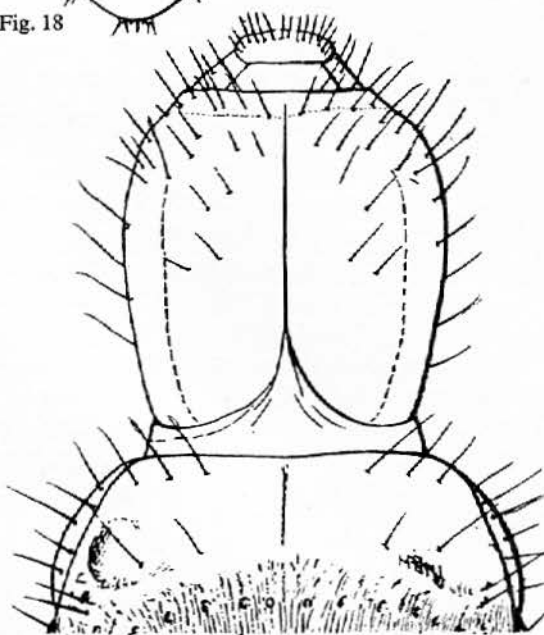


Fig. 19

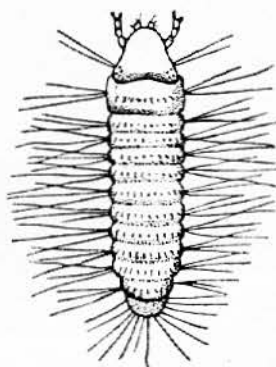


Fig. 20

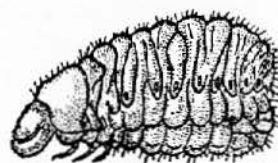


Fig. 21

Fig. 18. Larva of *Apiocephalus* group. Dorsal aspect. (Gardner, 1931)

Fig. 19. *Tetraglenes insignis* Newman. Larval head and prothorax. Dorsal aspect. (Gardner, 1931)

Fig. 20. *Vesperus xatarti* Duftschmid. First-instar larva. Dorsal aspect. (Mayet, 1884)

Fig. 21. *Vesperus xatarti* Duftschmid. Mature larva. Lateral aspect. (Mayet, 1884)

As already pointed out, the ninth abdominal segment is often equipped with some form of caudal armature. In the larva of an unidentified species of *Phaula* (LAMIINAE) from Brazil, the ninth segment is curiously modified, being produced posteriorly into a long, thick, claw-like process which is bifurcated apically (fig. 1); the dorsum of the tenth segment is strongly sclerotised (see also p. 12).

Another curious South American larva is that of *Trachyderes hilaris* Bates (fig. 149), which bears three large sclerotised, striate plates on its abdominal sternites (see p. 13).

In the case of the European *Vesperus xatarti* Mulsant there are two distinct and unusual larval forms. In the first instar the larva is cylindrical, parallel-sided, with extremely long antennae and abdominal setae (fig. 20), whereas the mature larva is very robust, increasing in girth posteriorly and is abruptly truncate (fig. 21).

### FAMILY CHARACTERS OF CERAMBYCID LARVAE

The following summary of the larval characters of the Cerambycidae has mainly been adapted from that by Craighead (1923b):

*Form* elongate, usually subcylindrical, occasionally cylindrical or strongly depressed. Cuticle thin, often rather leathery, especially on prothorax; never deeply pigmented or extensively sclerotised, usually greyish or milky white or pale testaceous; pubescent, especially on lateral regions.

*Head* extensible, usually deeply invaginated into prothorax; occiput large, occipital foramen very large, ventral and often divided into two portions by the tentorial bridge. Ventral surface with a broad, transverse bridge formed completely or mainly by the large hypostoma, the front margin of which is never strongly curved or retracted. Clypeus distinct, membranous, usually glabrous. Mandibles short, cutting edge either oblique or gouge-like; never with molar part or prosthema. Antennae usually strongly retractile; second segment usually bearing a tapering hyaline process; generally three, but sometimes apparently only two-segmented (see p. 52); basal membrane often large and conspicuous. Maxillae protracted but compact; maxillary stipes movable only in one plane; maxillary articulating area distinct, generally fleshy. Labial palpi distinct, conical.

*Prothorax* large, with a wide collar; mesothorax, metathorax and abdomen narrower; never with hypopleural sclerites; always with a rectangular, sclerotised, dorsal plate which is generally more or less glabrous posteriorly, but sometimes pubescent or asperate.

*Abdomen* extended; dorsally, and usually ventrally, bearing fleshy ambulatory ampullae on first six or seven segments; ninth segment often with a sclerotised plate or process or with rigid urogomphi. Anal region nearly always trilobate, exerted.

*Legs* often vestigial or absent; if present, then widely separated. Never more than four-segmented (excluding unguiculus).

*Spiracles* annular, bilabiate, with respiratory opening narrow; lips membranous, clothed with setigerous tubercles; peritreme often with marginal chambers.

## KEY TO SUBFAMILIES OF CERAMBYCID LARVAE

In the following keys an attempt has been made to place the subfamilies and genera in a phylogenetic order instead of in an artificial sequence, without losing sight of the primary object of the key, which is to enable the user to identify the specimens with ease and certainty. All former keys to Cerambycid larvae have dealt with the fauna of a particular region or country. The present key has not been split up regionally, as it is believed that a "world" key gives a clearer picture of relationship. Moreover, from the practical point of view, the country of origin of the timber is not always traceable, and couplets referring to widely distributed species would have to be repeated under each region. It is believed that by pursuing this policy, despite the greater difficulties involved, a more reliable system of classification will evolve, thus assisting in the recognition of more exact relationships among the adults.

In view of the relatively small proportion of species of which immature material is available at present, it seemed logical to base a larval classification on as many characters as possible, as it is difficult to foresee which characters will retain their diagnostic importance after more complete material is available. This was also done for a more practical reason, namely that larvae are so frequently in a damaged condition when submitted for identification. Because of this, characters have been used relating to as many different parts of the body as possible.

With this key it should be possible to identify larvae of any instar except the first or, in some cases, the second. The first-instar larva of *Rhagium* species, for example, has five ocelli, no terminal spine, and even if it were possible to prepare a single key applicable to all instars, it would be so complicated that it would defeat its own ends. However, it is felt that the omission of a key to first-instar larvae will not seriously detract from the usefulness of this work.

All the established British genera and nearly all the species are contained in the key. Imported species are marked with an asterisk, \*, and doubtfully indigenous species are indicated by an asterisk enclosed in brackets (\*). Supplementary characters are contained in square brackets [ ].

Larvae are best studied in shallow glass receptacles containing 80 per cent alcohol. It is often necessary to examine the ventral mouthparts critically, in which case they are best detached in one piece, and if very small, made into a slide preparation. This applies also to the antennae, legs and spiracles. The technique adopted for the present material was as follows. Firstly, the dissected parts were transferred to 95 per cent and then to absolute alcohol, in both cases for periods varying from fifteen to sixty minutes according to size. This was followed by immersion in clove oil for approximately twenty-four hours. The dissected parts were then transferred to a slide, the superfluous fluid being absorbed by means of a piece of filter paper, and then covered with a few drops of Canada balsam on to which a cover-glass was gently lowered, care being taken to ensure that the desired position of the material was not disturbed. In the case of antennae this was not at all easy, for as they are cylindrical, they tend to revolve. This may be discouraged by using a reasonably thick balsam and by slightly raising and lowering the cover-glass from one side until the required position is obtained.

Generally speaking, is it not necessary to remove the head capsule. The position of

the tentorial cross-arm, as pointed out by Emden (1939-1940), may be ascertained without dissection, from the membranous connection between the anterior foramen and the prothorax: in the ASEMINEAE and LEPTURINEAE, the gula is exposed, or can be exposed, merely by pushing back the front part of the prothorax, whereas in the PRIONINEAE and CERAMBYCINEAE, a skinfold, which is attached to the front margin of the gula, is revealed when the gula is pushed back.

When larvae are being critically examined it is advisable to remove them from the spirit and place them on a piece of filter paper. By absorbing the excess fluid, this makes minute structures such as pleural discs, asperities, setae and ocelli more conspicuous, as often they are indiscernible when the larva is wet. The dorso-external process of the palpifer is often concealed between the maxilla and the mandible, but it may easily be exposed by slightly raising the maxilla with a needle.

1. Legs absent or vestigial and mandible with an oblique cutting edge (fig. 257). Head distinctly oblong (only slightly in *Sternotomis*), with sides parallel or converging posteriorly (fig. 221). Maxillae rigid, only movable from stipes; cardo, maxillary articulating area, and submentum fused. Pleural tubercle often bearing a sclerotised pit at each extremity (fig. 227). [Occipital foramen undivided (fig. 257). At least six epistomal setae present. Pronotum and/or ampullae often asperate.] . . . . . 6. LAMINAE, p. 77
- Legs usually present and well developed, but if absent or vestigial, then mandible with a gouge-like cutting edge. Head transverse to subquadrate, with sides diverging posteriorly (figs. 31, 105). Maxillae movable; cardo, maxillary articulating area, and submentum distinct. Pleural tubercle never with sclerotised pits . . . . . 2
2. Occipital foramen divided into a small anterior, and a larger posterior portion by the tentorial bridge which is in the same plane as the hypostoma (figs. 32, 179). Ventral mouthparts attached to hypostoma by little more than width of gula. Maxillary palpifer with outer margin strongly rounded and protuberant (figs. 34, 198); maxillary lobe apparently borne on stipes. Epipleurum strongly protuberant on last three segments only (fig. 189). Four or six epistomal setae present. Postnotal fold usually present . . . . . 3
- Occipital foramen not divided into two portions, as the tentorial cross-arm is internal (fig. 77). Ventral mouthparts attached to hypostoma for nearly its entire breadth. Maxillary palpifer with outer margin not strongly rounded and protuberant (figs. 57, 107); maxillary lobe apparently borne on palpifer. Epipleurum slightly protuberant on all abdominal segments; seldom strongly protuberant on last three only, but if so, then ninth tergum with urogomphi. From six to twenty epistomal setae present. Postnotal fold absent . . . . . 5
3. Mandible with an oblique cutting edge (figs. 24, 67). Front margin of frons with the lower boundary usually projecting over the clypeus and the upper boundary dentate or carinate (except Indian genera *Macrotoma* and *Sarmyds*), but if not, then pronotum asperate posteriorly. Clypeus wide (fig. 24), filling space between dorsal articulations of mandibles. Maxillae with palpi and lobes in same plane as cardo; lobe slender, subcylindrical, and densely setose on inner margin (figs. 26, 34). Ninth abdominal segment long, extended (fig. 38). Legs present, well developed, and at least as long as maxillary palp; unguiculus stout and straight (fig. 39). Six epistomal setae present. Antenna with or without a sclerotised, setose, third segment. Prothoracic coxae almost meeting medially. Pronotum sometimes asperate (fig. 27). Dorsal ampullae with two very distinct, transverse impressions (fig. 36). Pleural discs present or absent. . . . . 4
- Mandible with a gouge-like cutting edge (fig. 123). Front margin of frons with the lower boundary never projecting over clypeus (except *Hoplocerambyx*), and upper boundary never dentate or carinate (fig. 178). Clypeus narrow, not filling space between dorsal articulations of mandibles (fig. 178). Maxillae with palpi and lobes curved upward

against ventral surface of mandibles; broad and flat, with inner margin glabrous or almost so (fig. 198). Ninth abdominal segment never long and extended (fig. 189). Legs smaller, seldom as long as maxillary palp and sometimes absent; unguiculus slender, usually flagelliform (figs. 152, 212). Four epistomal setae present. Antenna always with a strongly sclerotised, setose, third segment (figs. 197, 211). Prothoracic coxae widely separated. Pronotum never asperate (except in *Xylotrechus aceris* Fisher). Dorsal ampullae with posterior transverse impression generally indistinct. Pleural discs present. Palpifer and/or first palpal segment often with a dorso-external process (fig. 163).

5. CERAMBYCINAE, p. 71

4. Posterior area of pronotum and the ampullae without asperities. Front margin of frons with lower boundary projecting over clypeus (except Indian genera *Macrotoma* and *Sarmydsus*) (figs. 31, 46). Postcondylar carina and subfossal process present (figs. 31, 32). Pleural discs present (fig. 37). Antenna sometimes without a strongly sclerotised, setose, third segment. Spiracles with marginal chambers, if present, very small and not extending beyond outer margin of peritreme . . . . . 2. PRIONINAE, p. 66
- Posterior area of pronotum (fig. 27), and the ampullae asperate. Front margin of frons with lower boundary never projecting over clypeus. Postcondylar carina and subfossal process absent. Pleural discs absent. Antenna always with a strongly sclerotised, setose, third segment (fig. 25). Spiracles with marginal chambers large, and extending well beyond outer margin of peritreme (fig. 29) . . . . . 1. \*PARANDRINAE (*Parandra*), p. 101
5. Posterior emargination of head deep, often extending to frons (figs. 53, 70). Ampullae always tuberculate (fig. 80), and sometimes asperate. Prothorax with lateral furrows indistinct; pronotum never velvety asperate. Maxillary palp with first segment small, only slightly larger than second (fig. 57). Prothoracic coxae almost meeting medially. Unguiculus with a very stout seta near base (fig. 62). Ninth tergite sometimes with a terminal spine (fig. 61), very seldom with urogomphi, but usually simple. Ligula longer than labial palpi. Antenna with or without a strongly sclerotised, setose, third segment. General form moderately to strongly depressed . . . . . 3. LEPTURINAE,<sup>1</sup> p. 67
- Posterior emargination of head very shallow (fig. 105). Ampullae never tuberculate, always micro-asperate. Prothorax with lateral furrows deep and distinct; pronotum velvety-asperate (fig. 108). Maxillary palp with first segment large, about twice size of second (fig. 107). Prothoracic coxae widely separated. Unguiculus never with a basal seta. Ninth tergite with a pair of short, often blunt urogomphi (fig. 109). Ligula shorter than labial palpi. Antenna always with a strongly sclerotised, setose, third segment (except *Nothorrhina*). General form subcylindrical . . . . . 4. ASEMINAE, p. 70

## KEYS TO GENERA AND SPECIES OF CERAMBYCID LARVAE

### 2. PRIONINAE

1. Front margin of frons with upper boundary projecting in four large, blunt teeth (fig. 46). [Pleural discs finely rugose.] . . . . . \**Ergates*, p. 67
- Front margin of frons with upper boundary projecting in an almost straight, keel-shaped, transverse ridge (fig. 31) . . . . . 2
2. Three pairs of ocelli present. Labrum cordate, about as long as wide. Front margin of frons with lower boundary simple, or with one pair of lateral teeth . . . . . 3
- Ocelli absent. Labrum transversely oval. Front margin of frons with lower boundary produced into four lobes, the paramedian pair being small and blunt (fig. 31). [Antenna with third segment short, obliquely truncate apically (fig. 33).]

*Prionus coriarius* Linnaeus, p. 106

<sup>1</sup> The genus *Ulochaetes*, possessing as it does many affinities towards the ASEMINAE, can only with difficulty be included in the LEPTURINAE as only the first character given in the key is applicable (see also p. 146).

3. Prothorax with each lateral area of presternum bearing a group of teat-like tubercles which are sclerotised apically (fig. 51). Antenna two-segmented (fig. 50); second segment obliquely truncate apically. African species . . . . . \**Malldon downesi* Hope, p. 117  
 — Prothorax without tubercles on presternum. Antenna three-segmented (fig. 44); second segment not obliquely truncate apically, and third segment elongate and cylindrical. Oriental species . . . . . \**Megopsis* sp., p. 112

## \*Ergates

1. Front margin of frons with outer pair of teeth on upper boundary projecting well beyond inner pair. Frons completely ferruginous. North American species. . . . . \**E. spiculatus* Leconte, p. 116  
 — Front margin of frons with outer pair of teeth on upper boundary not projecting beyond inner pair (fig. 46). Frons ferruginous only near front margin. European species. . . . . \**E. faber* Linnaeus, p. 114

## 3. LEPTURINAE

1. Anus ventral and used as a pseudopod (fig. 52); ninth segment tapering posteriorly (fig. 52). Six pairs of very conspicuous ocelli present (one pair placed ventrally). Head and abdomen bearing some extremely long stout setae (fig. 53). Head capsule broadly angulate laterally, and frons with six round depressions (fig. 53). [Form very strongly depressed and legs exceptionally long (fig. 52). Under loose bark of old rotten stumps and poles.] . . . . . *Acmaeops collaris* (Linnaeus), p. 118  
 — Anus terminal; ninth segment not tapering posteriorly. Ocelli, if present, not more than three pairs, usually one pair. Head and abdomen with setae much shorter and finer. Head capsule not angulate laterally, and frons with at most two depressions (fig. 54) . . . . . 2
2. Ninth abdominal segment with a conspicuous terminal spine (fig. 61). Frons divided by a distinct, transverse line into an anterior ferruginous area, and a posterior paler area (fig. 54). [Length up to 34 mm. Antenna apparently two-segmented, the second segment bearing a small hyaline process. Mandible very slender. At least ten epistomal setae present.] . . . . . 3  
 — Ninth abdominal segment without a terminal spine. Frons without a distinct transverse line . . . . . 4
3. Ampullae present on abdominal tergites one to seven. Pronotum entirely shining, and slightly rugose on posterior half. At least ten epistomal setae present. . . . . *Rhagium* (s.g. *Rhagium*), p. 68  
 — Ampullae present on abdominal tergites one to six. Pronotum dull and densely spiculate on posterior half. Only six epistomal setae present. [Ampullae without tubercles and densely spiculate.] . . . . . *Stenocorus meridianus* Linnaeus, p. 129
4. Head strongly transverse, appreciably wider at thorax (in mature larvae), and very strongly depressed (fig. 70). Temple with a distinct longitudinal keel behind antenna. Mandible very slender, and strongly produced (fig. 71). About twenty epistomal setae present. Maxilla with first palpal segment broadened apically. Antenna apparently two-segmented, the second segment bearing a single hyaline process. [Length up to 27 mm. Northern species. In coniferous timber only.] . . . . . *Rhagium* (s.g. *Hargium*) *inquisitor* (Linnaeus), p. 127  
 — Head less transverse, not wider than thorax and seldom strongly depressed, but if so (*Grammoptera*), then three pairs of ocelli are present. Temple not keeled. Mandible shorter and stouter (fig. 74). Six epistomal setae present. Maxilla with first palpal segment not broadened apically. Antenna usually three-segmented, but if only apparently two-segmented, then second segment bearing one stout and one very slender hyaline process (fig. 78) . . . . . 5
5. Antenna apparently two-segmented, the second segment bearing one stout and one slender hyaline process (fig. 78). Hypostoma short, strongly transverse, at least four

- times as wide as median length (fig. 77); gular sutures not raised. Tibiotarsus distinctly longer than femur. Maxillary palp with third segment elongate, longer than second. Length up to 15 mm. [One or three pairs of ocelli present.] . . . . . 6
- Antenna distinctly three-segmented, the third segment strongly sclerotised, and with a few stout setae; second segment bearing a supplementary hyaline process (fig. 84). Hypostoma longer, less strongly transverse, and usually less than four times as wide as median length, but if more then claw concave along ventral margin (fig. 99), or front margin of hypostoma black, or proeusternum microscopically pubescent (fig. 79); gular sutures slightly raised. Tibiotarsus not longer than femur (except *Judolia*). Maxillary palp with third segment quadrate to elongate, not longer (usually shorter) than second (except *Judolia*). Length up to 40 mm. . . . . 7
6. Three pairs of small ocelli present. Dorsal ampullae present on first seven segments. Head strongly depressed. Hypostoma about four times as wide as median length, with sutures diverging. Larvae generally subcortical . . . . . *Grammoptera*, p. 68
- One pair of large ocelli present. Dorsal ampullae present on first six segments. Head only slightly depressed. Hypostoma more than four times as wide as median length, with sutures parallel for posterior half (fig. 77). Larvae usually in sapwood except early stages . . . . . *Alosterna tabacicola* (Degeer), p. 132
7. Legs very long; tibiotarsus distinctly longer than femur; unguiculus with basal third parallel-sided, and apical two-thirds concave along ventral margin (fig. 99). Antenna with third segment elongate, parallel-sided, at least twice as long as basal diameter; supplementary process extending at least as far as apex of third segment (fig. 98). Hypostoma about four and a half times as wide as median length. Dorsal ampullae distinctly spiculate. Spiracle with marginal chambers forming a characteristic crescent (fig. 100). [Proeusternum reticulate, shining. Maxillary palp with third segment elongate, slightly longer than second.] . . . . . *Judolia*, p. 69
- Legs shorter; tibiotarsus shorter than femur; unguiculus gradually tapering. Antenna if with third segment elongate and parallel-sided, then supplementary process shorter than third segment. Hypostoma usually less than four times as wide as median length, but, if more, then proeusternum microscopically pubescent (fig. 79), or front margin of hypostoma black. Dorsal ampullae never spiculate (except *Leptura scutellata* Fabricius). Spiracle with marginal chambers much less protuberant . . . . . 8
8. Abdominal ampullae non-tuberculate. Pronotum velvety asperate. Gular sutures conspicuous, protuberant. [Length up to 40 mm. North American species.]  
\**Ulochaetes leoninus* Leconte, p. 145
- Abdominal ampullae with rows of tubercles. Pronotum smooth. Gular sutures scarcely protuberant . . . . . *Leptura*, *Strangalia*, p. 69

#### Rhagium (s.g. Rhagium)

1. Dorsal ampullae dull, microscopically spiculate, with tubercles feebly developed. Genae much darker than anterior part of frons, and deeply transversely-striate. Angle between sides of support of terminal spine about 120° . . . . . *R. mordax* (Degeer), p. 125
- Dorsal ampullae shining, glabrous, with tubercles well-defined (fig. 59). Genae not darker than anterior part of frons, and slightly rugose. Angle between sides of support of terminal spine about 100° (fig. 61) . . . . . *R. bifasciatum* Fabricius, p. 121

#### Grammoptera

1. Third segment of maxillary palp less than twice as long as its basal width. Ocelli with pigmented spot indistinct, deep beneath cuticle. Form rather robust, maximum breadth (at prothorax), 2.5 mm. . . . . *G. variegata* (Germar), p. 132
- Third segment of maxillary palp at least twice as long as its basal width (fig. 75). Ocelli with pigmented spot black and very distinct. Form more slender, maximum breadth (at prothorax), 2.25 mm. . . . . *G. ruficornis* (Fabricius), p. 130

**Judolia**

1. Legs unusually long, three to four times the length of maxillary palp, protruding laterally, and visible from above; femur at least twice as long as basal width; tibiotarsus about four times as long as basal width. Confined to Scotland. In stumps and roots of coniferous trees. [Ocellus with pigmented spot black and bead-like.]

*J. sexmaculata* (Linnaeus), p. 145

- Legs slightly shorter, about twice the length of maxillary palp; femur at most one and a half times as long as basal width; tibiotarsus at most three times as long as basal width. Occurring south of the Midlands. In stumps and roots of deciduous trees.

*J. cerambyciformis* (Schrank), p. 143

**Leptura, Strangalia**

1. Mandible with an oblique, dull, sculptured plate on cutting edge (fig. 93). Proeusternum entirely micro-reticulate (fig. 79). [Ampullae present on first seven segments.] . . . 2

- Mandible without a sculptured plate on cutting edge. Proeusternum not entirely micro-reticulate except in *S. melanura* (Linnaeus), but then ampullae present only on first six segments . . . . . 3

2. Metanotum with a few small tubercles near middle. Proeusternum completely smooth, shining, without velvety-pubescent areas. Antenna with supplementary process much longer than third segment. Maxillary palp with third segment as long as second. Pigmented sclerotisation of gena not surrounding ocellus behind. Occurring north of the Midlands. [In coniferous trees only.] . . . . . *L. sanguinolenta* Linnaeus, p. 143

- Metanotum not tuberculate. Proeusternum with a small, triangular, pubescent area near each basal angle (as in *S. maculata* Poda). Antenna with supplementary process slightly shorter than third segment. Maxillary palp with third segment shorter than second. Pigmented sclerotisation of gena surrounding ocellus behind. Occurring south of the Midlands . . . . . *L. rubra* (Linnaeus), p. 141

3. Labial palpi separated by twice their width. Maxilla with third palpal segment as long as second. Hypostoma with anterior margin black to pitchy. [Proeusternum coarsely rugose, without spicules or pubescence. Dorsal ampullae present on first seven segments.] . . . . . *L. scutellata* Fabricius, p. 140

- Labial palpi usually separated by about their own width, but if more, then proeusternum spiculate posteriorly. Maxilla with third palpal segment shorter than second. Hypostoma with anterior margin ferruginous . . . . . 4

4. Dorsal ampullae present on first six segments only. Third antennal segment subquadrate; supplementary process as long as third segment . . . . . 5

- Dorsal ampullae present on first seven segments. Third antennal segment elongate; supplementary process shorter than third segment . . . . . 6

5. Proeusternum shining, finely reticulate, and with a few scattered setae (fig. 88). Temples pale behind ocellus. Hypostoma about three times as wide as median length. Ocellus with pigmented spot black, very distinct. Length up to 16 mm.

*S. melanura* (Linnaeus), p. 138

- Proeusternum dull, velvety spiculate (fig. 79). Temples ferruginous behind ocellus. Hypostoma about four times as wide as median length. Ocellus with pigmented spot greyish, indistinct. Length up to 24 mm. . . . . *S. quadrifasciata* (Linnaeus), p. 134

6. Proeusternum dull, entirely covered with very short microscopical pubescence. Hypostoma at least four times as wide as median length. Gena with a deep transverse furrow immediately in front of ocellus . . . . . *S. aurulenta* (Fabricius), p. 138

- Proeusternum smooth and shining at least in middle, and with a conspicuous triangular, velvety-spiculate or microscopically-pubescent area near each basal angle (fig. 85). Hypostoma about three times as wide as median length. Gena without a furrow in front of ocellus . . . . . *S. maculata* (Poda), p. 137

4. ASEMINAE<sup>1</sup>

1. Genal setae mostly arising from ferruginous basal dots which give the gena a spotted appearance. Labrum oval, about twice as wide as long. Antenna with third segment quadrate to slightly transverse. Mandible without an oblique plate along dorsal surface; a transverse row of not more than six minute setae present on outer face near base. Urogomphi very short and stunted (fig. 116). Femur and tibiotarsus distinctly ferruginous. Spiracles with a pair of large marginal chambers (fig. 117) . *Tetropium*, p. 70
- Genal setae simple at base. Labrum cordate, at most slightly wider than long. Antenna with third segment elongate. Mandible with an oblique plate along inner part of dorsal surface; a transverse row of from twelve to twenty-four long, fine setae present on outer face near base. Urogomphi longer, acutely-conical (fig. 109). Femur and tibiotarsus pale testaceous. Spiracles with at least six much smaller marginal chambers . . . 2
2. Gular sutures slightly raised and almost as darkly pigmented as hypostomal sutures. Urogomphi as long as or longer than basal width, subcontiguous at base, and with not more than apical third strongly sclerotised. Pronotum very finely asperate (asperities not individually distinguishable with a  $\times 15$  lens). Maxillary palpi with third segment almost as long as second. Head with sides rather strongly diverging posteriorly. Length up to 20 mm. . . . *Asemum striatum* (Linnaeus), p. 152
- Gular sutures not raised and much lighter than hypostomal sutures. Urogomphi shorter than their basal width and widely separated (fig. 109). Pronotum more coarsely asperate (asperities individually distinguishable with a  $\times 15$  lens) (fig. 108). Maxillary palpi with third segment not more than half as long as second (fig. 107). Head with sides only slightly diverging posteriorly. Length up to 34 mm. . . . 3
3. Proeusternum completely spiculate. Urogomphi conspicuous and separated by at most three times their basal width. Labrum slightly longer than broad . . . *Arhopalus*, p. 70
- Proeusternum with spiculae confined to two small paramedian areas, the median area being smooth and shining. Urogomphi minute and separated by at least four times their basal width. Labrum slightly wider than long. . . . *Spondylis buprestoides* Linnaeus, p. 154

**Arhopalus<sup>2</sup>**

1. Supplementary process of antenna distinctly shorter than its basal width. Urogomphi small and separated by two or three times their basal width. Genal setae not occurring beyond level of posterior end of frontal sutures. Prothorax with lateral setae pale golden yellow; posterior part of pronotum pale yellow. Occurring chiefly north of the Midlands . . . . *A. rusticus* (Linnaeus), p. 15
- Supplementary process of antenna at least as long as its basal width. Urogomphi longer (fig. 109), seldom separated by more than their basal width, usually less. Genal setae occurring beyond level of posterior end of frontal sutures. Prothorax with lateral setae ferruginous; posterior part of pronotum orange-yellow. Occurring chiefly south of the Midlands . . . . *A. ferus* (Mulsant), p. 147

**Tetropium**

1. Urogomphi (fig. 121) connate conical to apex where they become abruptly bifurcate. [North American species.] . . . . *T. cinnamopterum* Kirby, p. 159
- Urogomphi (fig. 116) not connate and bifurcate apically . . . . 2
2. Urogomphi in the form of two round, flat, reddish brown, sclerotised knobs, which arise from a well-defined, oval, testaceous protuberance (fig. 116b). Ventral region of

<sup>1</sup> Larvae of this subfamily are so variable intraspecifically that in the case of *Arhopalus* and *Tetropium* species, long series are necessary in order to verify the reliability of the diagnostic characters used.

<sup>2</sup> As larvae of this genus are unusually variable and only a single larva of *A. rusticus* (Linnaeus) is available, this key should be regarded as provisional.

epicranial halves coarsely striate, rugose, and with numerous (at least twenty) setae. Posterior half of pronotum distinctly orange (at least in older larvae).

*T. gabrieli* Weise, p. 155

- Urogomphi in the form of two conical, slightly converging, dark brown processes which arise from a feebly defined, pale protuberance (fig. 116a). Ventral region of epicranial halves almost or quite smooth, and with very few setae. Posterior half of pronotum lemon-yellow . . . . . (\*) *T. castaneum* Linnaeus, p. 158

### 5. CERAMBYCINAE

1. Entire head capsule, including mouthframe, very feebly sclerotised and pale testaceous. Antenna (fig. 122) with supplementary process as long as third segment. Eusternum distinct, triangular and striate. [Form very slender, maximum breadth, 2.2 mm. Basal third of mandible testaceous. North American species.]

\**Smodicum cucujiforme* Say, p. 160

- Head capsule with at least mouthframe strongly sclerotised and ferruginous to pitchy (figs. 135, 146), except sometimes in certain species of Callichromini, but then form robust, maximum breadth at least 5 mm. Antenna (figs. 190, 197) with supplementary process shorter than third segment, rarely more than half as long. Eusternum seldom distinctly triangular, but if so, then legs vestigial or absent or three pairs of ocelli present . . . . . 2

2. Three pairs of large subcontiguous ocelli present, and head capsule rectangular (with sides not or scarcely diverging behind middle) (fig. 128). Temple usually with a distinct postocular carina (fig. 128), but if without (*Plocaederus*), then ampullae spiculate. Maxillary lobe with several stout setae on inner margin. Dorsal ampullae usually either with large, flat tubercles or spiculate, but if non-tuberculate and glabrous (*Pachydissus*), then anal lobes encircled by a fringe of short reddish setae (fig. 132); always with two distinct transverse impressions. Length up to at least 40 mm. . . . . Cerambycini 3

- Usually none or less than three pairs of ocelli present, but if three pairs present (*Hylotrupes*, *Plagionotus*, *Cyllene*), then head capsule distinctly trapezoidal (with sides strongly diverging behind middle). Temples without postocular carina. Maxillary lobe entirely glabrous on inner margin (fig. 181). Dorsal ampullae never with distinct tubercles or spicules; posterior transverse impression usually indistinct. Length seldom exceeding 30 mm., usually much less . . . . . 5

3. Ampullae spiculate, without tubercles. Temples without carinae or raised areas. Antenna with third segment about four times as long as basal width. [Imported from Africa.]

\**Plocaederus viridipennis* Hope, p. 167

- Ampullae not spiculate; with or without tubercles. Temples with a transverse carina immediately behind ocelli, and a raised elongate-oval area at posterior end of sclerotised part (fig. 128). Antenna with third segment not more than three times as long as basal width . . . . . 4

4. Ampullae without tubercles. Anal lobes encircled by a fringe of short, reddish setae, behind which are scattered longer setae (fig. 132). Temples with raised ridge at posterior end of sclerotised part much more protuberant than postocular carina. Dorsal boundary of antennal foramen scarcely produced and not raised. [Imported from Africa.]

\**Pachydissus hector* Kolbe, p. 168

- Ampullae bearing four rows of large flat, oval tubercles. Anal lobes rather sparsely setose. Temples with raised area at posterior end of sclerotised part not more protuberant than postocular carina (fig. 128). Dorsal boundary of antennal foramen produced.

\**Cerambyx*, p. 76

5. Hypostoma with front margin distinctly tuberculate (fig. 140). Antenna with a very long basal membrane (fig. 139). Legs four-segmented, long. Gula narrow, with raised sutures.

Hesperophanini, Trachyderini and allied genera 6

- Hypostoma with front margin without tubercles. Antenna with basal membrane much shorter . . . . . 8
6. Frons feebly sclerotised and pale testaceous immediately above antennae. Ocellar lens indistinct, small, narrowly oval; outer margin enclosed by protuberant gena. Lateral regions of prothorax, and anterior third of pronotum rather sparsely covered with pale yellow setae. Dorsal ampullae with transverse impressions incomplete or indistinct medially. Front margin of frons feebly concave. Gular sutures not protuberant. Imported from the Orient. [Antenna with third segment less than two-thirds length of second. Hypostoma (fig. 140) with front margin very strongly tuberculate.]  
\**Stromatium barbatum* Fabricius, p. 171
- Frons strongly sclerotised and broadly ferruginous immediately above antennae. Ocellar lens distinct, large, round; outer margin not enclosed by gena. Lateral regions of prothorax and anterior third of pronotum rather densely covered with reddish setae. Dorsal ampullae with transverse impressions complete and very distinct medially. Front margin of frons convex. Gular sutures distinctly protuberant. Imported from North and South America . . . . . 7
7. Fifth and sixth ventral ampullae with the area behind transverse impression feebly sclerotised and smooth. Dorsal ampullae each with two complete transverse impressions. Antenna (fig. 147) with third segment more than two-thirds length of second. North American species . . . . . \**Chion cinctus* Drury, p. 176
- Fifth and sixth ventral ampullae with the area behind transverse impression bearing a strongly sclerotised, testaceous, striate plate (fig. 149). Dorsal ampullae each with only one complete transverse impression. Antenna with third segment less than two-thirds length of second. South American species . . . . . \**Trachyderes hilaris* Bates, p. 177
8. Gena shouldered; temple with one to three well-marked transverse impressions, or one to three small, oval, corneous tubercles behind ocellus (fig. 151). Lateral regions of prothorax velvety micro-pubescent or with very dense reddish setae (except *Elaphidion* pars, but then two pairs of ocelli present). [Legs rather short but clearly four-segmented. Head with sides strongly diverging posteriorly. Imported from America, Australia, and Africa.] . . . . . \**Phoracanthini* 9
- Gena seldom shouldered, but if so, then sides of head never strongly diverging; temples without transverse impressions or tubercles behind ocellus. Lateral regions of prothorax never velvety pubescent or with dense reddish setae . . . . . 12
9. Two pairs of ocelli present laterad and ventrad of antenna; pigmented spot distinct. Prothorax without velvety pubescence or dense reddish setae. Length up to 19 mm. American species . . . . . \**Elaphidion*, p. 76
- Ocelli absent or only one pair present. Prothorax with velvety, microscopic pubescence or dense reddish setae. Length up to 32 mm. . . . . 10
10. Genae narrowly ferruginous, the region behind ocellus entirely testaceous and with a transverse row of three small, oval tubercles (sometimes contiguous, forming a single tubercle) about the size of the ocellus (fig. 151). Antenna with third segment about four times as long as basal width. Prothorax with lateral regions microscopically reticulate and bearing numerous short, reddish setae. Imported from Africa. [One pair of indistinct ocelli present.]  
\**Cordylomera suturalis* Chevrolat and \**C. spinicornis* Fabricius, p. 182
- Genae broadly ferruginous, the region behind ocellus entirely ferruginous, and with at least one deep, transverse impression. Antenna with third segment about twice as long as basal width. Prothorax with lateral regions not reticulate, but microscopically velvety pubescent. Imported from Australia and South Africa . . . . . 11
11. Ocelli indiscernible. Front margin of head narrowly ferruginous. Temple with ferruginous area behind antenna with a single well-marked transverse impression only. Length up to 25 mm.; maximum breadth, 6.5 mm. . . . . \**Coleocoptus senio* Newman, p. 179
- One pair of distinct ocelli present laterad and ventrad of antenna. Front margin of

- head rather broadly pitchy to black. Temple with one or two shallow impressions on each side of the well-marked transverse impression. Length up to 32 mm.; maximum breadth, 10.5 mm. . . . . \**Phoracantha semipunctata* Fabricius, p. 180
12. Hypostoma with front margin finely longitudinally to obliquely striate (fig. 156). Legs four-segmented, longer than maxillary palpi. Dorso-external process of palpifer less than half as long as third segment of maxillary palp. [Length up to 29 mm. North American species.] . . . . . \**Romaleum rufulum* Haldeman, p. 185
- Hypostoma usually smooth, but, if striate, then either legs absent (*Clytus arietis* Linnaeus) or dorso-external process of palpifer as long as third segment of maxillary palp (*Pyrrhodium sanguineum* Linnaeus) . . . . . 13
13. Front margin of prosternum with a row of about thirty small brown, elongate tubercles (fig. 159). Pronotum and proeusternum dull, milky white and finely granulate. . . . . \**Cylindera flava* Fabricius, p. 188
- Front margin of prosternum without brownish tubercles. Pronotum and proeusternum never both dull and finely granulate . . . . . 14
14. Legs vestigial or absent. Head strongly transverse, with sides strongly rounded and widest at or just behind middle (fig. 161). Genae bearing numerous long, slightly curved setae (fig. 161). Ocelli usually absent, but sometimes one pair present. Eusternum distinct. [Maxillary palp with third segment much longer than second (fig. 163). Process of palpifer rather large (fig. 163).] . . . . . Molorchini and allied genera 15
- Legs nearly always present, and even if small distinctly three- or four-segmented, but if vestigial or absent (*Poecilium*, *Clytus*), then mandible with a deep longitudinal impression on outer face or front margin of hypostoma longitudinally striate (fig. 202). Head subquadrate to trapezoidal (figs. 186, 208), with sides feebly rounded and widest posteriorly. Genae with a few short, straight setae or glabrous. One or three (rarely two) ocelli present. Eusternum indistinct and usually with a pair of round, glabrous, shining areas (except *Hylotrupes*) . . . . . 18
15. Legs absent. Ocelli absent or indistinct. Pronotum feebly or irregularly striate posteriorly . . . . . 16
- Legs present though minute (one- or two-segmented). Ocelli distinct. Pronotum distinctly longitudinally striate posteriorly . . . . . 17
16. Ampullae on sternites three to six moderately protuberant, not deeply bilobed. Antenna with third segment not more than three times as long as its basal width (fig. 162). Pronotum longitudinally striate posteriorly. Form moderately slender . . . . . *Molorchus*, p. 76
- Ampullae on sternites three to six very strongly and deeply bilobed and teat-like (fig. 176). Antenna with third segment at least four times as long as its basal width. Pronotum reticulate posteriorly. Form very slender (fig. 176). [Segments three to six with very wide intersegmental skin. Chiefly in wickerwork.] . . . . . *Leptideella brevipennis* (Mulsant), p. 197
17. Antenna with third segment about four times as long as basal width. Ampullae very deeply bilobed and very strongly protuberant, the ventral ampullae visible from above (fig. 175). Pronotum coarsely striate . . . . . *Obrium cantharinum* (Linnaeus), p. 195
- Antenna with third segment about three times as long as its basal width. Ampullae moderately protuberant, the ventral ampullae not visible from above. Pronotum closely and finely striate . . . . . *Gracilia minuta* (Fabricius), p. 194
18. Ninth tergite with a pair of paramedian, oval, testaceous carinae or tubercles (fig. 125). Prosternum bisected by a strongly raised, longitudinal ridge. [Mandible with a shallow fovea or longitudinal impression. Process of palpifer much shorter than third segment of maxillary palp. Ocellus contiguous with base of antenna; lens strongly protuberant. North American species.] . . . . . \**Achryson surinamum* Linnaeus, p. 161
- Ninth tergite without carinae or tubercles. Prosternum without a strongly raised, longitudinal ridge . . . . . 19
19. Mandible with a deep, longitudinal impression on outer face (shallow in *Semanotus*). Dorso-external process of palpifer as long as or almost as long as third segment of

- maxillary palp (fig. 198). Legs usually three- or four-segmented, nearly always as long as maxillary palp and with femur and tibiotarsus quadrate to elongate, but, if absent or vestigial (*Poecilium*) then larva very small (length not exceeding 7 mm.; maximum breadth, 3 mm.). Pleural discs distinct . . . . . 20
- Mandible without a longitudinal impression on outer face. Dorso-external process of palpifer very much shorter than third segment of maxillary palp, sometimes absent. Legs usually absent or vestigial, but if about as long as maxillary palp, then only one- or two-segmented (the femur and/or tibiotarsus being distinctly transverse), or mandible (fig. 178) with basal part pale (much lighter than apical part). Pleural discs indistinct 26
20. Pronotum with anterior third pale brown. Prothorax rather sparsely setose laterally. Pleural discs indiscernible. [South African species.] \**Zamium incultum* Pascoe, p. 222
- Pronotum with anterior third testaceous or pale orange. Prothorax densely setose laterally. Pleural discs distinct (except *Hylotrupes*) . . . . . Callidini 21
21. Three pairs of distinct ocelli present in a row laterad and ventrad of antenna. Dorsal ampullae with two very distinct, transverse furrows. Pleural discs indistinct. Eusternum of prothorax distinct, triangular. [In dry, seasoned, coniferous timber, especially rafters, posts, etc.] . . . . . *Hylotrupes bajulus* (Linnaeus), p. 207
- Ocelli absent or only one pair present. Dorsal ampullae with posterior, transverse furrow very indistinct. Pleural discs distinct. Eusternum of prothorax indistinct . . . . . 22
22. Ocelli absent. Mandible without a deep longitudinal impression. [Third segment of maxillary palp about as long as second. Mouthframe completely sclerotised beneath antennae. In coniferous woods.] . . . . . \**Semanotus undatus* Linnaeus, p. 214
- One pair of ocelli present. Mandible with a deep longitudinal impression . . . . . 23
23. Legs with femur and tibiotarsus dark brown, the former elongate. Gena with ferruginous area enclosing ocellus. Ventral margin of head with a distinct, sclerotised tubercle (subfossal process) on acetabulum. Maxilla with third segment of palp not longer than second. Mouthframe completely sclerotised beneath antennae. [In seasoned coniferous woods, especially *Larix* posts, etc.] . . . . . *Callidium violaceum* (Linnaeus), p. 214
- Legs, if present, with femur and tibiotarsus pale, the former quadrate to transverse. Gena with ferruginous area not enclosing ocellus. Ventral margin of head without a tubercle on acetabulum. Maxilla with third segment of palp one and one-half times to twice as long as second segment. Mouthframe interrupted by a pale narrow line beneath antennae . . . . . 24
24. Legs extremely minute or absent (not visible with a  $\times 15$  lens). Ocellus with pigmented spot very indistinct, deep beneath cuticle. Maxilla with third segment of palp twice as long as second (fig. 198). Front margin of hypostoma pale testaceous. Length up to 7 mm.; maximum breadth, 3 mm. . . . . *Poecilium alni* (Linnaeus), p. 219
- Legs distinct (visible with a  $\times 15$  lens). Ocellus with pigmented spot black, distinct. Maxilla with third segment of palp not more than one and one-half times as long as second. Front margin of hypostoma ferruginous. Length up to 24 mm.; maximum breadth, 5.5 mm. . . . . 25
25. Head with front margin of hypostoma distinctly longitudinally to slightly obliquely striate and broadly ferruginous. Pronotum with anterior third orange-yellow and distinctly darker than posterior area which is pale testaceous.
- (\*) *Pyrrhidium sanguineum* (Linnaeus), p. 221
- Head with front margin of hypostoma smooth and narrowly ferruginous. Pronotum with anterior third testaceous and scarcely darker than posterior area.
- Phymatodes testaceus* (Linnaeus), p. 217
26. Legs moderately long, at least as long as maxillary palpi and with femur and tibiotarsus quadrate to elongate. Antenna with third segment about twice as long as basal width (fig. 180), but, if longer (*Philematium*) then second segment bearing several apical setae (fig. 188). Maxilla with third papal segment shorter than second (fig. 181). Dorsal ampullae with two distinct, transverse impressions \*Eburiini, \*Callichromini (pars) 27

- Legs usually minute or absent, never as long as maxillary palpi, but, if nearly so (*Anaglyptus*) then femur and tibiotarsus transverse. Antenna with third segment at least three times as long as basal width (fig. 211). Maxilla with third palpal segment usually as long as or longer than second, but if shorter, then three pairs of ocelli present. Dorsal ampullae with posterior transverse impression incomplete or absent. [One or three (rarely two) pairs of ocelli present.] . . . . . Clytini 29
27. Mandible with basal part ferruginous, slightly lighter than apical part. Clypeus extremely short. Ocellus contiguous with base of antenna; lens large, round. Genae with long, fine setae. Spiracles with peritreme indistinct, pale. Length up to 25 mm. [Usually in seasoned deciduous timber, especially *Quercus*. Imported from North America.]  
*\*Eburia quadrigeminata* Say, p. 198
- Mandible with basal part testaceous (at least in mature larvae), distinctly lighter than apical part. Clypeus normal (fig. 186). Ocellus well behind and ventrad of antenna; lens small, oblong. Genae with short, stiff setae (fig. 186). Spiracles with peritreme distinct, testaceous. Length up to 35 mm. . . . . 28
28. Gena (fig. 186) bearing not more than about twenty pale yellow setae. Abdominal setae short and pale. Antenna with third segment not more than three times as long as basal width (fig. 180). British species. In *Salix* and *Acer*. *Aromia moschata* (Linnaeus), p. 199
- Gena (fig. 188) bearing at least a hundred short reddish setae. Abdominal setae longer and distinctly reddish. Antenna (fig. 188) with third segment at least four times as long as basal width. West African species. In *Mimusops africana*.  
*\*Philematium natalense* Bates, p. 205
29. Three pairs of ocelli present in a row laterad and ventrad of antenna. Third segment of maxillary palp shorter than second. [Legs much shorter than maxillary palpi, but distinctly two-segmented. Genae broadly ferruginous.] . . . . . 30
- One pair of ocelli present. Third segment of maxillary palp at least as long as second 31
30. Ampullae with rather coarse reticulation (which is clearly visible with a  $\times 15$  lens), slightly shining, testaceous. Ocelli with pigmented spot distinct. Front margin of hypostoma with fine transverse rugae. Antenna with third segment less than half as long as second. European species. [Chiefly in *Quercus*.]  
*(\*)Plagionotus arcuatus* (Linnaeus), p. 225
- Ampullae with extremely fine reticulation (which is not discernible with a  $\times 15$  lens), dull, milky white. Ocelli with pigmented spot indistinct. Front margin of hypostoma with very coarse rugae. Antenna with third segment at least half as long as second. American species . . . . . *\*Cyllene*, p. 76
31. Legs at least half as long as maxillary palpi (distinctly visible when viewed laterally with a  $\times 15$  lens). Genae rather strongly shouldered . . . . . 32
- Legs either minute, less than half as long as maxillary palpi (not visible with a  $\times 15$  lens), or absent. Genae never shouldered, the head being gradually narrowed up to base of mandible . . . . . 34
32. Front margin of hypostoma broadly pitchy, strongly transversely striate and protuberant near gula (fig. 205). Gena broadly pitchy . . . . . 36
- Front margin of hypostoma pale or very narrowly ferruginous, and never strongly transversely striate or protuberant. Gena pale testaceous or ferruginous . . . . . 33
33. Temple with a small protuberant sclerotised area immediately behind ocellus. Legs at least two-thirds as long as maxillary palp. Hypostoma testaceous and glabrous.  
*Anaglyptus*, p. 77
- Temple not protuberant or testaceous behind ocellus. Legs at most half as long as maxillary palp. Hypostoma milky white, and with several fine, pale setae.  
*\*Isotomus speciosus* Schneider, p. 237
34. Posterior part of pronotum and lateral areas of prothorax dull, velvety, microscopically spiculate or pubescent. [Legs absent or vestigial. North American and Indian species.]  
*\*Xylotrechus*, p. 77

- Posterior part of pronotum and lateral areas of prothorax never velvety pubescent . 35
35. Hypostoma with front margin distinctly longitudinally striate (fig. 202). Legs absent.  
*Clytus arietis* (Linnaeus), p. 223
- Hypostoma with front margin not longitudinally striate. Legs present but minute . 36
36. Sclerotisation of mouthframe interrupted beneath antennae. Front margin of hypostoma narrowly testaceous. Imported from the Orient. In *Bambusa*, etc.  
*\*Chlorophorus annularis* Fabricius, p. 237
- Sclerotisation of mouthframe complete and strong beneath antennae. Front margin of hypostoma broadly pitchy. Imported from North America. In *Quercus*, etc.  
*\*Neoclytus*, p. 77

(\*) **Cerambyx**

1. Front margin of head broadly ferruginous, the pigmented band being at least as wide as length of labrum. Front margin of frons with upper boundary distinctly cariniform in each lateral third. Temple with the elongate-oval area at posterior end of sclerotised part strongly raised. Dorsal boundary of antennal foramen slightly raised. Sutures and front margin of hypostoma ferruginous. Length up to 50 mm.; maximum breadth, 7.5 mm. . . . . (\*) *C. scopoli* Füssly, p. 163
- Front margin of head less broadly ferruginous, the pigmented band being about two-thirds as wide as length of labrum. Front margin of frons with upper boundary not cariniform. Temple with the elongate-oval area at posterior end of sclerotised part scarcely raised (fig. 128). Dorsal boundary of antennal foramen not raised. Sutures and front margin of hypostoma black to pitchy (fig. 128). Length up to 100 mm.; maximum breadth, 13 mm. . . . . (\*) *C. cerdo* Linnaeus, p. 165

\***Elaphidion**

1. Temple with ferruginous area behind ocelli extending for a greater distance than that between ocelli and mandibular articulations and bisected by a well-marked, transverse impression bearing three setiferous pores. South American species.  
*\*E. nanum* Fabricius, p. 183
- Temple with ferruginous area behind ocelli extending for a shorter distance than that between ocelli and mandibular articulations and not bisected by a transverse impression. North American species . . . . . *\*E. mucronatum* Fabricius, p. 185

**Molorchus**

1. Anal lobes (fig. 164) transversely oval, dome-shaped. Antenna (fig. 162) with supplementary process slender and lanceolate. Ninth abdominal segment with numerous short brownish setae along hind margin. Epipleura (fig. 164) of eighth segment markedly protuberant. Hypostomal sutures nearly straight, divergent. Cuticle milky white and strongly shining. Length up to 9 mm. In recently dead stems of *Rubus* and *Rosa*, and dead twigs of fruit-trees, etc. . . . . *M. umbellatarum* (von Schreber), p. 189
- Anal lobes (fig. 171) slightly elongate and semicylindrical. Antenna (fig. 170) with supplementary process stout and shaped as figured. Ninth abdominal segment with a few scattered long, fine, pale setae. Epipleura (fig. 171) of eighth segment less protuberant. Hypostomal sutures shouldered and curved. Cuticle pale yellowish to greyish white, feebly shining. Length up to 14 mm. In dead or decaying *Pinus* and *Abies*.  
*M. minor* (Linnaeus), p. 192

\***Cyllene**

1. Abdominal spiracles with peritreme broadly oval to almost round (fig. 204). Setae on lateral regions of thorax short, bristly and reddish. North American species. Chiefly in *Robinia* . . . . . *\*C. robiniae* Forster, p. 228
- Abdominal spiracles with peritreme narrowly oval (fig. 204). Setae on lateral regions of thorax long, fine and golden. South American species. Chiefly in *Balfourodendron*.  
*\*C. acuta* Germar, p. 227

**\*Xylotrechus**

1. Pronotum dull and microscopically velvety pubescent. North American species.  
     *\*X. colonus* Fabricius, p. 232  
 — Pronotum shining and glabrous. Oriental species *\*X. smei* Castelnau & Gory, p. 233

**Anaglyptus**

1. Legs ferruginous (at least near articulation of segments) and distinctly darker than surrounding cuticle. Form robust; maximum breadth about 4.5 mm. British species.  
     *A. mysticus* (Linnaeus), p. 236  
 — Legs pale and not darker than surrounding cuticle. Form slender; maximum breadth about 2.1 mm. North American species . . . . . *\*A. verrucosus* Olivier, p. 237

**\*Neoclytus**

1. Hypostoma with front margin markedly protuberant near each side of gula (fig. 205). Third segment of maxillary palp about equal in length to second . . . . . 2  
 — Hypostoma with front margin not protuberant near each side of gula. Third segment of maxillary palp longer than second . . . . . *\*N. acuminatus* Fabricius, p. 230  
 2. Hypostoma entirely and strongly transversely striate (fig. 205). Ocellar lens strongly protuberant. Form robust . . . . . *\*N. caprea* Say, p. 231  
 — Hypostoma smooth. Ocellar lens not protuberant. Form slender.  
     *\*N. scutellaris* Olivier, p. 232

**6. LAMIINAE**

1. Antenna three-segmented, the third segment being distinctly sclerotised and bearing a few setae (figs. 222, 239). Dorsal ampullae generally with two conspicuous transverse furrows (fig. 225) but, if with only one (Mesosini), then anterior part of hypostoma steeply sloping down to anterior margin (fig. 238); generally with two or four rows of conspicuous tubercles (fig. 225), but, if non-tuberculate (Lamiini), then pronotum without asperities, and ninth tergite without a sclerotised process. Lobe of maxilla very narrow and elongate (fig. 223). Spiracles broadly oval (fig. 227). Pleural tubercle with one or a pair of sclerotised pits (fig. 227). . . . . 2  
 — Antenna apparently two-segmented, the second segment bearing a glabrous, tapering, hyaline process (figs. 254, 258). Dorsal ampullae, if with two transverse furrows, seldom tuberculate, but, if so, never with tubercles arranged in two or four rows; if with a single furrow, hypostoma never with front part steeply sloping (except *Stenidea*, but then ninth tergite without a spine); if non-tuberculate, then pronotum asperate (fig. 273) or ninth tergite bearing a sclerotised process (figs. 251, 256). Lobe of maxilla broader and less elongate (figs. 250, 281). Spiracles variable. Pleural tubercle with sclerotised pits present or absent . . . . . 8  
 2. Dorsal ampullae without tubercles. The anus a transverse cleft (Kemner, 1922).  
     (\*) *Lamia textor* (Linnaeus), p. 242.  
 — Dorsal ampullae with two or four rows of distinct tubercles (fig. 225). The anus usually trilobate, but, if transverse, then lower lobe with a group of spinules or legs distinctly visible with a  $\times 15$  lens . . . . . 3  
 3. Ninth tergum without a spine and tenth segment never spinulose. Hypostoma flat or slightly convex, the front margin in same plane as hind margin; no distinct paramedian setiferous pores present. Dorsal ampullae with two distinct transverse furrows and four transverse rows of tubercles, which are usually asperate (fig. 225). Posterior area of pronotum finely velvety pubescent or asperate. Head abruptly but feebly constricted just behind middle (fig. 221). Antennal foramen closed behind. Spiracles without marginal chambers . . . . . 4  
 — Ninth tergum usually with a small median spine (which has no basal sclerotised plate) near posterior margin (fig. 240), but, if without (Niphonini pars) then tenth segment conspicuously spinulose. Hypostoma with anterior region steeply sloping down to

- anterior margin, the front margin being in a lower plane than that of hind margin; a conspicuous pair of paramedian, setiferous pores present. Dorsal ampullae with a single transverse furrow, and two transverse rows of smooth, glabrous tubercles, anterior to which are a few irregularly arranged ones. Posterior area of pronotum glabrous. Head abruptly and very deeply constricted posteriorly (fig. 237). Antennal foramen open behind. Spiracles with marginal chambers . . . . . \*Niphonini and Mesosini 6
4. Legs distinctly visible with a  $\times 15$  lens. Anus a transverse cleft (as in *Phryneta*, fig. 247); lobes never spinulose. Prosternum coarsely asperate. Pronotum very coarsely asperate. Gular sutures indistinct. [African species.] . . . . . \**Batocera wyliei* Chevrolat, p. 256
- Legs not visible with a  $\times 15$  lens. Anus generally trilobate (fig. 226), but if with a transverse cleft, then the lower lobe spinulose (fig. 234). Prosternum not asperate. Pronotum very finely asperate (as in *Arhopalus*, fig. 108), or pubescent. Gular sutures distinct, raised . . . . . 5
5. Anus trilobate (fig. 226); lobes never spinulose (fig. 226). Pleural tubercles with a pair of sclerotised pits (fig. 227). Usually in coniferous wood. [North American, Scandinavian, European, and African species.] . . . . . (\*) *Monochamus*, p. 81
- Anus a transverse cleft (fig. 234); lower lobe spinulose (fig. 234). Pleural tubercles without sclerotised pits. Never in coniferous wood. [North American species.] . . . . . \**Neoptychodes trilineatus* (Linnaeus), p. 254
6. Ninth tergite without a median spine. Tenth segment bearing numerous ferruginous spinules. Hypostoma with posterior part marked with two large triangular, ferruginous areas which are very much darker than the remainder of the hypostoma (fig. 244). [In *Bambusa*. Oriental species.] . . . . . \**Niphona hookeri* Gahan, p. 262
- Ninth tergite with a small median spine. Tenth segment without spinules. Hypostoma never with posterior part marked with two triangular areas which are darker than the remainder of the hypostoma (fig. 238) . . . . . Mesosini 7
7. Frons (fig. 237) distinctly longitudinally striate, with eight setiferous pores. Hypostoma (fig. 238) without a transverse median ridge. Antenna (fig. 239) with third segment dome-shaped, only slightly longer than broad; supplementary process as long as third segment. Spiracles with about six marginal chambers. Length up to 23 mm.; maximum breadth, 5 mm. . . . . *Mesosa nebulosa* (Fabricius), p. 258
- Frons not longitudinally striate, but with setiferous pores feebly longitudinally impressed. Hypostoma with an abrupt, widely-curved ridge across middle. Antenna (fig. 242) with third segment cylindrical, three times as long as broad; supplementary process shorter than third segment. Spiracles with about twenty-four marginal chambers. Length up to 36 mm.; maximum breadth, 7.5 mm. [Imported from Africa.] . . . . . \**Coptops aedificator* Fabricius, p. 260
8. Abdomen with each dorsal ampulla (fig. 214) very strongly protuberant, deeply bilobed and densely covered with irregular, spiculate tubercles. Mandible scarcely tapering, not more than twice as long as basal width, and with cutting edge roundly emarginate. In Cactaceae only. [Form cylindrical, very robust. American and Mexican species.] . . . . . \*Dorcadionini pars. \**Moncilema* spp., p. 239
- Abdomen with dorsal ampullae seldom strongly protuberant or deeply bilobed, but if so (*Phytoecia*), then tubercles absent. Mandible distinctly tapering, more than twice as long as basal width, and with cutting edge never roundly emarginate. Never in Cactaceae . . . . . 9
9. Pronotum (fig. 246) with posterior part covered with a distinct network of ferruginous ridges which branch out from the oblique sublateral impressions. Ninth tergite (fig. 247) with a very stout curved spine, the base of which is concealed beneath posterior margin. Tenth segment (fig. 247) distinctly ferruginous, and finely striate. Each dorsal ampulla with a pair of sublateral, as well as a pair of lateral furrows; microscopically pubescent. Anus (fig. 247) a simple transverse cleft. Length up to 55 mm. [African species.] . . . . . \**Phryneta leprosa* Fabricius, p. 262

- Pronotum with posterior part without a network of ferruginous ridges. Ninth tergite never with a stout curved spine arising from beneath posterior margin. Tenth segment with dorsum never ferruginous and striate. Dorsal ampullae with only one pair of lateral furrows, and never micro-pubescent, although sometimes finely asperate. Anus trilobate. Length up to 36 mm. . . . . 10
10. Ampullae almost entirely covered with small oval, irregularly placed tubercles (fig. 249). Hypostoma entirely ferruginous to pitchy. Sternellum of prothorax microscopically spiculate. [Posterior half of pronotum microscopically spiculate and with scattered coarse setae.] . . . . . 11
- Ampullae if tuberculate, then tubercles arranged in one or two distinct rows along transverse furrow (figs. 266, 291). Hypostoma not entirely ferruginous to pitchy. Sternellum of prothorax never spiculate (except in *Chreonoma*, but then spiracles each with a conspicuous pair of marginal tubes, fig. 289), although sometimes with a transverse row of asperities . . . . . 12
11. Each dorsal ampulla with two complete transverse impressions. Anterior part of gena pitchy, as dark as mandible. Ocelli indiscernible. Antennal foramen open behind. Pleural tubercle without sclerotised pits. Imported from Africa.  
*Ancylonotus tribulus* Fabricius, p. 264
- Each dorsal ampulla with a single complete V-shaped impression (fig. 249). Anterior part of gena ferruginous, not as dark as mandible. Ocelli distinct, protuberant. Antennal foramen closed behind. Pleural tubercle with a pair of sclerotised pits. Imported from Canary Is. . . . . \*Dorcacionini pars. \**Lepromouris gibba* Brullé, p. 265
12. Ninth tergum with a distinctly sclerotised keel or plate (figs. 251, 256). Epipleurum strongly protuberant on last three segments only. Pleural tubercle with a single seta, and without sclerotised pits. [Abdomen with ampullae feebly tuberculate, with a broad, longitudinal, median furrow. Pronotum with posterior part glabrous, shining. Length not exceeding 14 mm. In decaying twigs and slender branches.]  
 Pogonocherini. *Pogonocherus*, p. 82
- Ninth tergum without a sclerotised process. Epipleurum seldom strongly protuberant on last three segments only, but, if so, then pronotum velvety asperate. Pleural tubercle with two or more setae, and sometimes with sclerotised pits . . . . . 13
13. Head (fig. 257) very elongate, strongly depressed; sides parallel and abruptly constricted before or at middle. Gena with a conspicuous transverse furrow immediately in front of ocellus. Hypostoma (fig. 257) with a rugose area (bearing two to six setae) on each side of gular region. Maxilla (fig. 259) with outer margin of palpifer strongly rounded and protuberant. Pronotum with posterior part velvety asperate. Epipleurum strongly protuberant on last three segments only. Pleural tubercle with a pair of distinct sclerotised pits. [Spiracles with posterior margin of peritreme with chambers.]  
 Acanthocinini 14
- Head never very elongate or strongly depressed; sides subparallel to strongly rounded, and never abruptly constricted. Gena without a transverse furrow in front of ocellus. Hypostoma without paramedian rugose areas. Maxilla with outer margin of palpifer not strongly rounded and protuberant. Pronotum, if asperate, then coarsely so, the asperities individually distinguishable. Epipleurum slightly protuberant on all segments. Pleural tubercle without sclerotised pits . . . . . 15
14. Ampullae with irregular, shining, glabrous tubercles. Ocellus with lens large, oval, pale, and very distinct. Posterior part of pronotum testaceous and completely velvety asperate. Head very elongate, with antennal foramen narrowly but distinctly open behind. Hypostoma with each rugose area bearing two setae. Maxilla with third palpal segment as long as second. Pleural tubercle with about five setae. Length up to 12 mm.; maximum breadth, 3 mm. In slender branches of deciduous trees.  
*Leiopus nebulosus* (Linnaeus), p. 275
- Ampullae non-tuberculate, dull, velvety spiculate. Ocellus with lens ferruginous and

indistinct. Posterior part of pronotum ferruginous, and interrupted by a pale median line. Head (fig. 257) extremely elongate, with antennal foramen closed behind. Hypostoma (fig. 257) with each rugose area bearing four to six setae. Maxilla (fig. 259) with third palpal segment about two-thirds length of second. Pleural tubercle with at least ten setae. Length up to 37 mm.; maximum breadth, 6.5 mm. In boles of coniferous trees. [Not occurring south of Scotland, but frequently imported from Europe and Scandinavia.]

*Acanthocinus aedilis* (Linnaeus), p. 271

15. Head (fig. 267) salient, oval in cross-section; almost entirely uniformly sclerotised and chocolate-brown; occipital foramen postero-ventral. At least twenty epistomal setae present. Prothorax (fig. 266) with a large brown sclerotised plate (which is bisected by a pale cleavage line) on dorsum; presternum with a pair of large brown sclerotised plates. Ninth abdominal segment (fig. 266) swollen, densely setose, and as wide and high as apex of eighth; truncate posteriorly. Spiracles with about thirty marginal chambers which occupy the entire inner margin of the peritreme. [In stems of herbaceous plants, especially *Carduus* and *Heracleum*.] *Agapanthia villosoviridescens* (Degeer), p. 278
- Head retracted into prothorax; never entirely uniformly sclerotised or chocolate-brown; occipital foramen ventral. Not more than six epistomal setae present. Prothorax and presternum never with brown sclerotised plates. Ninth abdominal segment smaller than eighth, tapering posteriorly, sparsely setose. Spiracles never with numerous marginal chambers . . . . . 16
16. Pronotum (fig. 273) with sublateral impressions and asperites. Ampullae (fig. 280) generally asperate, but if not, then strongly protuberant and bilobed; tubercles absent. Spiracles rather narrowly to extremely narrowly oval (fig. 285) . . . . . 17
- Pronotum without sublateral impressions, and if asperate then spiracles each with a conspicuous pair of marginal tubes (fig. 289). Ampullae glabrous, each with two or three rows of tubercles (fig. 291). Spiracles round (fig. 288) . . . . . 20
17. Spiracles with peritreme at most rather narrowly oval. Pronotum (fig. 273) with sublateral impressions transverse, semicircular or subcircular, and pale. Head depressed with sides subparallel, and broadly rounded at base. Abdomen with dorsal ampullae bearing two transverse furrows; asperate. Clypeus with two to six pairs of minute lateral setae. Tenth segment (fig.) strongly protuberant. Eusternum usually asperate. Saperdini 18
- Spiracles (fig. 285) with peritreme extremely narrow and slot-like. Pronotum (fig. 284) with sublateral impressions linear, straight and brownish. Head not or scarcely depressed, thick, with sides strongly converging posteriorly (as in *Agapanthia*, fig. 267). Abdomen with dorsal ampullae with a single transverse furrow (which is sometimes callose); generally glabrous, but if asperate, then two or more pairs of secondary ocelli present. Clypeus glabrous. Tenth segment not strongly protuberant. Eusternum never asperate . . . . . Phytoeciini 19
18. Each dorsal ampulla (fig. 280) with a transverse row of widely separated asperities on each side of the two transverse furrows; each asperity elongate, pointed and spine-like. Pigmented spot of ocellus very distinct. Pronotum almost horizontal. [In branches and twigs of *Tilia*.] *Stenostola ferrea* (Schrank), p. 291
- Each dorsal ampulla rather densely or very densely covered with very short asperities. Pigmented spot of ocellus indistinct. Pronotum obliquely slanting. *Saperda*, p. 82
19. Ampullae finely asperate, moderately protuberant (not bilobed), and with the transverse furrow distinctly callose. Pronotum (fig. 284) with asperities decreasing in size posteriorly. At least two pairs of vestigial ocelli present (see p. 295), in addition to the usual ocellus laterad and ventrad of antenna. Length up to 27 mm. In living stems and twigs of *Salix* . . . . . *Oberea oculata* (Linnaeus), p. 295
- Ampullae glabrous, microscopically reticulate, strongly protuberant and bilobed (rather as in *Obrium*, fig. 175), and with the transverse furrow not callose. Pronotum with asperities increasing in size posteriorly. Vestigial ocelli absent. Length up to 20 mm. In stems of herbaceous plants, especially Umbelliferae . . . *Phytoecia cylindrica* (Linnaeus), p. 293

20. Maxillary palp two-segmented (fig. 287). Abdominal segments four to seven with postero-dorsal and dorso-lateral regions with scattered irregular spicules or asperities. Spiracle with inner margin of peritreme digitate (fig. 288). Length up to 7 mm. [In slender twigs of fruit-trees, etc.] . . . . . *Tetrops praeusta* (Linnaeus), p. 297
- Maxillary palp three-segmented. Abdominal segments four to seven with postero-dorsal and dorso-lateral regions without spicules or asperities. Spiracle with inner margin of peritreme not digitate. Length up to 21 mm. . . . . 21
21. Pronotum and sternellum asperate. Spiracles each with a conspicuous pair of contiguous marginal tubes (fig. 289). [Imported from Burma and China in orchids, etc.]  
     . . . . . *Chreonoma* sp., p. 298
- Pronotum and sternellum without asperities. Spiracles without paired contiguous tubes . . . . . 22
22. Hypostoma with anterior half steeply sloping down to anterior margin as in *Mesosa* (fig. 238), and ferruginous. Maxillary and labial palpi with third segment tapering, longer than second. Mentum distinct from submentum (divided by transverse impression). Imported from Canary Is. In *Euphorbia* . . . . . *Stenidea annulicornis* Brullé, p. 301
- Hypostoma flat and testaceous. Maxillary and labial palpi with third segment bulbous, shorter than second. Mentum not distinct from submentum. Imported from Burma. In pseudobulbs of orchids . . . . . *Diaxenes dendrobii* Gahan, p. 299

(\*) *Monochamus*

1. Tubercles of dorsal ampullae (fig. 225) conspicuously and densely spiculate, yellowish and dull when viewed with a  $\times 15$  lens . . . . . 2
- Tubercles of dorsal ampullae with spicules shorter and much less dense, so that when viewed with a  $\times 15$  lens they appear to be glabrous and shining . . . . . 5
2. Dorsal anal lobe strongly protruding beyond ventral pair (fig. 226). [Imported from North America.] . . . . . *M. titillator* (Fabricius), p. 244
- Dorsal anal lobe not or scarcely protruding beyond ventral pair . . . . . 3
3. Hypostoma reddish brown. Gular sutures slightly raised. [Imported from North America.] . . . . . 4
- Hypostoma black to pitchy. Gular sutures (and gula) strongly raised. [Imported from Scandinavia.] . . . . . *M. rosenmülleri* (Cederhjelms), p. 253
4. Setae on ninth and tenth abdominal segments rather coarse, bristly, and distinctly reddish brown. Pronotum with the row of setae across anterior margin arranged in a continuous band . . . . . *M. notatus* Drury, p. 250
- Setae on ninth and tenth abdominal segments fine, silky, and yellowish white. Pronotum with the row of setae across anterior margin irregular and interrupted medially.  
     . . . . . *M. scutellatus* Say, p. 249
5. Antenna with third segment elongate (fig. 232). [Imported from West Africa.]  
     . . . . . *M. ruspator* Fabricius, p. 253
- Antenna with third segment transverse (as in fig. 222). . . . . 6
6. Ventral ampullae with tubercles dull and distinctly spiculate when viewed under medium power ( $\times 60$ ). Abdominal spiracles large, slightly more than half as long as mesothoracic spiracle. Hypostoma black to pitchy (?). Scandinavian and European species.  
     . . . . . (\*) *M. sutor* (Linnaeus), p. 251
- Ventral ampullae with tubercles shining and devoid of spicules when viewed under medium power ( $\times 60$ ). Abdominal spiracles small, less than half as long as mesothoracic spiracle (except North American species). Hypostoma reddish brown . . . . . 7
7. First four ventral ampullae with tubercles on median area moniliform and very distinct. Abdominal spiracles large, more than half as long as mesothoracic spiracle. North American species . . . . . *M. maculosus* Haldeman, p. 250
- First four ventral ampullae with tubercles on median area not moniliform, and either indistinct or absent. Abdominal spiracle small, less than half as long as mesothoracic spiracle. European and Scandinavian species. *M. galloprovincialis* (Olivier), p. 253

**Pogonocherus**

1. Ninth tergite (fig. 251) with a more or less circular, strongly sclerotised, striate plate, the centre of which is produced into a short spine. Maxillary palpi two-segmented (fig. 250). [In twigs of fruit-trees, *Ilex*, *Hedera*, etc.] . . . . . *P. hispidus* (Linnaeus), p. 267
- Ninth tergite never with a spine arising from the sclerotised process. Maxillary palpi three-segmented (fig. 253) . . . . . 2
2. Ninth tergite (fig. 256) with a protuberance which bears a longitudinally oval, feebly sclerotised plate, the centre of which is raised, forming a single longitudinal, narrowly ferruginous keel. In twigs of conifers only. [Scottish species.]  
*P. fasciculatus* (Degeer), p. 270
- Ninth tergite (fig. 255) without a protuberance, and with a transversely oval, strongly sclerotised plate, on which is a series of from eight to twelve longitudinal furrows. In twigs of fruit-trees, etc. . . . . *P. hispidulus* (Piller & Mitterpacher), p. 269

**Saperda**

1. Prothorax (fig. 279) with eusternum, and sternellum with coarse asperities scattered across entire breadth in a broad band, and presternum bearing numerous long, fine, pale setae. [North American species. Usually in *Hicoria*.] . . . . . \**S. discoidea* Fabricius, p. 290
- Prothorax with eusternum and sternellum with asperities, if present, much finer, not scattered across entire breadth, and arranged in a narrow band; presternum with short, stouter setae . . . . . 2
2. Asperities of ampullae extremely fine and dense, not individually distinguishable with a  $\times 15$  lens. Ocellus with lens flat. Maxillary palp with third segment not longer than second; lobe not extending beyond second palpal segment. Pronotum with asperities on anterior half of asperate area almost uniform in size. Presternum very finely asperate. Eusternum with posterior part not asperate . . . . . *S. scalaris* (Linnaeus), p. 287
- Asperities of ampullae less fine and dense, individually distinguishable with a  $\times 15$  lens. Ocellus with lens strongly protuberant. Maxillary palp with third segment slightly longer than second; lobe elongate, nearly as long as palp. Pronotum (fig. 273) with asperities on anterior half of asperate area of varying size (the largest varying from one and one-half to more than twice as wide as long). Presternum not asperate. Eusternum with a transverse band of asperities . . . . . 3
3. Asperities of ampullae rather long and sharply pointed. Sublateral impressions of pronotum very deep, particularly along the hind margin where they are very sharply defined. Length up to 22 mm.; maximum breadth, 3 mm. In stems of *Salix*, *Populus*, and *Betula*, the larvae usually inhabiting a conspicuous gall *S. populnea* (Linnaeus), p. 285
- Asperities of ampullae short and blunt. Sublateral impressions of pronotum shallow (fig. 273). Length up to 36 mm.; maximum breadth, 6 mm. In boles and branches of *Populus* . . . . . *S. carcharias* (Linnaeus), p. 281

## CHARACTERS OF CERAMBYCID PUPAE

### PUPAL PROCESSES AND APPENDAGES

IN Cerambycid pupae the external surface of the cuticle, in addition to being often sculptured in various ways, bears a great variety of processes and appendages which may conveniently be grouped as follows:

1. *Setae*. Setae or "hairs" are connected to the cuticle by an articulated membranous ring. Although they vary considerably in size and shape, they are apparently always simple in structure. The two principal forms are those which are very long, slender and hair-like, and those which are short, stout and spine-like; the latter are usually ferruginous. They may arise either directly from the cuticle, from a small tubercle or apically or subapically from a larger spine (fig. 127).

2. *Spicules and small spines*. These are essentially rigid cuticular structures such as are present on the antennae of pupae of the ASEMINAE (fig. 113), and are not articulated basally.

3. *Spines*. Those which are stunted and triangular (fig. 48) are often termed "points" and usually occur on the abdominal tergites of many species (*Saperda*, *Ergates*). Most spines, however, are moderately long, slightly curved and thorn-like (fig. 154). In some cases they may be very stout with a tuberculate base, which may be more or less rounded or conical as on the ninth abdominal tergite of *Pogonocherus* (fig. 252). Stout, more strongly curved spines occur on the seventh to ninth abdominal tergites of most Clytini, whereas characteristic blade-like spines are present on the seventh abdominal tergite of *Molorchus* (fig. 168). The most specialised spines apparently are those on the abdominal tergites of *Agapanthia*: each spine is heavily sclerotised, long, slender and strongly curved backward like a hook (fig. 270). In many pupae the spines are equipped with either an apical, subapical or basal seta, which is often several times longer than the spine itself (fig. 261). Subapical setae are usually placed on a minute ledge as in *Cerambyx* (fig. 127).

4. *Papillae*. These small fleshy processes occur on the pronotum and abdominal tergites of many pupae; they are mostly stunted and either conical as in *Cerambyx* (fig. 127) or dome-shaped as in *Prionus* (fig. 42). In *Gracilia*, however, the papillae on the pronotum are strongly attenuated and sclerotised apically.

5. *Tuberculate outgrowths and protuberances*. These are present in a great number of pupae and constitute important primary subfamily and generic characters. Although in the majority of cases they are actually sheaths enclosing processes of the future imago, there are exceptions: *Oncideres cingulata* Say, for instance, has a well-developed spine-like tubercle at the base of the antenna, which is absent in the adult. A number of species in the adult stage are equipped with lateral thoracic spines (*Prionus*, *Cerambyx*), which in the pupae are in the form of stout, rather blunt tubercles; these are generally glabrous. Pupae of certain Callidini are characterised

by the presence of a median, conical protuberance on the pronotum (fig. 200). Other tuberculate processes present only in the pupal stage are the bifurcated protuberance on the seventh tergite of *Agapanthia* (fig. 271), and the pair of conical tubercles on the head of *Strangalia maculata* (Poda) (fig. 86). Pupae of the Monochamini are characterised by having on the ninth segment a long, vertical, tubular process (fig. 229). The adult tibial spurs of *Leptura* and *Strangalia* species are quite evident in the pupal stage but are less pointed and non-articulated. Similar but very much longer processes are present on the mid and hind femora of pupae of *Acanthocinus*, although there is no corresponding spur in the imaginal stage; presumably these originally enclosed well-developed spurs of the primitive adult which have since become lost.

In many pupae paired non-jointed processes known as urogomphi are to be found on the ninth abdominal tergum; these are usually either slender and strongly incurved (fig. 113), or stout and outwardly curved (fig. 103). In the PARANDRINAE these processes are always present, but in the Callipogonini they are present in *Ergates* and absent in *Megopis*. In *Prionus*, which is probably the most specialised genus of the PRIONINAE, they are totally absent. In the primitive ASEMINAE they are present throughout, but in the LEPTURINAE they are absent in the more specialised species. This suggests that the presence of urogomphi is a primitive feature in Cerambycid pupae.

A number of pupae of the PRIONINAE possess paired, median, strongly sclerotised processes which are usually in the form of transverse dentate or smooth ridges; these have recently been termed "gin-traps" (Hinton, 1946a). They appear to be absent in the remaining subfamilies. In *Ergates* these structures are present on abdominal segments 2-3, 3-4, 4-5, 5-6 and 6-7: the first four pairs each consist of an anterior, feebly sclerotised, labiate, transverse protuberance; and a posterior, strongly sclerotised transverse plate, which is produced anteriorly into a ferruginous ridge (fig. 47). The fifth pair are entirely pale and more feebly sclerotised, and the posterior plates are not produced.

#### FAMILY CHARACTERS OF CERAMBYCID PUPAE

Pupae of the family Cerambycidae may, in general, be characterised as follows:

*Form.* Body closely resembling form of adult both in size and shape, and in the proportions of the cephalic and thoracic appendages. Secondary sexual differences in the adults, such as the proportions of certain appendages, are generally evident also in the pupae. *Cuticle* exarate, weakly to moderately strongly sclerotised but sometimes very strongly in parts (e.g. urogomphi, gin-traps, etc.); colour usually waxy or milky white to testaceous, but occasionally orange or brown; usually with scattered setae or spinose areas or combinations of each.<sup>1</sup> *Head* nearly always strongly bent beneath prothorax so that mouthparts are directed posteriorly. Antennae extending at least as far as mesothorax (where they terminate between front and mid femora) but generally much longer, extending to abdominal segments (sometimes as far as seventh or eighth), where they are nearly always curved downward beneath body and arranged characteristically as follows: (1) slightly curved inward and terminating near hind femora (*Prionus*, *Phymatodes*); (2) more strongly curved inward and crossed (*Cerambyx*, *Molorchus*); (3) arranged in a single or in several coils on top of each

<sup>1</sup> The distribution and function of these and other cuticular outgrowths are discussed on p. 18.

elytron (Batocerini, Monochamini); (4) directed anteriorly to terminate near front or mid coxae (*Mesosa*, *Saperda*); or (5) directed anteriorly for a considerable distance to terminate alongside or on top of head (*Phytoecia*, *Agapanthia*), or strongly recurved and directed posteriorly to seventh abdominal segment where they are again recurved to terminate near apices of elytra (*Acanthocinus* (male specimens)). *Abdomen* usually

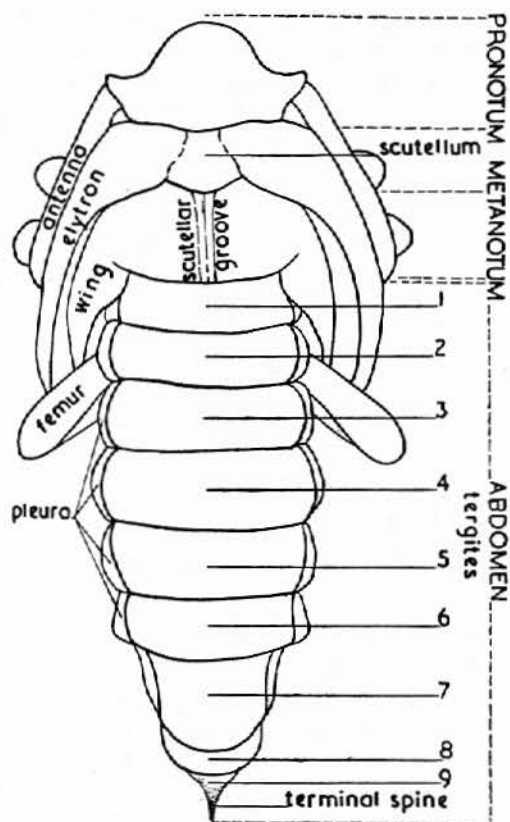


Fig. 22

Fig. 22. Diagrammatic figure of a Cerambycid pupa. Dorsal aspect.

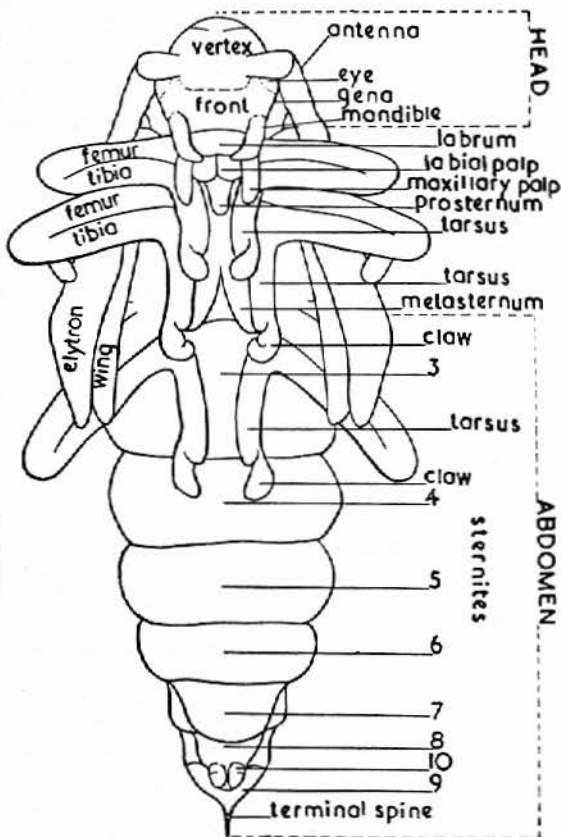


Fig. 23

Fig. 23. Diagrammatic figure of a Cerambycid pupa. Ventral aspect.

with nine movable segments, the tenth, and occasionally the ninth, being telescoped within the preceding segments; seventh and eighth segments usually more elongate than the preceding ones, and sometimes considerably produced. Seventh, eighth, and ninth segments either continuous laterally, or eighth and ninth explanate laterally; ninth segment often terminating in a vertical or horizontal spine or process, or with incurved or excurved urogomphi. Paired median gin-traps sometimes present (PRIONINAE). Functional ampullae absent, although in certain herbaceous plant-feeding Lammiids there are cushioned, spinose areas on the abdominal tergites which appear to be analogous to the larval ampullae. *Legs* often with subapical setae on the femur and sometimes with one or two setae on the tarsus. *Spiracles* of mesothorax functional,

large, oval, and placed ventro-laterally; spiracles of first five abdominal segments always functional, as are sometimes also those of sixth or sixth and seventh segments.

A study of the abdominal spiracles has shown them to be of little value as sub-family characters, and no satisfactory correlation between the number present and the pupal environment could be found. Although the number of functional spiracles appears to be constant in the subfamilies LEPTURINAE and ASEMINAE (in which they number five and seven pairs respectively), the number present in species of the subfamilies CERAMBYCINAE and LAMIINAE varies interspecifically from five to seven pairs. In the PRIONINAE the number of functional spiracles is usually six, but in the PARANDRINAE the two species of *Parandra* examined appeared to have the seventh pair functional.

*Sexual differences.* Generally speaking, a transverse, rectangular protuberance is present posterior to the eighth sternite in the male, whereas in the female this is represented by a pair of subcontiguous, rounded lobes which often bear one or more pairs of setae. A secondary sexual characteristic is the proportion and arrangement of the antennae, which in the male are often considerably longer and more elaborately arranged.

A detailed account of the morphology of the pupa is not considered necessary as all the parts referred to in the descriptions and keys are indicated in the figures (figs. 22, 23).

#### KEY TO SUBFAMILIES OF CERAMBYCID PUPAE

Considerable difficulty has been experienced in the construction of the following pupal key, particularly in so far as subfamily characters are concerned, and it has been necessary in some instances to follow an artificial rather than a phylogenetic sequence, and to use what are in fact adult characters instead of truly pupal ones.

As would be expected from the quiescent condition of the pupa, it presents few characters other than those derived directly from the external structure of the contained imago. Indeed it is only the scattered spines and setae and various caudal processes which can be regarded as truly independent pupal modifications. Unfortunately even these appear to vary intraspecifically, sometimes to a considerable extent, and as in the case of many species, only a single specimen was available, this key must be regarded as provisional.

1. Length usually at least 25 mm., but if less then outwardly-curved urogomphi present on ninth abdominal segment (fig. 30), and antennae not extending beyond mid femora (fig. 30). Head never with conspicuous spines or setae (occasionally with a few scattered spinules or papillae), and spiracles narrowly oval. Prothorax either with three pairs of lateral tubercles or none; never one pair only. Prosternum produced into a rounded or truncate process behind coxae (fig. 43). [Femora without setae. Abdominal tergites sometimes with gin-traps (fig. 47). Functional spiracles present on first six or seven abdominal segments; peritreme very thick.] . . . . . 2
- Length seldom exceeding 20 mm., but if more, then either a single pair of lateral prothoracic tubercles present (fig. 228) or head or femora with spines or setae. Head usually bearing conspicuous spines or setae, but if without then spiracles broadly oval (fig. 203). Prothorax either with a single pair of lateral tubercles or none; never three pairs. Prosternum seldom produced beyond coxae, but if so then never simply rounded or truncate,

- but either tapering and confluent with mesosternum (ASEMINAE) or enlarged into a 'T'-shaped process (LAMIINAE pars) . . . . . 3
2. Length, 15-28 mm.; usually considerably less than 28 mm. Ninth abdominal segment with a pair of excurved or divergent urogomphi (fig. 30). Antennae extending to between front and middle femora; moniliform, never serrate or pectinate (fig. 30). [Abdominal sternites without setae. Prothorax never with lateral tubercles.]
1. \*PARANDRINAE (\**Parandra*), p. 102
- Length, 29-60 mm.; if slightly less than 29 mm., then incurved urogomphi present. Ninth abdominal segment usually simple, but occasionally with incurved urogomphi or a pair of short, vertical tubercles (fig. 42). Antennae extending to at least first abdominal segment, and often recurved beneath body (fig. 42); never moniliform but sometimes serrate or pectinate (fig. 42). [Abdominal tergites sometimes with gin-traps.]
2. PRIONINAE, p. 88
3. Ninth abdominal segment either with a horizontal spine (fig. 65) or with excurved or parallel urogomphi (fig. 82). Tarsi each bearing one or a pair of setae (fig. 65). Hind tibiae with long, apical, tuberculate spurs (fig. 76). Labrum transverse, rectangular (fig. 65). Functional spiracles absent on sixth and seventh abdominal segments. [Femora always with apical setae (fig. 65). Head triangular and usually rather elongate. Clypeus usually with a deep impression and a row of setae across base (fig. 65).]
3. LEPTURINAE,<sup>1</sup> p. 88
- Ninth abdominal segment usually simple but sometimes with either a vertical spine or with strongly incurved urogomphi (figs. 111, 248). Tarsi nearly always without setae, but if setose (*Monochamus*) then antennae coiled. Hind tibiae never with long, apical, tuberculate spurs. Labrum seldom transverse, but if so never rectangular; usually triangular or cordate (fig. 286). Functional spiracles present on sixth or sixth and seventh abdominal segments (fig. 193) . . . . . 4
4. Antennae with several conspicuous spines at or near apex of basal segment, and entirely microscopically spiculate (fig. 113). Ninth abdominal segment with a pair of strongly incurved urogomphi (fig. 113); never with a vertical spine. Abdominal sternites four to eight each with paired, sublateral groups of spines (fig. 111). Apices of femora with spines (each with an apical seta). Functional spiracles present on first seven abdominal segments . . . . . 4. ASEMINAE, p. 91
- Antennae without spines or spicules. Ninth abdominal segment never with incurved urogomphi; occasionally with a vertical spine (fig. 248). Abdominal sternites never with paired groups of numerous spines, but sometimes with two or three very small spines. Apices of femora usually glabrous or with setae only, but if with spines then each spine with a basal seta. Functional spiracles often restricted to first five or six segments . . . 5
5. Clypeus without setae (fig. 126). Mandibles without setae (fig. 126). Head strongly bent beneath prothorax so that vertex is totally or for the greater part concealed from above; vertex convex (sometimes dome-shaped); never flat or deeply excavate between bases of antennae (fig. 126). Femora without setae (fig. 196). Pleura strongly protuberant (fig. 196). Seventh, eighth, and ninth abdominal segments continuous laterally. Eyes moderately convex (fig. 196). Maxillary palpi never strongly tapering; sometimes enlarged apically. Prosternum never produced behind coxae into a 'T'-shaped process. [Abdominal sternites glabrous (fig. 196).] . . . . . 5. CERAMBYCINAE, p. 92
- Clypeus with several setae across base (fig. 277). Mandibles each with one to six setae near middle of outer face (fig. 277). Head less strongly bent beneath prothorax so that the vertex is entirely or for the greater part visible from above; vertex either deeply excavate or flat; never convex between bases of antennae (fig. 241). Femora nearly always with apical spines or setae, but if without then abdomen either cylindrical and parallel-sided or ninth tergite with a vertical process (Frontispiece). Pleura never strongly protuberant (fig. 252). Eighth or ninth abdominal segment obliquely explanate laterally, the

<sup>1</sup> The genus *Ulochaetes* can only with difficulty be included in the LEPTURINAE as only the first two characters given in the key are applicable (see also p. 145).

latter often deeply divided beneath (fig. 228). Eyes at most feebly convex, generally flat (fig. 286). Maxillary palpi gradually to strongly tapering; never truncate or enlarged apically (fig. 228). Prosternum often produced beyond coxae into a 'T'-shaped process (fig. 290) . . . . . 6. LAMIINAE, p. 97

## KEYS TO GENERA AND SPECIES OF CERAMBYCID PUPAE

### 2. PRIONINAE

1. Pronotum without spines, and with three pairs of lateral tubercles, of which the middle pair is the most strongly produced (fig. 42). Antennae thick (serrate in male), moderately long, and not curved beneath body (fig. 42). Abdomen very broad at middle. Abdominal tergites with only scattered pale papillae (fig. 42). [Usually in an earthen cocoon near roots of mature trees.] . . . . . *Prionus coriarius* (Linnaeus), p. 106
- Pronotum spinose, and without lateral tubercles (fig. 45). Antennae slender (never serrate), usually very long, and recurved beneath body (except *Megopsis* pars). Abdomen only slightly broader at middle. Abdominal tergites conspicuously spinose (fig. 48) . . . . . 2
2. Gin-traps present on abdominal tergites 2-3, 3-4, 4-5, 5-6, and 6-7 (figs. 47, 48) . . . . . 3
- Gin-traps absent. [Meso- and metanotum spinose. Ninth abdominal tergite with urogomphi, if present, incurved. Head not bent beneath prothorax (fig. 45).] . . . . . *Megopsis* (Oriental sp.), p. 112
3. Head strongly bent beneath prothorax. Meso- and metanotum without spinules. Antennae slender, long, and recurved beneath body . . . . . *Ergates*, p. 88
- Head not bent beneath prothorax. Meso- and metanotum with numerous scattered spinules. Antennae stout, short, and not recurved beneath body. [African species.] . . . . . *Mallodon downesi* Hope, p. 117

#### \**Ergates*

1. Gin-traps with posterior transverse plate strongly dentate or crenulate along its front margin. North American species . . . . . *E. spiculatus* Leconte, p. 116
- Gin-traps (fig. 48) with posterior transverse plate smooth and straight along its front margin. European species . . . . . *E. faber* Linnaeus, p. 114

### 3. LEPTURINAE

1. Abdominal tergites with all setae long, slender, and pale; never stout and spine-like. Ninth abdominal segment never with terminal spine; urogomphi, if present, with at least basal two-thirds only feebly sclerotised. Femora with several long, fine setae near apex; each tarsal claw with a single long seta (fig. 101). Length never more than 12 mm. . . . . 2
- Abdominal tergites with short, stout, spine-like setae or spines, as well as slender setae of varying length (fig. 64). Ninth abdominal segment either with a terminal spine (fig. 64) or with urogomphi which are usually entirely strongly sclerotised (fig. 82). Femora with a row of short (usually stout) setae near apex; each tarsal claw with one or a pair of setae (minute in *Ulochaetes*). Length usually more than 12 mm., but, if less, then vertex of head with two pairs of very long setae (fig. 89) . . . . . 5
2. Urogomphi absent. Breadth at least 3 mm. [Front and vertex of head with ferruginous setae which are curved forward. In earthen cocoons beneath old stumps, etc.] . . . . . *Acmaeops collaris* (Linnaeus),<sup>1</sup> p. 118
- Urogomphi present (fig. 76). Breadth usually less than 3 mm. . . . . 3
3. Pronotum strongly bent downward so that it is almost at right angles to meso- and metanotum (fig. 101); rather densely covered with scattered, ferruginous setae. Vertex of head with five or six pairs of short setae (fig. 101). Hind femora very long, with apices considerably higher than general dorsal level of body (fig. 101). Metanotum with a pair

<sup>1</sup> Based on a description by Perris (1877).

of raised oval, tuberculate areas each bearing numerous setae. Usually in earthen cocoons near roots of trees . . . . . *Judolia cerambyciformis* (Schrank), p. 143

- Pronotum scarcely or not bent downward; setae much less numerous and confined chiefly to marginal areas. Vertex of head with not more than three pairs of long setae (fig. 76). Hind femora much shorter, with apices scarcely, if at all, raised above general dorsal level of body (fig. 76). Metanotum never with raised, tuberculate areas, but sometimes setose. Never in earthen cocoons . . . . . 4
- 4. Vertex of head with a single pair of long, fine setae above bases of antennae. Urogomphi short and stout. Abdominal tergites one to six with very long, fine setae; tergites seven and eight with setae of about the same length. Hind legs with tarsi longer than tibiae. Metanotum with about twelve long rather stout setae which are almost as long as those on pronotum . . . . . *Alosterna tabacicola* (Degeer), p. 132
- Vertex of head with two or three pairs of long, fine setae (fig. 76). Urogomphi long, slender, and tapering; often strongly excurved (fig. 76). Abdominal tergites one to six with moderately long setae; tergites seven and eight with setae much longer. Hind legs with tarsi slightly shorter than tibiae (fig. 76). Metanotum glabrous or with very short setae which are less than a quarter the length of those on pronotum . . . . . *Grammoptera*, p. 130
- 5. Ninth abdominal segment without urogomphi but bearing a stout, terminal spine (fig. 64). Lateral prothoracic tubercles present. Tarsi each with a pair of stout setae (fig. 65). [Spines on abdominal tergites mostly with a subapical or basal seta (fig. 64). Spurs of tibiae short (fig. 65). Femora with apical setae long (fig. 64). Hind legs with tarsi much shorter than tibiae (fig. 65).] . . . . . 7
- Ninth abdominal segment with urogomphi (fig. 81); never with a terminal spine. Lateral prothoracic tubercles absent. Tarsi each with a single seta (fig. 81) (except *Ulochaetes* which has two minute setae) . . . . . 6
- 6. Abdominal tergites bearing spines (each with a subapical seta). Tarsi with a pair of minute setae. Spurs of tibiae short. Femora without or with extremely minute setae. Hind legs with tarsi shorter than tibiae. [Length up to 34 mm. North American species.]  
\**Ulochaetes leoninus* Leconte, p. 145
- Abdominal tergites with stout setae only (fig. 82). Tarsi each with a single seta (fig. 81). Spurs of tibiae long (fig. 81). Femora with several conspicuous apical setae which are usually short. Hind legs with tarsi as long as or longer than tibiae (fig. 81).  
*Leptura*, *Strangalia*,<sup>1</sup> p. 89
- 7. Eighth tergite without tubercles but with a transverse row of spines near hind margin (fig. 64). Ninth tergite with terminal spine pitchy or ferruginous for at least apical fourth, and its basal spinules ferruginous (fig. 64). Head very elongate (fig. 65). Maxillary palpi long and rather slender . . . . . *Rhagium* (s.g. *Rhagium*), p. 90
- Eighth tergite with a pair of small, raised tubercles each bearing two or three spines. Ninth tergite with terminal spine, and the spinules on each side of its base pale testaceous. Head slightly elongate (fig. 72). Maxillary palpi short, and rather stout.  
*Rhagium* (s.g. *Hargium*) *inquisitor* (Linnaeus), p. 127

#### **Leptura, Strangalia**

1. Length, 9.25–6 mm. Vertex of head with a pair of very long, moderately stout setae above base of each antenna (fig. 89). Front and lateral margins of pronotum bearing several widely separated, long setae which arise from basal papillae. Abdominal tergites one to seven almost flat, and with paired groups of from two to three stout setae (fig. 89). Eighth tergite with long fine setae (fig. 89). Ninth segment fringed with several long setae (fig. 89). Sternites three to seven with a posterior row of long fine setae. Eighth sternite with a pair of very long setae. Femora each with one stout seta, and two or three smaller setae (fig. 89) . . . . . *S. melanura* (Linnaeus), p. 138

<sup>1</sup> Dealt with as one genus for convenience, as no truly pupal distinction is evident. British species, however, are separable on the form of the basal angles of the pronotum (i.e. an adult character). In *Strangalia* they are acutely angular, whereas in *Leptura* they are right-angled and never protuberant.

- Length, 11–25 mm. Vertex of head never with two pairs of very long setae but with several short ones. Front and lateral margins of pronotum seldom with long setae, but if so then setae simple at base. Abdominal tergites one to seven with paired, oval, slightly raised areas bearing numerous stout setae (fig. 82). Eighth tergite with short stout setae (fig. 82). Ninth segment simple, not fringed with setae, but sometimes with short spines bearing apical setae. Sternites three to seven sometimes glabrous, but usually with a posterior row of short setae. Eighth sternite with at most two to four short setae (fig. 82). Femora each with a transverse row of setae, behind which are sometimes smaller scattered setae (fig. 82) . . . . . 2
- 2. Head with a small bifurcated tuberculate process on vertex, immediately in front of anterior margin of pronotum (fig. 86). Urogomphi long and very slender; almost parallel, and projecting vertically (fig. 87). Femora with fine setae which are distributed along apical third of outer face. Front margin of pronotum without a raised tuberculate process, and with median part fringed with slender setae. Pleura bearing paired, long, slender setae . . . . . *S. maculata* (Poda), p. 137
- Head without a tuberculate process on vertex. Urogomphi short and usually stout; excurved, projecting posteriorly, and usually horizontally (fig. 81). Femora with very short setae which are distributed along at most apical fourth of outer face. Front margin of pronotum often with one or a pair of oval tuberculate processes, and bearing short stout setae (fig. 95); never fringed with slender setae. Pleura bearing paired short setae . . . . . 3
- 3. Front margin of pronotum with a conspicuous pair of paramedian, raised, tuberculate processes, each with four to six stout setae: basal half of pronotum more or less flat (fig. 91). Urogomphi curved downward (fig. 92). [Clypeus with six stout setae.]  
*L. scutellata* Fabricius, p. 140
- Front margin of pronotum simple or with only a single (median) tuberculate process; basal half of pronotum usually with a pair of raised setose areas (fig. 95). Urogomphi slightly curved upwards (fig. 81) . . . . . 4
- 4. Urogomphi very slender, scarcely, if at all, larger than accompanying spines on posterior margin of ninth tergite (fig. 96). Head with three or four setae opposite base of each antenna. Femora with a transverse row of short setae near apex only.  
*L. rubra* (Linnaeus), p. 142
- Urogomphi very stout, at least twice as large as accompanying spines on posterior margin of ninth tergite (fig. 81). Head with at least ten setae opposite base of each antenna. Femora with a transverse row of short setae near apex, and with several scattered (usually smaller) setae behind . . . . . 5
- 5. Eighth sternite without setae. Setae on abdominal tergites one to six stout, and rather closely set on large tuberculate bases (fig. 83). Clypeus with a row of six setae across base.  
*S. aurulenta* (Fabricius), p. 138
- Eighth sternite with two to four moderately stout setae. Setae on abdominal tergites one to six more slender, rather scattered, and with tuberculate bases smaller (fig. 83). Clypeus with only four setae across base (fig. 18) *S. quadrifasciata* (Linnaeus), p. 135

#### Rhagium (s.g. Rhagium)

- 1. Sternites four to eight each with sublateral groups of rather stout, pale spines (each with a long, fine, basal seta). Lateral prothoracic tubercles bearing short, stout spines (each with a subapical seta). Antennae terminating between fore and mid femora. Setae on head and pronotum slender and testaceous. Mandibles each with three or four very fine, pale setae . . . . . *R. mordax* (Degeer), p. 126
- Sternites four to eight with sublateral groups of long setae only (fig. 64). Lateral prothoracic tubercles bearing setae only (fig. 64). Antennae terminating behind mid femora (fig. 65). Setae on head and pronotum stout and ferruginous (fig. 64). Mandibles each with a single stout spine . . . . . *R. bifasciatum* Fabricius, p. 123

## 4. ASEMINAE

1. Spines on abdominal tergites long, straight, testaceous, and never with subapical setae (fig. 111). Pronotum usually with a pair of paramedian, rather large, shallow depressions. Mesosternum broad and flat, with posterior margin at most slightly rounded (fig. 114). [Vertex of head with only a few fine, pale setae. Maxillary palpi slightly obliquely truncate.] . . . . . *Arhopalus*, p. 91
- Spines on abdominal tergites either curved or straight, and ferruginous or darker; if straight, then each with a long subapical seta. Pronotum without depressions but sometimes with a pair of longitudinal grooves. Mesosternum narrow, with posterior margin either strongly rounded, protuberant, or confluent with metasternum (fig. 114) 2
2. Pronotum (fig. 115) bearing a few stout curved spines arising from large basal tubercles near lateral margins. Abdomen with subparallel sides. Robust, maximum breadth 10 mm. . . . . \**Spondylis buprestoides* Linnaeus, p. 154
- Pronotum (fig. 118) with spines slender, straight, and not arising from large basal tubercles. Abdomen (fig. 118) tapering posteriorly. Slender, maximum breadth 5.5 mm. . . . . 3
3. Eighth abdominal tergite with numerous short stout ferruginous spines. Clypeus with several short, ferruginous spinules extending more or less transversely behind front margin (fig. 113). Vertex of head with numerous spines. Mesosternum parallel-sided, and ending in a rounded, protuberant process. Abdominal sternites four to seven with paired sublateral groups of moderately long, ferruginous spines (fig. 113). Maxillary palpi cylindrical and rounded apically. Spiracles with peritreme testaceous and completely raised above general level of cuticle . . . . . *Asemum striatum* (Linnaeus), p. 152
- Eighth abdominal tergite with at most three or four small spines. Clypeus without spinules. Vertex of head with two to six minute spines. Mesosternum slightly tapering, and not protuberant but confluent with metasternum (fig. 114). Abdominal sternites four to seven with paired sublateral groups of minute spines, each equipped with a long, fine, subapical seta. Maxillary palpi explanate and obliquely truncate apically. Spiracles with peritreme white, and with only anterior half raised above general level of cuticle . . . . . *Tetropium*, p. 92

*Arhopalus*<sup>1</sup>

1. Sublateral spinose areas of abdominal sternites with numerous long, ferruginous setae and short spines (the latter each with a long apical seta). Dorsal surface of eyes with numerous (at least twenty) very short ferruginous spines (each bearing a long, ferruginous apical seta). Spiracles with peritreme narrowly oval, rather thick, strongly sclerotised and ferruginous. Basal segment of antenna with at least six stout ferruginous spines near apex and several short scattered spines distributed nearly to base; remaining segments with shorter scattered spines. Mesosternum at least twice as long as minimum width, with hind margin broadly rounded. Chiefly a northern species. . . . . *A. rusticus* (Linnaeus), p. 151
- Sublateral spinose areas without long setae. Dorsal surface of eyes with at most a few pale spines (each bearing a short pale apical seta). Spiracles with peritreme broadly oval, thinner, less strongly sclerotised, and pale testaceous. Basal segment of antenna with at most six shorter spines near apex, seldom with any shorter scattered spines, the basal half being without spines; remaining segments with pale papillae. Mesosternum at most one and one-half times as long as minimum width, the hind margin almost straight. Chiefly a southern species . . . . . *A. ferus* (Mulsant), p. 149

<sup>1</sup> As pupae of this genus are apparently unusually variable in the nature and distribution of spines, etc., and only one pupa of *A. rusticus* is available, this key should be regarded as provisional.

## Tetropium

1. First abdominal tergite with not more than twenty spines. Front margin of pronotum not or only slightly raised medially. Scutellum without spines (fig. 118).  
*T. gabrieli* Weise, p. 155
- First abdominal tergite with at least twenty-five spines. Front margin of pronotum with a distinctly raised, median, spinose tubercle. Scutellum with two or more distinct spines . . . . . (\*) *T. castaneum* Linnaeus, p. 158

## 5. CERAMBYCINAE

1. Length at least 16 mm. Prothorax with a pair of medio-lateral tubercles (except *Romaleum*), fig. 187. Head with vertex dome-shaped, and usually with a deep transverse impression immediately above bases of antennae; base of clypeus with a similar impression (fig. 126). Seventh tergite with hind margin strongly rounded or angled medially; sometimes with a single or a pair of oval, spinose, tubercular protuberances, but never with a transverse row of large curved or flat, blade-like spines, or with numerous scattered spinules. Abdominal spiracles usually with peritreme narrowly oval, but if broadly oval (Phoracanthini pars) then antennae pectinate on inner margins. [Antennae recurved beneath body. Eyes feebly convex and glabrous (fig. 126).] . . . . . 2
- Length usually much less than 16 mm., but if exceeding 10 mm., then pronotum without setae or papillate. Prothorax without medio-lateral tubercles (but antero-lateral tubercles present in *Cylindera*). Head never with vertex dome-shaped or with a deep transverse impression above antennae; clypeus without a deep impression. Seventh tergite with hind margin feebly rounded, and never angled medially (except Callidini pars, but then femora short and robust); never with spinose protuberances (except *Elaphidion*), but often with a transverse row of long, curved or flat, blade-like spines, or with numerous scattered spinules. Abdominal spiracles with peritreme always broadly oval (fig. 203) 11
2. Spines on abdominal tergites one to six mostly inclined forward (fig. 187). Front margin of pronotum distinctly angled medially (fig. 187). Pronotum bearing several groups of short setae; never with paramedian, raised, oval tubercles or with scattered short, curved spines or setose papillae. [Eighth tergite acutely tapering posteriorly. Spiracles very narrowly oval (fig. 187).] . . . . . *Aromia moschata* (Linnaeus), p. 202
- Spines on abdominal tergites one to six mostly inclined backward. Front margin of pronotum not angled medially. Pronotum never with groups of short setae; either with paramedian, oval, tuberculate areas, or with scattered short spines or setose papillae (fig. 150) . . . . . 3
3. Antennae filiform or slightly pectinate on outer margins. Pronotum never with raised tuberculate areas near base. Femora subparallel-sided . . . . . 4
- Antennae strongly pectinate on inner margins, and recurved, but not crossed beneath body (fig. 150). Pronotum with a pair of paramedian, raised, tuberculate areas (each bearing numerous setose papillae) near base (fig. 150). Femora strongly clavate. [Seventh tergite either with a pair of oval, tuberculate protuberances (each bearing a few spines) or with a single, median, spinose protuberance] . . . . . \*Phoracanthini 9
4. Antennae not crossed beneath body; extending at least as far as prothorax. [Seventh tergite with groups of stout curved spines near hind margin (fig. 148). Pupal cell without calcareous operculum.] North American species . . . . . 5
- Antennae crossed beneath body; not extending as far as prothorax (fig. 126) . . . . . 6
5. Pronotum with a pair of lateral tubercles. Eighth tergite with a transverse row of spinules. Hind femora extending to fifth abdominal segment \**Chion cinctus* Drury, p. 176
- Pronotum without lateral tubercles. Eighth tergite without spinules. Hind femora not extending beyond fourth abdominal segment . . . . . \**Romaleum rufulum* Haldeman, p. 186
6. Seventh tergite with stout curved spines near posterior margin (as in *Chion*, fig. 148). Pupal cell never with calcareous lining or operculum. North American species.  
 \**Eburia quadrigeminata* Say, p. 199

- Seventh tergite without stout, curved spines near posterior margin. Pupal cell with calcareous lining or operculum. European and African species . . . Cerambycini 7
7. Seventh tergite with a pair of small, oval, tuberculate protuberances (each bearing numerous stout spines) near hind margin. Ninth tergite strongly bilobed and protuberant; not concealed from above by eighth. Eighth tergite with posterior angles rounded and explanate; a few ferruginous spines present. African species.  
\**Pachydissus hector* Kolbe, p. 169
- Seventh tergite simple. Ninth tergite only slightly bilobed, and concealed from above by eighth. Eighth tergite if with posterior angles rounded, then only a few pale papillae present. African and European species . . . . . 8
8. Eighth tergite with posterior angles rounded and explanate; a few pale papillae present. Ninth tergite without spinules. Antennae filiform. Abdominal tergites two to six with spines each arising from a conical papillate base. Functional spiracles present on first seven abdominal segments . . . . . (\*) *Cerambyx*, p. 96
- Eighth tergite acutely produced posteriorly; a few ferruginous spines present. Ninth tergite with a few scattered ferruginous spinules. Antennae slightly pectinate on outer margin. Abdominal tergites two to six with spines simple at base. Functional spiracles present on first five abdominal segments. [African species.]  
\**Plocaederus viridipennis* Hope, p. 167
9. Seventh tergite with a single tuberculate, spinose protuberance. Eighth tergite with spines very much smaller than those on seventh tergite. Tergites one to six each with numerous spines which are closely set (separated by about their own basal width), and arranged in a single, almost straight row. Functional spiracles present on first six abdominal segments. Hind femora without a tuberculate process at base. African species.  
\**Cordylomera suturalis* Chevrolat, p. 182
- Seventh tergite with paired tuberculate, spinose protuberances. Eighth tergite with two small groups of spines which are as large as those on seventh tergite (fig. 150). Tergites one to six each with spines more widely set (separated by at least twice their own basal width), and irregularly arranged on a slightly raised area (fig. 150). Functional spiracles present on first five abdominal segments. Hind femora each with a tapering tuberculate process at base. Australian species . . . . . 10
10. Vertex of head not visible from above. Pronotum very elongate, with front margin strongly rounded and bearing groups of setae. Mesonotum with two groups of minute setae. Abdominal spiracles broadly oval; peritreme rather strongly raised above general level of cuticle (fig. 150) . . . . . \**Coleoceptus senio* Newman, p. 179
- Vertex of head partly visible from above. Pronotum quadrate, with front margin feebly rounded; bearing scattered, short, curved, testaceous spines, especially near front margin. Mesonotum without setae. Abdominal spiracles less broadly oval; peritreme scarcely or not raised above general level of cuticle.  
\**Phoracantha semipunctata* Fabricius, p. 180
11. Seventh tergite (fig. 154) with numerous long, slender spines which are mostly recumbent and pointing inward; posterior margin with a pair of very small tuberculate protuberances which bear a few sub-erect spines. Ventral margin of eye (near base of mandible) bearing three or four rather long fine setae. Eighth tergite without spines; hind margin semicircular. [Pronotum with only a few fine spinules and setae along front margin. Length about 13 mm. Imported from Jamaica in *Lignum vitae*.]  
\**Elaphidion nanum* Fabricius, p. 184
- Seventh tergite seldom as densely spinose, but if so, then spines directed posteriorly; posterior margin without tuberculate protuberances. Eyes generally without setae, but sometimes spinose. Eighth tergite if without spines never semicircular . . . . . 12
12. Head with papillae on vertex or setae on front (near bases of antennae). Pronotum either with conspicuous groups of setae or long, pale papillae (each with a long, fine basal seta). [Pronotum elongate. Eyes strongly convex.] . . . . . 13

- Head without papillae or setae. Pronotum never bearing conspicuous groups of setae or papillae but either glabrous or with scattered fine setae or a few short papillae. [Pleura without setae. Eighth tergite never with a row of long fine setae near posterior margin.] . . . . . 15
13. Pronotum with a pair of prominent, spinose, lateral tubercles near front margin (fig. 160). Ventral margin of eye with at least three conspicuous spines. Seventh tergite without spines. Spines on abdominal tergites one to six mostly directed anteriorly.  
\**Cylindera flava* Fabricius, p. 188
- Pronotum without lateral tubercles near front margin. Ventral margin of eye without spines. Seventh tergite with stout, recurved or blade-like spines. Spines on abdominal tergites one to six mostly directed posteriorly . . . . . 14
14. Pronotum very elongate, bearing numerous long papillae (each with a fine basal seta, (fig. 174). Head with a few pale papillae on vertex; front with two groups of from two to three setae near base of each antenna. Seventh tergite with about four recurved spines on papillate bases (fig. 174). Elytra as long as wings. Antennae always recurved but never crossed beneath body. Ninth segment retracted in eighth and not visible from above. Functional spiracles present on first seven abdominal segments; peritreme round.  
*Gracilia minuta* (Fabricius), p. 194
- Pronotum less elongate, bearing conspicuous groups of setae only (fig. 166). Head without papillae, and front with two groups of from two to four setae near base of each antenna. Seventh tergite with four to six broad, straight, blade-like or thorn-like spines which are inclined forward. Elytra very short, about half the length of the wings. Antennae, if recurved beneath body, always crossed. Ninth segment not retracted; visible from above. Functional spiracles present on first six abdominal segments; peritreme oval . . . . . *Molorchus*, p. 96
15. Pronotum elongate and depressed (fig. 124), and antennae curved beneath body. Seventh tergite without stout, curved spines. [Apices of hind femora extending as far as fourth abdominal segment. Length up to 10 mm. North American species.]  
\**Smodicum cucujiforme* Say, p. 161
- Pronotum usually quadrate, but if elongate (Clytini pars) then antennae not curved beneath body; seventh tergite bearing stout, curved spines . . . . . 16
16. Seventh abdominal tergite without a row of anteriorly-curved spines or tubercles (fig. 193). Pronotum never with stout spines or tubercles; generally glabrous (fig. 199). Antennae long, extending at least as far as second abdominal segment where they are curved beneath body (fig. 199) Eyes feebly convex. Hind femora short, stout, and lying rather obliquely to longitudinal axis of body, and extending to fourth or fifth abdominal segment (fig. 193). Ninth segment very short but visible from above (fig. 199) Callidini 17
- Seventh abdominal tergite with a transverse row of four to eight large stout spines which are curved anteriorly or inwards (fig. 203). Pronotum bearing some rather stout spines or tubercles (setae only in *Chlorophorus*) along front and lateral margins (except *Neoclytus*). Antennae short (fig. 203), not extending beyond second abdominal segment (except *Anaglyptus*). Eyes strongly convex. Hind femora long and slender, lying more or less parallel to the longitudinal axis of body, and extending to fifth or sixth abdominal segment. Ninth segment retracted in eighth and not visible from above (fig. 203).  
Clytini 21
17. Eighth tergite with a longitudinal median groove, on each side of which are numerous spines (fig. 191). Mesonotum with several fine pale setae on each side of scutellum, and metanotum with numerous similar setae. Abdominal tergites one to six each with numerous short ferruginous spines which are arranged in a row across anterior and posterior margins, and in a broad semi-oval group near each lateral margin (fig. 191). Seventh tergite very elongate, with hind margin narrowly rounded (fig. 191). Ninth segment bilobed, each lobe bearing a fine seta. [Functional spiracles present on first five abdominal segments.] . . . . . *Hylotrupes bajulus* (Linnaeus), p. 208

- Eighth tergite without a groove, and with at most four short spines near centre (fig. 193). Mesonotum and metanotum usually without setae, but sometimes with a few short testaceous spines (fig. 199). Abdominal tergites one to six each with only a few spines which are arranged in a row across posterior margin only, and never formed into sub-lateral groups (fig. 193). Seventh tergite less elongate, and with hind margin either rather sharply angled medially or broadly rounded (fig. 199). Ninth segment not bilobed . . . . . 18
18. Pronotum with a conspicuous median, tuberculate protuberance (which is covered with a few wart-like setose papillae) near front margin (fig. 200). [Maxillary palpi scarcely enlarged apically. Functional spiracles present on first seven abdominal segments (with a vestigial pair on segment eight); peritreme moderately thick, and very strongly raised above general level of cuticle.] . . . . . (\*) *Pyrrhidium sanguineum* (Linnaeus), p. 221
- Pronotum without a conspicuous protuberance but sometimes with a short conical glabrous tubercle . . . . . 19
19. Pronotum with a few conical papillae above middle of posterior margin. Mesonotum and metanotum bearing a few short, testaceous spines. Seventh tergite with hind margin produced and rather sharply angled medially (fig. 193). Eighth tergite slightly elongate, and with about four short spines near centre. Spiracles present on abdominal segments one to five (but vestigial pairs present on segments six and seven). [Peritreme thin and very strongly raised above general level of cuticle (fig. 193).] . . . . . *Callidium violaceum* (Linnaeus), p. 215
- Pronotum simple. Mesonotum and metanotum without spines. Seventh tergite with hind margin simple. Eighth tergite transverse and without spines. Spiracles present on abdominal segments one to seven (fig. 199) . . . . . 20
20. Length, 7.5–16.5 mm. Antennae extending as far as first abdominal segment, where they are curved downward alongside the mid femora to terminate near mid coxae. Maxillary palpi greatly enlarged apically. Pronotum bearing a conspicuous conical, tuberculate process just behind middle of front margin. Abdomen with tergites one to six each with a transverse group of small pale spines across posterior half, and generally with an incomplete row of smaller spines across anterior half. Seventh tergite bearing scattered spines which are stoutest near hind margin. Abdominal spiracles with peritreme broadly oval. . . . . *Phymatodes testaceus* (Linnaeus), p. 217
- Length, 4–7 mm. Antennae not curved downward alongside mid femora, but continuing posteriorly as far as hind femora, where they are slightly curved to terminate near apices of elytra. Maxillary palpi simple. Pronotum without a conical process but front margin very slightly raised medially. Abdomen with tergites one to six each with paired groups of two or three small spines near posterior margin; anterior half without spines. Seventh tergite with a single row of spines near posterior margin. Abdominal spiracles with peritreme less broadly oval (fig. 199) . . . . . *Poecilium alni* (Linnaeus), p. 219
21. Pronotum quadrate to transverse with sides strongly rounded. Form robust; length up to 25 mm.; maximum breadth, 6 mm. [Hind femora not extending beyond fifth abdominal segment.] . . . . . 22
- Pronotum slightly to strongly elongate with sides moderately rounded (fig. 203). Form more slender; length up to 21 mm.; maximum breadth, 4 mm. . . . . 23
22. Apex of hind femora with a pair of blunt, rounded tubercles which are only slightly protuberant. European species. . . . .
- (\*) *Plagionotus arcuatus* (Linnaeus) and \**P. detritus* Linnaeus, pp. 225, 226
- Apex of hind femora with a pair of conical tubercles, the outer one strongly protuberant. American species . . . . . \**Cyllene*, p. 96
23. Seventh tergite with a transverse row of at least eight stout, anteriorly-curved spines across posterior margin, and four pairs of inwardly-curved spines along middle (fig. 213). Pronotum with fine pale setae along lateral margins. [Oriental species; chiefly in *Bambusa*.] . . . . . \**Chlorophorus annularis* Fabricius, p. 237

- Seventh tergite with a transverse row of not more than six stout, anteriorly-curved spines across posterior margin, and with remaining spines not arranged in four pairs along middle (fig. 203). Pronotum with ferruginous tubercles, spines, or spinules about lateral margins . . . . . 24
- 24. Seventh tergite with a transverse row of six stout, anteriorly-curved spines. Process of prosternum as thick as maxillary palp, fleshy, and protuberant. Gena bearing a small teat-shaped tubercle near base of mandible. Functional spiracles present on first seven abdominal segments. [North American species.] . . . . . 25
- Seventh tergite with a transverse row of from four to five stout anteriorly-curved spines. Process of prosternum much narrower than maxillary palp, and depressed. Gena simple. Functional spiracles present on first five abdominal segments . . . . . 26
- 25. Antennae not extending beyond first abdominal segment, and not recurved beneath abdomen. Head without spines. Prothorax with an acute tuberculate process between mesothoracic spiracle and front coxa. Length up to 20 mm.
  - \**Neoclytus acuminatus* Fabricius, p. 230
- Antennae extending to third abdominal segment where they are recurved beneath abdomen. Head with one or two pairs of spines on frons, mandibles, and genae. Prothorax without a tuberculate process. Length up to 10 mm.
  - \**Anaglyptus verrucosus* Olivier, p. 237
- 26. Hind femora stoutly clavate, and not extending beyond fifth abdominal segment. Pronotum with disc feebly convex and transversely rugose. North American species.
  - \**Xylotrechus colonus* Fabricius, p. 233
- Hind femora slender, subparallel-sided, and extending as far as sixth abdominal segment (fig. 203). Pronotum with disc strongly convex and smooth (fig. 203). European species.
  - Clytus arietis* (Linnaeus), p. 223

#### (\*) *Cerambyx*

- 1. Length, 18–30 mm. Abdominal tergites two to six each bearing a transverse group of short stout spines which arise from pale papillate bases (fig. 127). Metanotum with two small conical protuberances near base. Pronotum elongate.
  - (\*) *C. scopoli* Füssly, p. 163
- Length, 30–35 mm. Abdominal tergites two to six each bearing paired oval groups of much stouter spines which arise from ferruginous papillate bases which are each surrounded by a pigmented disc (fig. 127). Metanotum without protuberances. Pronotum slightly transverse . . . . . (\*) *C. cerdo* Linnaeus, p. 165

#### *Molorchus*

- 1. Seventh abdominal tergite with six anteriorly-directed, thorn-like spines. Eighth tergite with two or more much smaller spines as well as setae. Front of head usually bearing two groups of two very fine setae. Length up to 11 mm. In dead or decaying coniferous trees . . . . . *M. minor* (Linnaeus), p. 192
- Seventh abdominal tergite with four (occasionally five) anteriorly-directed spines; each spine proportionately larger, flat, and blade-like (fig. 166). Eighth tergite with long fine setae only. Front of head with two groups of four rather stout setae. Length up to 9.5 mm. In dead stems of bramble, briar, and in twigs of fruit-trees, etc.; never in conifers.
  - M. umbellatarum* (von Schreber), p. 191

#### \**Cyllene*

- 1. Meso- and metanotum with numerous spines and setae. Lateral region of pronotum densely spinose (at least twenty rather stout spines present). North American species. Chiefly in *Robinia* . . . . . \**C. robiniae* Forster, p. 228
- Meso- and metanotum without spines or setae. Lateral region of pronotum sparsely spinose (about six small spines present). South American species. Chiefly in *Balfourodendron* . . . . . \**C. acuta* Germar, p. 227

## 6. LAMIINAE

1. Abdominal tergites two to six each with a deep transverse furrow. Ninth tergite with a pair of short conical spines (fig. 215). Setae on mandibles very stout and spine-like (fig. 215). Abdominal sternites five to seven each with two or three sublateral pairs of long fine setae, each of which arises from the base of a short stout spine (fig. 215). Antennae short, terminating alongside outer faces of hind femora (fig. 215). [Legs extremely stout, especially tarsi (fig. 215). Abdominal spiracles with peritreme narrowly oval and reniform. Occasionally introduced in cacti from North America and Mexico.]  
*\*Moneilema* spp., p. 240
- Abdominal tergites two to six without transverse furrows. Ninth tergite without spines or with several spines and/or setae, or with a vertical tuberculate process (fig. 248). Setae on mandibles never stout and spine-like (fig. 277). Abdominal sternites five to seven without spines, but sometimes with fine setae (or occasionally spinules). Antennae longer, and always recurved beneath body (fig. 227) . . . . . 2
2. Ninth tergite produced dorsally into a long vertical protuberance which is sclerotised apically (fig. 229). [Prothorax with a pair of stout lateral tubercles. Scutellum bearing numerous short setae. Length, 16–80 mm.] . . . . . 3
- Ninth tergite seldom with a vertical process, but if so (*Pogonocherini*) then length not exceeding 10 mm. . . . . 7
3. Antennae very long and each arranged in one or more coils (fig. 228). Abdominal tergites two to five with transverse bands of dense setae more or less uniform in width, or with two transverse rows of close-set stout spines (fig. 248) . . . . . 4
- Antennae shorter and recurved, but not coiled ventrally (fig. 220). Abdominal tergites two to five with setose bands tapering outwardly; never with rows of spines. [Femora without setae (fig. 220).] . . . . . (\*) *Lamia textor* (Linnaeus),<sup>1</sup> p. 242
4. Femora without setae. [Tarsi without setae.]  
*\*Neoptychodes trilineatus* (Linnaeus), p. 255
- Femora with a transverse row of short setae near apex (fig. 228) . . . . . 5
5. Tarsus with a single conspicuous stout seta (fig. 228). Antennae usually arranged in two or more coils (fig. 228). Labrum with about twenty setae (fig. 228). [Length not exceeding 30 mm.; breadth not exceeding 8.5 mm.]  
*\*Monochamus titillator* (Fabricius), p. 246
- Tarsus without a seta. Antennae arranged to form a single coil (Frontispiece). Labrum with about 50–100 stout setae (Frontispiece). [African species.] . . . . . 6
6. Abdominal tergites two to five each with two transverse rows of closely-set, stout spines (fig. 248). Femora with numerous subapical setae (fig. 248). Pronotum with a large pair of paramedian, conical protuberances, and elytra each with two conical protuberances near base (fig. 248). Length up to 27 mm. *\*Ancyronotus tribulus* Fabricius, p. 265
- Abdominal tergites two to five each with a transverse band of long dense setae (Frontispiece). Femora without setae. Pronotum and elytra without protuberances. Length at least 55 mm. . . . . *\*Batocera wyliei* Chevrolat, p. 256
7. Abdominal tergites one to five each with paired broad bands of long, dense, golden pubescence. Front of head with at least twenty-five rather long, stout setae (each arising from a conical papillate base) near mesal margin of each eye. Clypeus with two groups of at least six stout setae at base. Mandibles extremely stout. [Length up to 30 mm. Functional spiracles present on first five abdominal segments; peritreme extremely thick and narrowly oval. Occasionally imported from Africa.]  
*\*Phryneta leprosa* Fabricius, p. 263
- Abdominal tergites never with pubescent bands (fig. 261). Front of head without or with at most six setae or spines near mesal margin of each eye (fig. 261). Clypeus hardly ever with more than six setae at base, but if so, then pronotum without lateral tubercles. Mandibles never very stout . . . . . 8

<sup>1</sup> Based on the description and figure by Kemner (1922).

8. Antennae extending to well beyond hind femora before they are recurved beneath body (fig. 261). Seventh abdominal tergite strongly produced posteriorly, with hind margin straight. Femora with short apical spines. Mid and hind femora each with a very long, tapering, tuberculate process near base. [Prothorax spinose and with a pair of lateral tubercles. Sternites without setae.] . . . . . *Acanthocinini* 9
- Antennae never extending beyond mid femora before being recurved beneath body (fig. 277). Seventh abdominal tergite never strongly produced, but if elongate, then hind margin strongly rounded. Femora never with apical spines; either glabrous or with fine setae. Mid and hind femora generally simple, but sometimes with a short tuberculate process which is less than one-quarter the length of tarsus . . . . . 10
9. Length, 6–10 mm. Eighth abdominal segment transverse, with hind margin bearing six to eight stout, inwardly-curved spines. Elytra without spines. Lateral prothoracic tubercles bearing one or sometimes two stout, apical spines (fig. 265).  
*Leiopus nebulosus* (Linnaeus), p. 276
- Length, 20–24 mm. Eighth abdominal segment extremely elongate, with hind margin simple. Elytra with two or three rather stout spines opposite mesonotum. Lateral prothoracic tubercles bearing one or two slender subapical spines (fig. 261).  
*Acanthocinus aedilis* (Linnaeus), p. 272
10. Prothorax with a pair of lateral tubercles. Ninth tergite with a median conical process which bears a short stout spine. Abdominal tergites one to six with a few long fine setae only. Length not exceeding 8 mm. Abdominal spiracles with peritreme very thin (fig. 252) . . . . . *Pogonocherus* spp., p. 267
- Prothorax simple. Ninth tergite simple. Abdominal tergites one to six with both spines and setae. Length generally much more than 8 mm., but if less (*Tetraopini* pars), then abdominal tergites without setae. Abdominal spiracles with peritreme rather thick (fig. 282) . . . . . 11
11. Labrum very strongly protuberant and with a very dense group of long, fine setae across base (fig. 241). Abdominal spiracles with peritreme reniform. Eyes each with a single seta. Abdominal tergites one to six each with two more or less complete transverse rows of long, stout, curved spines (each with a fine basal seta). Clypeus with a pair of setae at each end of basal margin. [Pronotum with short ferruginous spines. Femora with apical setae (fig. 241).] . . . . . *Mesosa nebulosa* (Fabricius), p. 259
- Labrum not strongly protuberant, generally without setae, but if densely setose at base, then antennae extremely long, extending beneath body right up to head. Abdominal spiracles with peritreme never reniform. Eyes without setae (although a few setae are sometimes present close to mesal margins). Abdominal tergites with spines, if present, never arranged in two transverse rows (except in *Diaxenes*, but then pronotum with long setae only). Clypeus usually with at least six setae across basal margin, but if with only four, then femora without setae (fig. 277) . . . . . 12
12. Abdominal tergites one to six with strongly protuberant bilobed ampullae which bear groups of curved, hook-like spines (fig. 270). Seventh tergite with a conspicuous bifurcated tuberculate protuberance at base (fig. 271). Antennae very long, extending ventrally as far as head where they are curled over on to vertex (fig. 269). Clypeus with about twelve setae across base. Vertex of head with two longitudinal rows of long fine setae. Sternites four to eight with numerous scattered very fine setae. Pleura bearing several fine setae. [Abdominal spiracles with peritreme broadly oval. In recently dead stems of herbaceous plants.] . . . . . *Agapanthia villosoviridescens* (Degeer), p. 279
- Abdominal tergites one to six with ampullae, if present, less strongly protuberant, and with spines straight (fig. 282). Seventh tergite simple. Antennae shorter, never recurved over head. Clypeus with at most six setae at base. Vertex of head with only two or three pairs of short setae or spines. Sternites four to eight without setae or with a few minute spinules or setae. Pleura either without setae or with two or three short spines 13
13. Pleura without spines but sometimes with one or two fine setae (fig. 277). Eyes at most

- feebly convex. Hind femora extending at least to fifth abdominal segment. [Apices of hind tarsi extending posteriorly beyond apices of elytra. Sternites four to eight without setae.] . . . . . *Saperdini* 14
- Pleura each with two to three short spines (fig. 290). Eyes rather strongly convex. Hind femora extending only to third or fourth abdominal segment . . . . . 15
14. Labrum with two to six setae; mandible with two or more setae (fig. 277). Antennae with apices not extending beyond front coxae (fig. 277). Setae when present on head and pronotum moderately long (fig. 277) . . . . . *Saperda*, p. 99
- Labrum and mandible without setae. Antennae with apices extending beyond front coxae. Setae on head and pronotum very long, about twice as long as in *Saperda populnea* . . . . . *Stenostola ferrea* (Schrank), p. 292
15. Antennae long, extending ventrally as far as maxillary palpi (fig. 282). Sternites four to eight with a few minute spinules and setae. Abdominal tergites one to seven with protuberant, bilobed ampullae which bear several short, straight spines, some of which are inclined anteriorly (fig. 282). Functional spiracles present on first seven abdominal segments. [In herbaceous plants.] . . . . . *Phytoecia cylindrica* (Linnaeus), p. 293
- Antennae shorter, extending ventrally as far as mid coxae (fig. 286). Sternites four to eight without spinules or setae (fig. 286). Ninth tergite setose only. Abdominal tergites one to seven without ampullae, and with a transverse group of short spines which are all inclined posteriorly (fig. 290). Functional spiracles present on first six abdominal segments . . . . . 16
16. Femora without setae (fig. 286). Mandibles with setae simple at base. Ninth sternite not bilobed, and bearing setae only (fig. 286). Vertex of head not excavated between bases of antennae (fig. 286). Spiracles with peritreme very narrowly oval. In recently dead stems of *Salix* . . . . . *Obera* sp., p. 295
- Femora with long apical setae (each arising from a basal papilla). Mandibles with setae arising from conspicuous, conical papillae or stunted spines (fig. 290). Ninth sternite bilobed, each lobe bearing several very short conical spines (each with a long basal seta). Vertex of head very deeply and broadly excavated between bases of antennae (fig. 290). Spiracles with peritreme round to broadly oval (fig. 290). Occasionally imported in pseudobulbs of orchids from Burma . . . . . \**Diaxenes dendrobii* Gahan, p. 300

#### Saperda

1. Spines of pronotum and ninth tergite each arising from a pale basal tubercle (fig. 278). Antennae extending ventrally as far as front coxae. [Length, 14–20 mm.] . . . . . *S. scalaris* (Linnaeus), p. 287
- Spines of pronotum and ninth tergite not tuberculate at base. Antennae not extending beyond mid coxae (fig. 277) . . . . . 2
2. Hind margin of ninth tergite bearing fine setae only. Head with vertex not or scarcely excavate between bases of antennae (fig. 277). Length, 10–15 mm. In slender stems, immediately above or below the conspicuous larval gall. . . . . *S. populnea* (Linnaeus), p. 285
- Hind margin of ninth tergite bearing short spines (each with a subapical seta). Head with vertex deeply and rather broadly excavate between bases of antennae. Length, 20–30 mm. In boles and branches . . . . . *S. carcharias* (Linnaeus), p. 283

## DESCRIPTIONS AND BIONOMICS OF THE IMMATURE STAGES

ALTHOUGH this work is really only concerned with immature stages, it is felt that at this juncture a brief account of adult characteristics would not be out of place.<sup>1</sup>

The general form of these beetles is rather elongate, more or less flattened, sub-cylindrical, and often somewhat narrowed posteriorly. Many species are well known for their cryptic coloration and mimicry of other beetles as well as bees, wasps, ants, crickets and so forth. Their characteristic antennae, which have gained them the name of "Longhorns", arise from conspicuous tubercles on the front of the head, and are generally more or less filiform (occasionally pectinate, tufted, or clubbed) and usually as long as, though often considerably longer than, the body. But this peculiarity by no means applies to them all. Another characteristic is the formation of the tarsi, which although always five-segmented have, with few exceptions, the fourth segment considerably reduced so that they appear to be only four-segmented. The third segment is always strongly bilobed. In general structure many resemble members of the Chrysomelidae or "Leaf Beetles", from which they may usually be distinguished by the more elongate form, and pubescent elytra; moreover, there is a tendency for the epimera of the metathorax to extend to the sides of the ventral segments, while in the latter family the first ventral segment is prolonged forward at the sides to meet the metathorax.

The family Cerambycidae on immature characters may conveniently be divided into six subfamilies, namely PARANDRINAE, PRIONINAE, LEPTURINAE, ASEMINAE, CERAMBYCINAE and LAMIINAE. To these may be added the ANOPLODERMINAE and DISTENIINAE, which have not been dealt with in the present work as there seems little likelihood of species of these subfamilies ever being imported into this country. As to whether some of these groups may be regarded as families, subfamilies, or even tribes seems of little consequence so far as the purpose of this work is concerned.

Although throughout the following descriptions an attempt has been made to follow the adult classification as cited in Junk's catalogue and in the Kloet and Hincks catalogue, it was found that in the process of constructing the larval keys certain relationships which were at variance with the accepted adult classification became evident, and warrant special mention. Firstly the Parandrini, Asemmini, and Lepturini, on account of the clear-cut characters have each been raised to subfamily rank, the latter being placed before the ASEMINAE instead of after them on account of the apparently more primitive characters. Larvae (and pupae) of *Leptura cerambyciformis* (Schrank) and *L. sexmaculata* (Linnaeus) are so distinctly different from the remaining species of *Leptura* that they have been segregated into *Judolia*, which is given generic status. In the case of *Eburia*, no characters could be found warranting its association

<sup>1</sup> An illustrated key to adults of British and imported Cerambycidae has recently been prepared by the writer and published by The Royal Entomological Society, 41 Queen's Gate, London, S.W.7.

with the Phoracanthini; in fact, it appears to be closely related to the Callichromini. *Phymatodes alni* (Linnaeus) showed few affinities to *P. testaceus* (Linnaeus), and has been placed under *Poecilium*, here regarded as a separate genus. *Acanthocinus* and *Leiopus* have several distinctive characters in common and appear to belong to the same tribe. The genus *Diaxenes* has previously been inserted between the Phrynetini and the Pogonocherini, but the larval characters (and pupal also) show far closer affinities to Tetraopini, into which it has here been transferred. *Stenostola*, although usually included in the Phytoecini, would seem to be far more appropriately placed, on both larval and pupal characters, in the Saperdini. Finally, reference should also be made to the genera *Zamium*, *Trachyderes* and *Lepromouris*.

For the sake of brevity, synonymy has not been given, except in cases where there have been recent changes or amendments since the publication of the aforementioned catalogues. In conformity with the keys the imported species are marked with an asterisk \* and doubtfully indigenous species are indicated by an asterisk enclosed in round brackets (\*).

In listing the references to each species and the material examined the following abbreviations have been used:

|               |   |
|---------------|---|
| In coll. B.M. | In the collection of the British Museum (N.H.), London.                           |
| „ „ D.        | In the collection of the writer.  |
| „ „ F.        | In the collection of Dr. F. I. van Emden.   |
| „ „ N.H.P.    | In the collection of the Muséum National d'Histoire Naturelle, Paris.             |
| „ „ U.S.N.M.  | In the collection of the United States National Museum, Washington.               |
| „ „ U.Z.M.C.  | In the collection of the Universitetets Zoologiske Museum, Copenhagen.            |
| „ „ F.P.R.L.  | In the collection of the Forest Products Research Laboratory, Princes Risborough. |

Leg.=collected by; D. leg.=collected by the writer; M.G.F. leg.=collected by M. G. de C. Fraser; E=egg, eggs; L=larva, larvae; P=pupa, pupae; I=imago, imagines; Biol.=Biology; Physiol.=Physiology; Fig.=figured or photographed; Paras.=parasites and predators; Contr.=control.

## 1. \*PARANDRINAE

### Larval Characters

Form cylindrical. *Head* with front margin of frons not projecting over clypeus. Antenna three-segmented, the apical segment elongate, cylindrical. Postcondylar carina absent. Subfossal process absent. Ocelli absent. Maxillary palpifer with outer margin rounded. *Prothorax* with posterior area of pronotum asperate. *Abdomen* with ampullae asperate; each dorsal ampulla with two transverse furrows, each ventral ampulla with one. Ninth segment long, extended; anal lobes glabrous and compact. Pleural discs absent. *Legs* with unguiculus imbricately spinose apically. *Spiracles* with posterior margin of peritreme with about twelve chambers which give it a crescentic appearance.

**\*Parandra brunnea** Fabricius

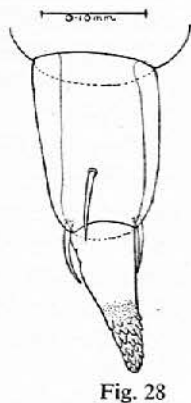
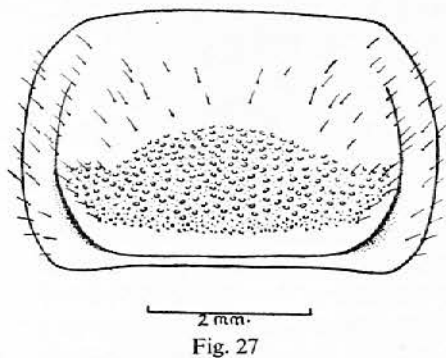
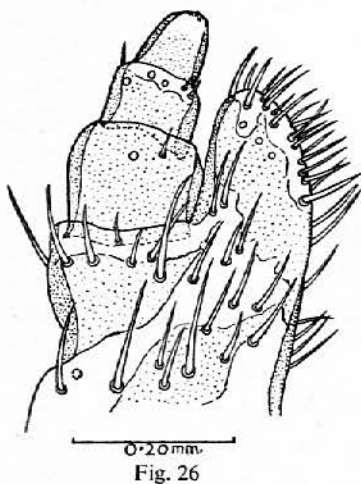
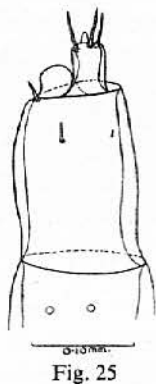
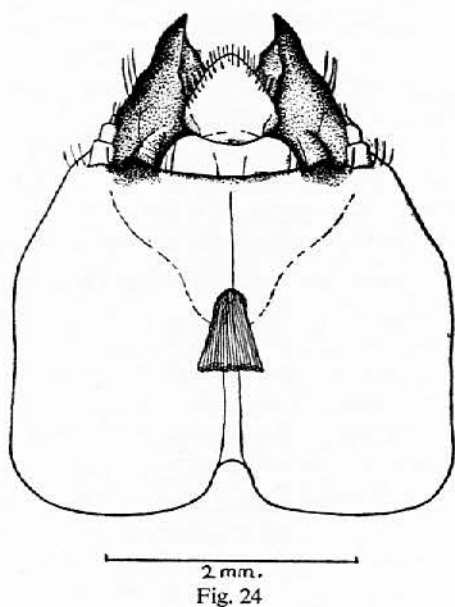
[Occasionally imported in timber from North America.]

*Mature larva* (figs. 24-29). Length up to 29 mm.; breadth (at prothorax) 4.45 mm. Form cylindrical, rather slender, gradually tapering posteriorly to ninth abdominal segment. *Head* (fig. 24) slightly depressed, quadrate to slightly transverse (maximum head-width 3.6 mm.), sides feebly rounded. Genae with a shallow constriction behind middle and bearing a few fine setae. Front margin of frons roundly declivous, almost straight. Antenna (fig. 25) long, fleshy, scarcely retractile, the second segment longest and bearing third and a supplementary one. Mandible robust, wedge-shaped, pitchy, shining; apex strongly and acutely pointed and directed downward; molar area flattened into a striate trapezoidal plate. Clypeus trapezoidal, leathery, as wide at base as epistoma. Labrum elongate, cordate, feebly sclerotised and fringed with a few fine setae. Maxilla (fig. 26) with shape and setae as figured; lobe rather slender, cylindrical, sparsely setose. *Prothorax* with posterior area of pronotum (fig. 27), lateral posterior angles of presternum and median area of eusternum asperate. Eusternum distinctly separated from presternum. *Abdomen* with dorsal ampullae present on segments one to seven; each ampulla abruptly and strongly protuberant and sparsely asperate. Pleural tubercles distinct, and epipleura slightly protuberant on last three segments. Anal lobes compact, rugose, glabrous. *Legs* slender, rather long; unguiculus (fig. 28) stout and imbricately spinose for apical third. *Spiracles* of mesothorax broadly oval but not protruding into prothorax; abdominal spiracles with peritreme broadly oval, thick but feebly sclerotised; marginal chambers forming a crescent (fig. 29).

*Pupa* (fig. 30). No pupae of this species are available. The following description is of an undetermined species of this genus which should be essentially similar:

Length 19-35 mm.; breadth 7-11 mm. *Head* strongly bent beneath prothorax; quadrate, rounded glabrous. Antennae rather thick, moniliform, and short, extending at most to the hind coxae. Labrum triangular, glabrous. *Pronotum* transverse, with short spines, especially on lateral margins. *Mesonotum* and *metanotum* usually with a few scattered, short, stout spines; scutellum prominent, fleshy, glabrous; scutellar groove shallow, inconspicuous. Elytra and wings extending as far as third or fourth abdominal segment. *Abdomen* with tergites one to seven, and pleura, bearing numerous short, rather stout, ferruginous spines (each with a fine basal seta). Eighth tergite glabrous. Ninth tergite glabrous, with stout urogomphi, which are widely separated at the base and extend postero-laterally. Sternites slightly rugose, glabrous. *Legs* with hind femora extending as far as third abdominal segment, and hind tibiae almost at right-angles to longitudinal axis of body. *Functional spiracles* present on first six or seven abdominal segments, the seventh pair being closed and probably non-functional in some species; peritreme narrowly oval, thick and appreciably raised above general level of cuticle.

*Egg*. Craighead (1923b) gives the following description: "Elongate, cylindrical, 1.5 mm. by 0.5 mm.; widest at middle, tapering slightly to both ends, which are bluntly rounded; bearing a rather large micropyle at the larger end; texture smooth, no trace of sculpturing."



- Fig. 24. *Parandra brunnea* Fabricius. Mature larva. Head. Dorsal aspect.  
 Fig. 25. *Parandra brunnea* Fabricius. Mature larva. Apical part of antenna.  
 Fig. 26. *Parandra brunnea* Fabricius. Mature larva. Apical part of right maxilla. Ventral aspect.  
 Fig. 27. *Parandra brunnea* Fabricius. Mature larva. Prothorax. Dorsal aspect.  
 Fig. 28. *Parandra brunnea* Fabricius. Mature larva. Apical part of mesothoracic right leg. Dorsal aspect.  
 Fig. 29. *Parandra brunnea* Fabricius. Mature larva. Peritreme of abdominal spiracle.

Host plants: *Pinus*, *Hicoria*, *Salix*, *Fagus*, *Castanea*, *Quercus*, *Ulmus*, *Pyrus malus*, *P. communis*, *Prunus cerasus*, *P. domestica*, *Robinia*, *Juglans*, *Liriodendron*, *Ailanthus*, *Acer*, *Tilia americana*, *Fraxinus*, etc. (Brooks, 1915). Craighead (1915) states that this species attacks nearly all species of coniferous and hardwood trees in the Eastern States. Cultivated fruit-trees, especially pear and apple, are particularly prone to attack, and there are numerous reports of widespread damage to chestnut poles.

*Biology.* The eggs are deposited individually in small pits about 2 mm. deep excavated by the adult; these pits are subsequently closed up with fine particles of wood. Rotting portions of the wood and old emergence holes are favourite oviposition sites. The incubation period is two to three weeks (Brooks, 1915).

The larval habitat is in living, decaying, or dead sapwood and heartwood. Although mature trees, especially those growing in sunny, exposed places, are most prone to attack, there have been records of damage to nursery stock. The larvae excavate numerous tortuous galleries which often completely honeycomb the wood. Their depredations are usually confined to the basal part of the tree, and generally tend to extend upward rather than downward. Each gallery is packed throughout its length with fine powdery frass. Pupation usually takes place in the heartwood at the base of a tree. The pupal cell is packed for a short distance beyond the entrance with coarse, string-like shavings. Pupation occurs during June and July, and adults emerge from July to October.

*Parasites.* Hymenoptera: *Odontomerus mellipes* Say (Brooks, 1915).

*Economic importance.* According to Brooks (1915), this species probably causes more severe damage to a greater variety of trees than any other North American species, destroying as it does the heartwood as well as the living sapwood. The most destructive attacks occur in the bole within a few feet from the ground, the larval depredations

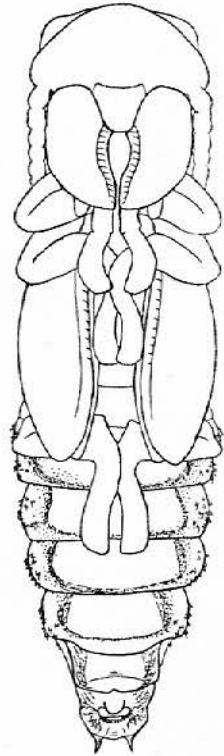


Fig. 30. *Parandra* sp. Male pupa. Ventral aspect.

usually being followed soon after by the decay of the affected wood, and frequently by the breaking of the tree at the point of injury by the wind. Infestation usually commences at some local point of injury to the bark or sapwood, such as bruises by farm tools, shoddy pruning, or scorching by fire. Snyder (1911) records the severe damage of approximately 600 chestnut poles in West Virginia, most of which was caused by this species. The beetles will attack perfectly sound poles, although they apparently prefer wood showing signs of incipient decay. Damage seems greatest when the poles are set in loose, well-drained soil.

*Control.* Brooks (1915) suggests the following measures: Trees should be kept in sound condition, and free from mechanical injury. The practice of leaving long stubs after pruning should be avoided, the cut being made as close as possible to the trunk to ensure rapid healing. All cut or rubbed surfaces should be smoothed and covered

with a heavy coat of white lead, which is best renewed annually. When a colony has become established, the only remedy is completely to chisel out the affected portion; the resulting cavity should then be creosoted, painted with coal-tar, and then filled with cement. For the protection of poles and posts, Snyder (1911) suggests the selection of only those which are perfectly sound and seasoned, and their complete impregnation with creosote by some standard process, to which he gives references.

*Material studied.* 7 L, North America, in coll. B.M.; 2 P (*Parandra* sp.), Sandwich Is., in coll. B.M.; 1 L, 4 P, no data, in coll. B.M.; 2 L, 1 P (*P. glabra* Degeer), Brazil, xi.1914, E. Gounelle leg., in coll. M.N.P.

*References.* Brooks, 1915 (E fig., Biol. fig.); Chittenden, 1894 (Biol.); Craighead, 1915 (L fig.), 1913b (E, P), 1950 (Biol., Contr.); Hart, 1911 (L fig., P fig., Biol. fig.); Osten Sacken, 1862 (L); Snyder, 1911 (L fig., P fig., Biol. fig.).

### \**Parandra polita* Say

[Very rarely imported from North America.]

No material available.

*References.* Lameere, 1885 (P fig.).

## 2. PRIONINAE

### Larval Characters

Form robust, subcylindrical and tapering posteriorly. *Head* usually slightly transverse but slightly elongate in certain tropical species; widest behind middle; dorsal margins of epicranial halves fused behind frons but sometimes separating near the base; tentorial cross-arm in same plane as hypostoma, forming a bridge behind it, which divides the occipital foramen into an anterior and posterior portion. Front margin of frons nearly always abruptly sloping, very strongly sclerotised, its lower boundary projecting over clypeus (except *Megopsis* pars), its upper boundary dentate or carinate (except Indian genera *Macrotoma*, *Sarmyds*); six epistomal setae present. Clypeus thick, trapezoidal, as wide at base as epistoma. Labrum thick and lanceolate, cordate, transversely elliptical or orbicular. Mandibles wedge-shaped, cutting edge broadly emarginate; apex produced, acute. Ocelli present or absent. Antenna two- or three-segmented, conical, partially retractile; second segment barrel-shaped or cylindrical, obliquely truncate, hollowed at the tip, and often bearing a small third segment. Subfossal process and postcondylar carina present. Ventral mouthparts attached to hypostoma by slightly more than width of gula. Maxillae movable; cardo distinct; palpifer with outer margin rounded; lobe borne on stipes; maxillary palpi short, conical, robust, three-segmented, the last segment relatively short and cylindrical, blunt or conical, the tip being truncate and bearing a sensory impression. Ligula large, fleshy and densely covered with short stout setae. *Prothorax* with eusternum partially or entirely and lateral zone distinct. *Abdomen* with dorsal ampullae with two transverse impressions; ventral ampullae with one. Epipleura protuberant only on last three segments; ninth segment large, elongate, extended. *Legs* distinct, stout, conical; unguiculus imbricately spinose. *Spiracles* of mesothorax protruding into prothorax; abdominal spiracles with small marginal chambers occasionally present.

## Prionini

*Prionus coriarius* (Linnaeus)

*Mature larva* (figs. 31–39). Length up to 76 mm.; breadth (at prothorax) 14.25 mm. Form subcylindrical, very robust, gradually tapering posteriorly to ninth segment. *Head* (figs. 31, 32) moderately depressed, slightly transverse (maximum head-width 9.2 mm.). Genae very strongly shouldered, rugose, darkly pigmented and bearing a few pale setae. Mouthframe strongly sclerotised, rugose, broadly pitchy. Frons with a broad pitchy anterior margin which merges posteriorly into a ferruginous area, which in turn gradually merges into a smooth testaceous area. Front margin of frons

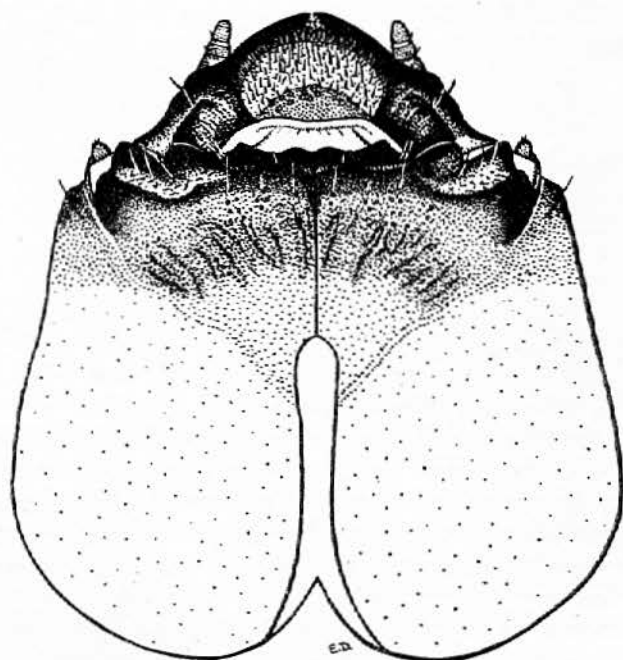


Fig. 31. *Prionus coriarius* (Linnaeus). Mature larva. Head. Dorsal aspect. (Duffy, 1946)

comprising a pitchy, heavily sclerotised ridge, which is abruptly sloping; upper boundary varying from straight to slightly bilobed, keel-shaped and notched medially; lower boundary produced over clypeus in four rugose lobes, the paramedian pair being small and blunt. Postcondylar carina distinct. Subfossal process acutely conical. Antenna three-segmented; second segment barrel-shaped, obliquely truncate apically, and bearing a minute oval sensory organ and a dome-shaped apical segment (fig. 33). Mandible very robust, pitchy, shining, with outer face strongly rugose. Labrum transversely oval, leathery, and with numerous stout setae. Ocelli absent. Gula extremely short; sutures diverging to meet anterior portion of occipital foramen. Maxillary lobe and palpus with shape and setae as figured (fig. 34). *Prothorax* (fig. 35) moderately depressed, about twice as broad as long, with a conspicuous transverse ferruginous band near front margin. Pronotum rectangular, delimited

laterally by a pair of conspicuous grooves; median cleavage line shallow, distinct; anterior region transversely rugose, bearing a few scattered setae; posterior region irregularly rugose, glabrous. Eusternum distinctly separated from presternum by a 'V'-shaped suture. Sternum coarsely rugose, with a few scattered short setae. *Mesonotum* and *metanotum* irregularly rugose, almost glabrous. *Abdomen* with

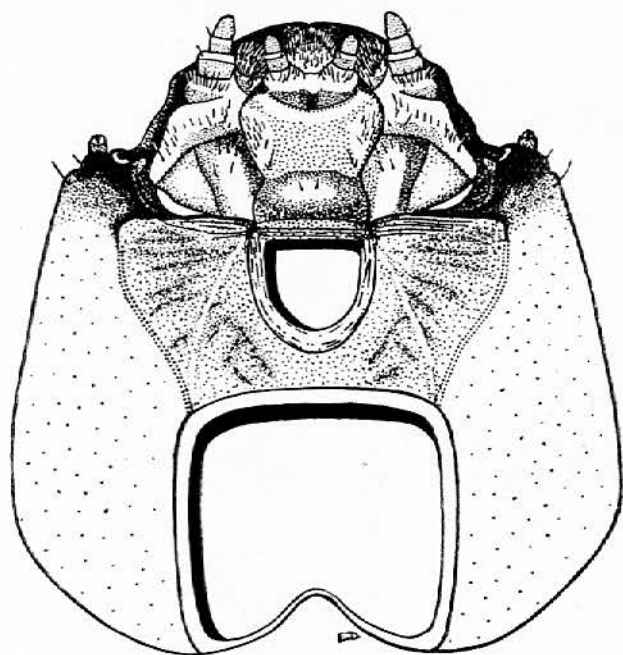


Fig. 32

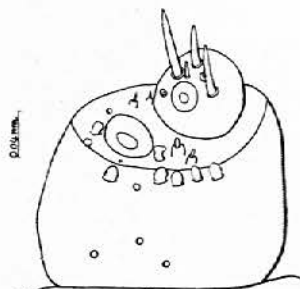


Fig. 33



Fig. 34

Fig. 32. *Prionus coriarius* (Linnaeus). Mature larva. Head. Ventral aspect. (Duffy, 1946)

Fig. 33. *Prionus coriarius* (Linnaeus). Mature larva. Apical part of antenna. (Duffy, 1946)

Fig. 34. *Prionus coriarius* (Linnaeus). Mature larva. Apical part of right maxilla. Ventral aspect. (Duffy, 1946)

dorsal and ventral ampullae on segments one to seven (fig. 36). Pleural discs present on segments one to six; each radially striate, with a deep pore (fig. 37). Segments eight and nine feebly rugose, the latter (fig. 38) large, extended, and with a few short, pale setae. Tenth segment (fig. 38) trilobed, each lobe strongly protuberant, rugose and bearing a few fine setae. *Legs* (fig. 39) rather short (slightly longer than maxillary palpi), ferruginous, very setose. *Spiracles* of mesothorax broadly oval; metathoracic pair minute; abdominal spiracles with peritreme broadly oval, thick, and slightly raised above general level of cuticle.

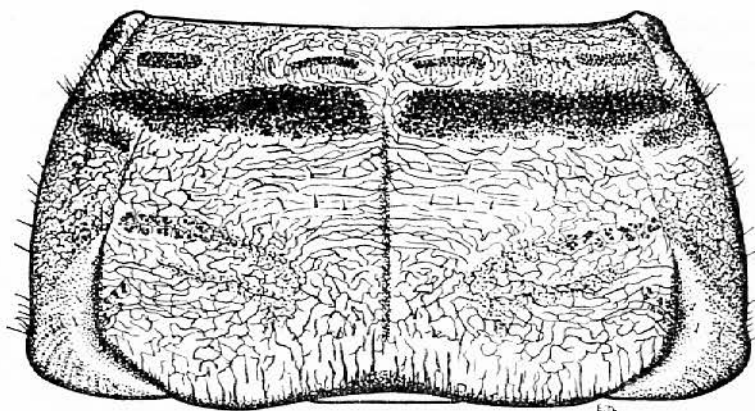


Fig. 35

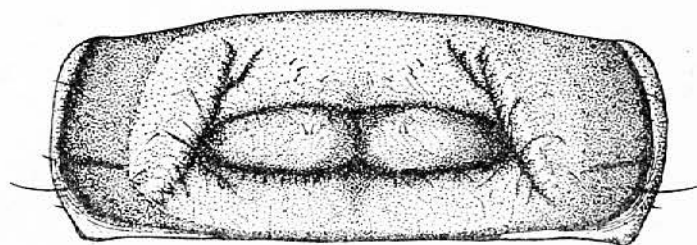


Fig. 36

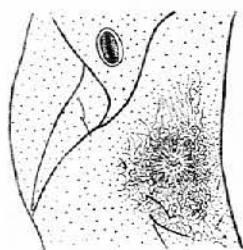


Fig. 37

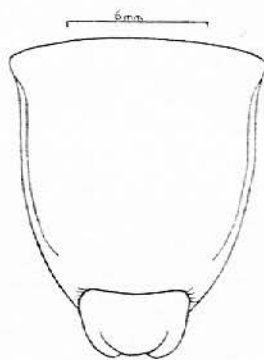


Fig. 38

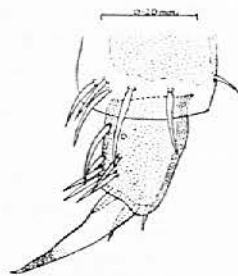


Fig. 39

- Fig. 35. *Prionus coriarius* (Linnaeus). Mature larva. Prothorax. Dorsal aspect. (Duffy, 1946)
- Fig. 36. *Prionus coriarius* (Linnaeus). Mature larva. First abdominal segment. Dorsal aspect. (Duffy, 1946)
- Fig. 37. *Prionus coriarius* (Linnaeus). Mature larva. First abdominal segment showing spiracle and pleural disc. Lateral aspect. (Duffy, 1946)
- Fig. 38. *Prionus coriarius* (Linnaeus). Mature larva. Outline of ninth and tenth abdominal segments. Dorsal aspect. (Duffy, 1946)
- Fig. 39. *Prionus coriarius* (Linnaeus). Mature larva. Apical part of mesothoracic leg. Lateral aspect.

*First-instar larva* (fig. 40). Length up to 5 mm. Its general form differs from that of later instars in that the thoracic segments are less transverse, the abdominal segments less tapering posteriorly, and the ninth segment is transverse. Cuticle covered with minute tubercles and spicules, and with numerous very long setae. *Head* quadrate (average head-width 0.75 mm.), mainly testaceous. Genae each with a pair of long setae. Front margin of frons ferruginous, bearing three pairs of long fine setae; lower boundary scarcely projecting beyond upper boundary, except for a single median lobe, the anterior margin of which is slightly inclined upward. Subfossal process strongly produced. Labrum white, strongly transverse, bearing on its inner margin numerous pale setae, most of which are about twice the length of labrum. *Prothorax* with

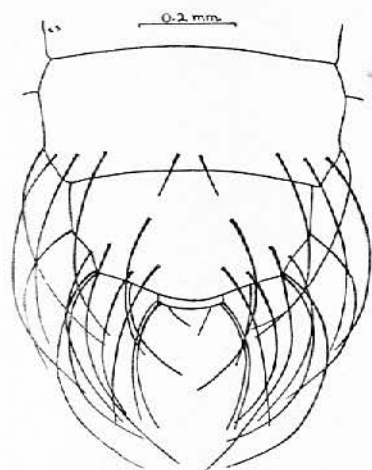


Fig. 40

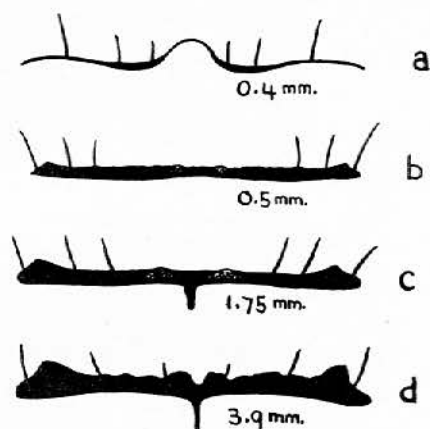


Fig. 41

Fig. 40. *Prionus coriarius* (Linnaeus). First-instar larva. Last three abdominal segments. Dorsal aspect. (Duffy, 1946)

Fig. 41. *Prionus coriarius* (Linnaeus). Variation in the front margin of the frons in various larval instars: (a) first instar, (b) second instar, (c) fourth instar and (d) final instar. (Duffy, 1946)

pronotum milky white; ferruginous band absent. *Abdomen* (fig. 40) with each segment bearing very long, slender setae. *Legs* testaceous; unguiculus long, slender, imbricately spinose. *Spiracles* biforous.

*Second-instar larva.* *Head* with median lobe of front margin of frons absent, the lower boundary entirely straight. Labrum testaceous, with setae proportionately shorter. *Abdomen* with setae proportionately much shorter. *Legs* with unguiculus shorter and stouter.

*Third-instar larva.* *Abdomen* with ninth segment slightly elongate. Dorsal ampullae clearly defined. Pleural discs still indiscernible.

The marked variation of a single character from one instar to another in the same species is exemplified by the front margin of the frons in the present species (fig. 41). In the first instar (a), the upper boundary is produced in the middle beyond the lower one to form a conspicuous lobe. In the second instar (b) this lobe is absent, but the ridge is more apparent, its two extremities being very slightly produced, and the two

small paramedian lobes are visible between the upper and lower boundaries. By the time the larva has entered its fourth instar (c), these lobes have developed appreciably, but it is not until the larva is in the second half of its development that both pairs of lobes are well formed and the entire front margin has become markedly keel-shaped (d).

*Pupa* (figs. 42, 43 and Pl. VIII, fig. 35). Length 29–40 mm.; maximum breadth 15 mm. *Head* almost concealed from above by prothorax; glabrous, with four converging series of striae on disc. Antennae thick (serrate in male), extending as far as first abdominal segment. Labrum triangular, elongate, glabrous. *Pronotum* strongly

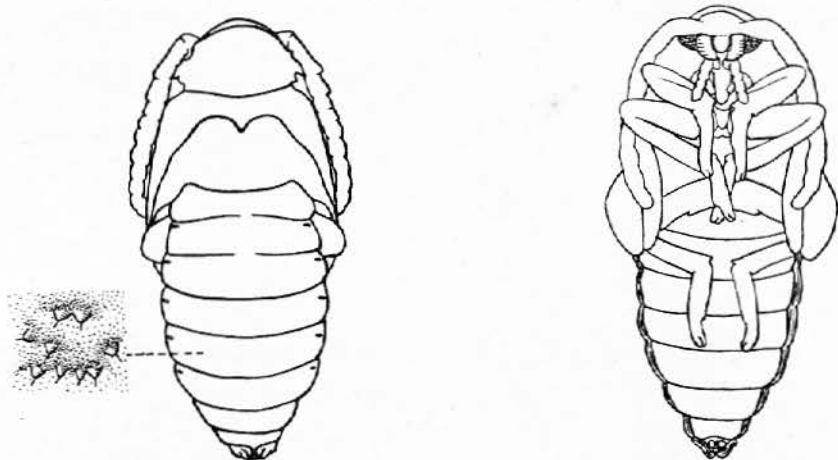


Fig. 42

Fig. 43

Fig. 42. *Prionus coriarius* (Linnaeus). Male pupa. Dorsal aspect.

Fig. 43. *Prionus coriarius* (Linnaeus). Female pupa. Ventral aspect.

transverse, with three pairs of lateral tubercles, the middle pair being the most strongly produced; transversely striate, glabrous. *Mesonotum* similarly striate, glabrous; scutellum prominent, fleshy, glabrous. *Metanotum* almost smooth. Elytra and wings extending as far as fourth abdominal segment. *Abdomen* with tergites rugose, the first six bearing scattered minute papillae; sternites smooth (except last two), and glabrous; ninth tergum markedly rugose, with two paramedian, elongate, fleshy protuberances. *Legs* with hind femora extending only as far as third abdominal segment. *Functional spiracles* present on first six abdominal segments, the seventh pair being almost closed and probably non-functional; peritreme narrowly oval and rather thick.

*Egg* (Pl. II, fig. 6). Form elongate-ovoid, with rounded ends, the posterior pole being slightly attenuated. When first deposited, the egg is almost white, becoming light brown later, and, if the secretion has been applied thickly, slightly shining as though varnished; but often the secretion fails to cover the egg completely and leaves dull patches. The average dimensions of twelve eggs were 4.1 mm. long by 1.4 mm. at their greatest width. The chorion is opaque, exceedingly thick and coarsely reticulated, each polygonal area being depressed and having a minute though deep puncture in the middle. It has proved to be impervious to some fluids. On one occasion a few eggs were immersed in 40 per cent formalin for one hour and allowed to dry; larvae

emerged a week later. Under laboratory conditions the period of incubation has varied from thirty to thirty-seven days, the average temperature being 60°F.

Host plants: *Quercus*, *Fagus*, *Betula*, *Abies* and *Pinus* appear to be the most popular. Also recorded from *Aesculus*, *Castanea*, *Fraxinus*, *Prunus*, *Ulmus*, *Carpinus*, *Platanus*, *Alnus*, *Salix*, *Ilex*, *Larix* and *Picea* (Duffy, 1946a, 1946b, 1946c). As the above records indicate, this species is markedly polyphagous, and there can be comparatively few species of our common trees which have escaped its ravages. It is unusual for a lignicolous species to attack both deciduous and coniferous trees; moreover, the species seems to have no preference, for the writer has recently obtained larvae from both birches and pines which were growing together in the same strip of woodland (Duffy, 1946a).

*Biology.* The eggs are inserted deeply into crevices in the bark, usually at the base of trunks or in partly exposed roots. They are usually deposited one against the other in batches of about eight to twelve in one place. Fowler (1889-1890) records the capture of an adult which was found to contain 162 eggs, and Kaufmann (1946) records one which contained 179 eggs. Oviposition usually takes two to three days.

The larva thrives only in moist wood, and despite occasional exceptions prefers to feed in the underground roots rather than in the bole. It also seems that trees growing in light, even sandy soil on the edges of woods, especially those in rather damp though not necessarily flooded situations, are most prone to attack (Duffy, 1946a).

Until the third or fourth stadium is attained, the larva feeds subcortically, and then proceeds to bore deeper towards the underground roots, where it remains until ready for pupation (Pl. IV, fig. 17). The longitudinal galleries are simple (i.e. without ramifications), extensive, and are packed with coarse, shredded shavings. Burrows up to two yards in length, with a maximum width of just over one inch have been observed by the writer. The individual tunnels are kept strictly separate, and even when they cross older ones, they usually pass round rather than through them. Larvae prefer damaged or rotting roots, and when their food supply is exhausted they travel, if necessary, through the soil to nearby roots. Roots of a diameter of roughly one to four inches have frequently been seen to be almost completely reduced to frass and shavings, nothing but the thin outer covering of bark, and sometimes a hard central core being left (Pl. VIII, fig. 40). The frass in the heartwood of stumps appears to be more tightly packed than it is in the roots. Soon after the final instar is attained, the larva generally leaves the root and makes its way, if necessary, to within an inch or so below the surface of the soil to pupate. Larvae are voracious feeders and are capable of breaking down four or five times their own bulk of wood within a week. The larval period is at least three years (Duffy, 1946a, 1946b).

The larvae pupate usually in earthen cocoons one to three inches below the surface of the soil alongside rotten roots of mature trees or beneath rotten logs or fallen trees. Occasionally they pupate actually in the wood, the cocoon then being made of wooden fragments. The cocoon is large and oval (Pl. IV, fig. 14), amply accommodating the pupa. It consists of rather fine particles of earth stuck together by the larval secretion; the interior is smooth. The external measurements are on an average 45 mm. by 30 mm. (Duffy, 1946a, 1949b). Pupation occurs from June to July, and emergence from July to August (Pl. VII, fig. 31).

*Parasites.* Hymenoptera: *Xorides albitarsus* Grav. (Duffy, 1946a). Diptera: *Parasarcophaga aratrix* Pand. (Saalas, 1943); *Billaea microcera* Rond., *B. subrotundata* Rond. (Lepesme & Paulian, 1943). *B. pectinata* Mg. (Thompson, 1943).

*Economic importance.* This species is not considered a serious pest in this country, consequently no control measures are taken against it. The fact still remains, however, that these larvae cause considerable damage to the roots of living deciduous and coniferous trees and, although their importance with regard to the timber industry may be negligible, the damage caused to ornamental trees in plantations, parklands and mature woodlands cannot be lightly disregarded (Duffy, 1946a). There have been recent records of this species damaging telegraph poles in Sweden and also to a minor extent in this country (Ellis, 1944).

*Material studied.* 27 L, Surrey, Mytchett, viii.1944, in felled bole of *Quercus*, D. leg., in coll. D.; 2 P, Surrey, Mytchett, vi.1945, in earthen cocoon at roots of *Betula*, D. leg., in coll. D. [Adults reared.]

*References.* Box, 1915 (Biol.); Champion, 1926 (Biol.); Curtis, 1838 (Biol.); Della Beffa, 1931 (L fig., P fig., Biol.); Duffy, 1946a (E fig., L fig., P fig., Biol. fig.), 1946b (Biol.), 1946c (Biol.), 1949b (Biol. fig.); Ellis, 1944 (Biol.); Emden, 1939-1940 (L); Fowler, 1889-1890 (Biol.); Fromont, 1882a (Biol.); Henriksen, 1914 (L fig.); Houlbert & Monnot, 1908 (L fig., Biol.); Hunt, 1914 (Biol.); Kaltenbach, 1874 (Biol.); Kaufmann, 1946 (Biol.); Lameere, 1885 (Biol.); Lepesme & Paulian, 1943 (Biol.); Lloyd, 1944 (Biol.); Lucas, 1914 (Biol.); Marié, 1924 (Biol.); Mjöberg, 1905 (Biol.); Planet, 1891 (L, P, Biol.); Pinhey, 1936 (Biol.); Reineck, 1919 (Biol.); Rösel von Rosenhof, 1746 (L fig., P fig., Biol.); Rothenburg, 1907 (Biol.); Saalas, 1923 (Biol.), 1943 (Paras.); Schiödt, 1876 (L fig.); Thompson, 1943 (Paras.); Trappen, 1908 (Biol.); Westwood, 1839 (L fig., Biol.); Xambeu, 1898-1902 (L, P, Biol.).

\**Callipogonini*

\**Megopis* sp.

[Very rarely imported from the Orient.]

*Mature larva* (fig. 44). Larvae of this genus apparently are rather similar to those of *Prionus*, from which they may be distinguished by the presence of three pairs of ocelli, the cordate labrum, the elongate, cylindrical apical segment of the antenna (fig. 44), and the absence of pleural discs on segments three to six. Gardner (1931) gives the following generic characters: "Head capsule nearly as long as wide, widest behind middle, posteriorly with a rather shallow, median emargination. Frontal margin carinate. Ocelli distinct, three on each side. Subfossal spine distinct. Labrum cordate, as long as, or nearly as long as, wide. Antennae with a well developed basal skin and three joints, the third small but distinct. The epistoma may project as a distinct tooth on each side above the lateral margins of the clypeus or it may be without any projection."

The only larva available for study is that of *M. nigropunctatus* Aurivillius. In this species the ocelli each have a distinct lens but the pigmented spot is rather indistinct; the subfossal spine is blunt; the epistoma is not produced over the clypeus; and the unguiculus is imbricately spinose.

*Pupa* (fig. 45). The following description is that of *M. (Megopis) modesta* White: length 46 mm.; breadth 12.4 mm. *Head* directed antero-ventrally, and not concealed by pronotum; slightly elongate with sides rounded; glabrous except sometimes for a few scattered spinules. Antennae filiform, moderately long, extending to between first and second abdominal segments where they are recurved to terminate just below mid coxae. Labrum transverse, fleshy and fringed with very fine, short setae. Maxillary palpi large and fleshy. *Pronotum* transverse, broadest behind middle, with lateral margins rounded; numerous short stout spines present, especially along front margin and on disc, which is an oval, strongly protuberant area. *Mesonotum* transversely striate, with two paramedian tuberculate areas which bear ferruginous spines; scutellum broad, fleshy, spinose. *Metanotum* transversely striate, with numerous rather stout



Fig. 44

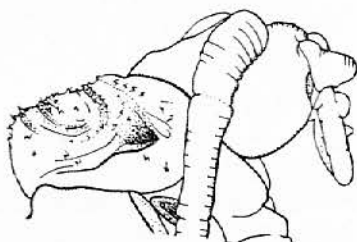


Fig. 45

Fig. 44. *Megopis nigropunctatus* Aurivillius. Mature larva. Apical part of antenna. Lateral aspect.

Fig. 45. *Megopis modesta* White. Pupa. Head and prothorax. Lateral aspect.

spines; scutellar groove shallow. Elytra and wings slightly curved upward at apex; extending as far as third abdominal segment. *Abdomen* with tergites one to seven and pleura bearing numerous scattered, stout, ferruginous spines, each with a basal seta. Eighth tergite much narrower than seventh and with fewer but stouter spines. Ninth tergite very short, with a transverse row of rather short stout spines. Sternites three to six dull and with a few scattered spinules; sternites seven to ten shining and glabrous. *Legs* with hind femora extending to fourth abdominal segment. *Functional spiracles* present on first six abdominal segments, those on segments seven and eight being partly or completely closed and probably non-functional; peritreme narrowly oval, exceedingly thick and scarcely raised.

The pupa of *Megopis (Dandamis) nigropunctata* Aurivillius differs from that of *M. (Megopis) modesta* White chiefly in that it possesses incurved urogomphi. Thus it would appear that the presence or absence of urogomphi affords a useful subgeneric character.

Host plants: Beeson & Bhatia (1939) list the following for *M. tibialis* White: *Evodia fraxinifolia*, *Ilex hookeri*, *Lindera pulcherrima*, *Machilus odoratissima* and *Symplocos theaeifolia*.

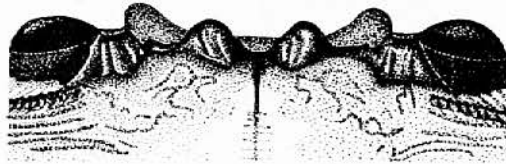
*Material studied.* 1 L, 3 P (*M. nigropunctata*), India, Nilgiri Hills, i.1902, H. E. Andrews leg., in coll. B.M.; 1 P (*M. modesta*), La Réunion, Plaine des Caffres, 1912, P. Carié leg., in coll. M.N.P.

*References.* Beeson & Bahtia, 1939 (Biol.); Gardner, 1931 (L fig.).

**\**Ergates faber* Linnaeus**

[Occasionally imported from the Continent.]

*Mature larva* (fig. 46). Rather similar to that of *Prionus coriarius*, from which it may be distinguished as follows: length up to 90 mm.; breadth (at prothorax) 17.5 mm. Form almost cylindrical. Cuticle finely rugose. *Head* broader (maximum



2 mm.

Fig. 46

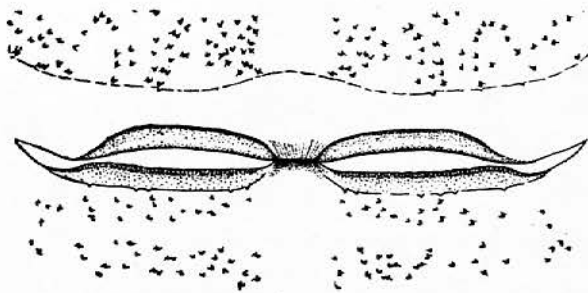


Fig. 47

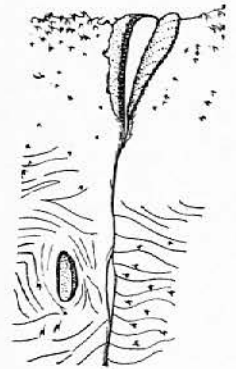


Fig. 48

Fig. 46. *Ergates faber* Fabricius. Mature larva. Front margin of the frons.

Fig. 47. *Ergates faber* Fabricius. Pupa. First pair of gin-traps.

Fig. 48. *Ergates faber* Fabricius. Pupa. Sixth abdominal segment showing gin-trap and spiracle. Lateral aspect.

head-width 11.75 mm.). Front margin of frons (fig. 46) with upper boundary projecting in four large shining, blunt teeth; lower boundary with a pair of well-developed lateral lobes. Labrum cordate, at least as long as wide. Three large but indistinct ocelli present. Maxillary palp with apical segment not longer than second segment acutely conical. *Prothorax* with the ferruginous transverse band absent. *Abdomen* with pleural discs present on segments one to six, though indistinct on segments three to six; disc finely rugose.

*Pupa* (figs. 47, 48). Length 27–60 mm.; breadth 15–20 mm. *Head* salient, not concealed from above by pronotum; elongate; sides with two paramedian depressions above antennae; strongly rugose and glabrous except for a few scattered pale papillae. Antennae long and slender, extending as far as third abdominal segment, where they

are recurved to terminate between the fore and hind coxae. Mandibles very rugose on apical third. Labrum triangular, rugose, with numerous fine setae near apex. *Pronotum* very strongly transverse, with sides slightly rounded and broadly explanate; strongly rugose, striate, with scattered pale papillae. *Mesonotum* and *metanotum* transversely striate and glabrous; scutellum very broad and depressed; scutellar groove conspicuous. Elytra and wings extending as far as third abdominal segment. *Abdomen* with tergites one to six rugose, and covered with numerous short, stout, ferruginous spines; gin-traps (figs. 47, 48) present on segments 1-2, 2-3, 3-4, 4-5, 5-6, and 6-7. Eighth tergite with only a few pale spines along posterior margin. Sternites less rugose, with a few scattered papillae. Ninth segment terminating dorsally in a pair of subvertical, very stout urogomphi; glabrous, strongly rugose and deeply divided ventrally. *Legs* with hind femora extending to between third and fourth abdominal segments. *Functional spiracles* present on first six abdominal segments; peritreme narrowly oval, thick and slightly raised in anterior half.

*Egg*. Form elongate-ovoid. Length up to 3 mm. Chorion dull white, with conspicuous grey reticulation.

Host plants: *Pinus*, *Larix*, *Picea* (Reineck, 1919); *Abies* (Becker, 1942b). There is also a single record from *Alnus* (Xambeu, 1898-1902) and *Cedrus* (Peyerimhoff, 1926).

*Biology*. Oviposition takes place on stumps, boles, branches and occasionally roots. The eggs are forced deeply into crevices in the bark. The incubation period is apparently about two weeks, although Zacher & Foerster (1938) and Della Beffa (1931) give it as three and one-half weeks and fifteen days respectively. According to Becker (1942b) oviposition does not take place at air temperatures below 22-23°C. The number of eggs laid by one female has been found to vary between 174 and 275. The incubation period averages from 12.1 days at 35°C. and 89-93 per cent relative humidity, to 4.35 days at 18°C. and 90-93 per cent relative humidity.

The larvae feed for only a short time under the bark, and then burrow into the sapwood, and often into the heartwood. When full-grown, the larva approaches the outer sapwood, and if the bark is present it perforates the sapwood and penetrates the inner layer of bark, so that only a very thin layer separates it from the exterior: if there is no bark, it bores close to the surface of the sapwood, where it excavates its pupal cell (Pl. II, fig. 8). Becker (1943a) found that fungi do not influence young larvae, and that their presence accelerates growth of older ones and appears essential for rapid development. The most effective species is *Poria contigua*.

The larvae pupate during June and July. The large elliptical pupal cell is parallel to the grain of the wood, and is extensively plugged at the entrance with coarse wooden shavings. Adults emerge from July to September. The life-cycle averages four to five years, and is sometimes twelve or more years (Becker, 1942b; Zacher & Foerster, 1938). Horn (1933) gives an account of this insect boring through lead.

*Parasites*. Hymenoptera: *Xorides filiformis* Grav. (Xambeu, 1898-1902).

*Natural enemies*. According to Xambeu (1898-1902), larvae and pupae of this species are excavated and readily consumed by martens and foxes, especially about midsummer when they are more easily accessible.

*Economic importance*. Similar to that of *E. spiculatus*. There are recent records of damage to telegraph poles by this species (Eckstein, 1936a). Becker (1942b) states

that timber in buildings, especially horizontal beams (where lodgment of water has caused dampness) are sometimes attacked.

*Control.* Infestation may be prevented by keeping timber dry.

*Material studied.* 5 L, France, Bay of Biscay, from *Pinus maritimus*, R. S. McDougall leg., in coll. B.M.; 3 L, 3 P, 3 I, no data, in coll. B.M.

*References.* Becker, 1942b (E fig., L fig., P fig., Biol. fig.), 1943 (L fig., Biol. fig.); Della Beffa, 1931 (L, P fig., Biol. fig.); Eckstein, 1936a (Biol. fig.); Escherich, 1923 (Biol. fig.); Escherich & Baer, 1913 (Biol.); Horn, 1933 (Biol.); Houlbert & Monnot, 1908 (L fig., P fig.); Kaltenbach, 1874 (Biol.); Kemner, 1922 (L fig.); Lucas, 1844 (Biol.); Mjöberg, 1905 (L fig., P fig., Biol. fig.); Perris, 1856 (L); Peyerimhoff, 1926 (Biol.); Reineck, 1919 (Biol.); Schulze & Becker, 1941 (Biol.); Xambeu, 1898-1902 (E, L, P, Biol.); Zacher & Foerster, 1938 (E, Biol. fig.).

**\**Ergates spiculatus* Leconte**

[Occasionally imported from North America.]

*Mature larva.* Similar to that of *E. faber*, from which it differs as follows: *Head* with frons distinctly and completely ferruginous. Front margin of frons with outer pair of teeth projecting well beyond inner pair. *Legs* with unguiculus pitchy for at least basal half.

*Pupa.* Similar to that of *E. faber*, from which it may be distinguished by the characters given in the key, p. 67.

*Egg* (fig. 49). Length 3.1 mm.; breadth 1.45 mm. Form ovoid, with one end bluntly tapering, the other more strongly tapering and truncate apically. Chorion light brown and covered with dark brown, coarse reticulation.

*Host plants:* Coniferae. *Pinus ponderosa* (Riley, 1880); *Pseudotsuga mucronata* (Hardy & Preece, 1926).

*Biology.* The eggs are deposited in clusters in dead or decaying logs, although sometimes in apparently sound wood (Craighead, 1915). The larva excavates a very large gallery, often extending deep into the heartwood. The gallery of a mature larva is about 2 cm. in diameter. Pupation

occurs in the sapwood. The pupal cell (Pl. III, fig. 11) is large, oval and plugged at the entrance with very coarse shredded shavings; the average dimensions are about 10 cm. by 4 cm.

*Economic importance.* The economic importance of this species lies not so much in the frequency of infestation, but rather in the enormous damage caused by a single larva in excavating its broad gallery right into the heartwood. There are numerous references to the destruction caused by this species which is often long after the timber has been used for structural purposes (Fraser, 1948g) (see also p. 9).

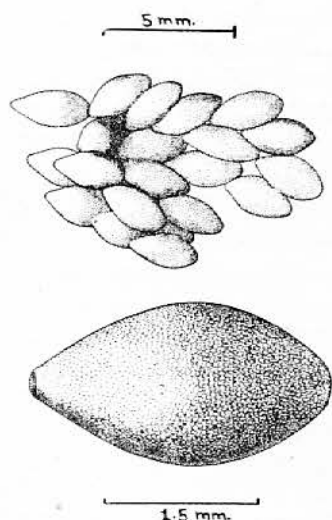


Fig. 49.  
*Ergates spiculatus* Leconte. Eggs.

*Material studied.* 2 L, 1 P, Canada, Vancouver, Hawkins leg., in coll. B.M.; 1 L, London, vii.1948, in imported *Pinus* from North America, in coll. D.

*References.* Craighead, 1915 (L fig., P, Biol.); Fraser, 1948g (Biol.); Hardy & Preece, 1926 (Biol.); Spencer, 1949 (E., Biol.).

\***Macrotomini**

\****Malloodon downesi* Hope**

[Occasionally in imported timber from Africa.]

*Mature larva* (figs. 50, 51). Rather similar to that of *Prionus coriarius*, from which it may be distinguished as follows. *Head* with lower boundary of front margin of frons with two broadly triangular lobes projecting over each side of clypeus. *Antenna* (fig. 50) two-segmented; second segment obliquely truncate apically and bearing

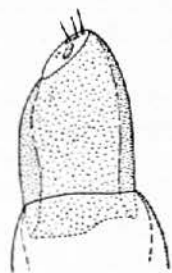


Fig. 50

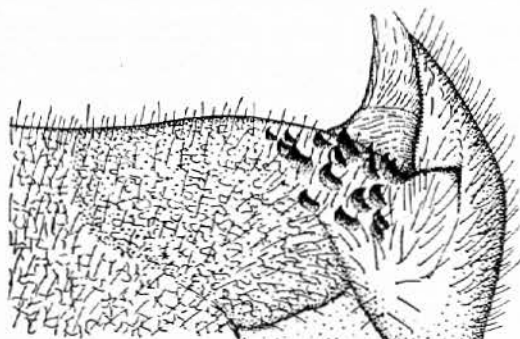


Fig. 51

Fig. 50. *Malloodon downesi* Hope. Mature larva. Apical part of antenna. Lateral aspect.

Fig. 51. *Malloodon downesi* Hope. Mature larva. Right half of prothoracic presternum.

sensory pores and setae. Three pairs of ocelli present. *Prothorax* without a transverse ferruginous band across front margin. Eusternum incompletely separated from presternum. Presternum (fig. 51) with lateral areas bearing a group of teat-like tubercles which are strongly sclerotised apically. *Legs* with unguiculus testaceous.

*Pupa.* Similar to that of *Ergates faber*, from which it may be distinguished as follows. *Head* with mouthparts extending in anterior direction. Antennae thick, short and not recurved beneath body. *Pro-, meso- and metanotum* with scattered spinules. *Abdomen* with ninth segment without tubercles or urogomphi.

*Host plants:* "Natal mahogany (Essenwood)" (Distant, 1904); *Ceiba*, *Eriodendron*, *Hevea* (Ghesquière, 1927); *Coffea*, *Theobroma*, *Cacao* (Lepesme, 1947).

*Biology.* According to Lepesme (1947) this species is polyphagous, and since it infests only decaying wood is of little economic importance. Distant (1904) states that the larva pupates in a hard "Cossus"-like cocoon. F. H. Rae has recently informed the writer that in Nigeria *Hevea brasiliensis* is the usual host, but only sound wood is attacked. He has also found stumps of the extremely hard "Ironwood" (*Lophita alata* var. *procera*) to be infested with this species.

*Material studied.* 1 L, Portuguese Congo, Cabinda, 16.vii.1920, R. Swainson-Hall leg., in coll. B.M.; 2 P, South Africa, L. S. Whicher leg., in coll. D.; 7 L, 3 P, 6 I, Nigeria, Sapele, xi.1950, from *Hevea*, F. H. Rae leg., in coll. D.

*References.* Corella, 1942 (L fig.); Distant, 1904 (P fig., Biol.); Eichelbaum, 1913 (L fig.); Ghesquière, 1927 (Biol.); Harris, 1937 (Biol.); Lepesme, 1947 (Biol.); Lepesme & Villiers, 1944 (Biol.).

### 3. LEPTURINAE

#### Larval Characters

Form subcylindrical to strongly depressed. *Head* slightly to strongly transverse; epicranial halves entirely separated behind frons (except in a few exotic species); occipital foramen not divided into an anterior and posterior portion, as the tentorial cross-arm is internal; postero-dorsal emargination very strong, extending to frons; front margin of frons never steeply declivous or projecting over clypeus, and with six to ten (occasionally as many as twenty) epistomal setae. Clypeus trapezoidal, as wide at base as front margin of frons. Labrum transverse, semicircular or cordate. Mandibles with an oblique cutting edge, apex acutely produced. Ocelli absent, or one to six pairs present. Antenna very small, retractile, and two- or three-segmented. Maxillae movable; palpifer with outer margin straight, and bearing lobe. Ligula larger than labial palpi. *Prothorax* with eusternum distinct, triangular. *Abdomen* with ampullae tuberculate; epipleurum strongly protuberant on all segments, but region surrounding spiracle not protuberant; pleural discs absent; ninth segment sometimes with a terminal spine or urogomphi. *Legs* slender and rather long; coxae large, almost touching inwardly between eusternum and sternellum; unguiculus with a long stout seta arising near base. *Spiracles* of mesothorax not protruding into prothorax; all spiracles with small, nearly contiguous marginal chambers.

#### *Acmaeops collaris* (Linnaeus)

*Mature larva* (figs. 52, 53). Length up to 12 mm.; maximum breadth (at prothorax) 3 mm. Form stout, very strongly depressed and parallel-sided. *Head* (fig. 53) slightly narrower than prothorax, very strongly depressed and transverse (maximum head-width 2.2 mm.), with sides broadly angulate; strongly sclerotised, completely ferruginous, and bearing several extremely long stout setae. Frons divided by a distinct transverse line; six rather deep depressions present. Six epistomal setae present. Antenna minute, two-segmented, the second segment bearing several spine-like processes. Mandible very slender, at least three times as long as basal width, and bearing two stout setae on outer face. Six ocelli present, one pair being placed ventrally; lens strongly protuberant; pigmented spot very distinct. Gular sutures indiscernible but a ventral white cleavage line present. Maxilla with third palpal segment longer than second; lobe slender, cylindrical. *Prothorax* depressed, more than three times as long as broad and with a pair of sublateral, dark brown depressions. Eusternum rugose and glabrous. *Mesonotum* and *metanotum* glabrous except for stout lateral setae. *Abdomen* very strongly depressed, with dorsal and ventral ampullae on

segments one to seven. Each dorsal ampulla tuberculate, glabrous and shining. Pleural tubercle very strongly protuberant and bearing five long setae. Ninth segment triangular, with a pair of sublateral, longitudinal impressions and bearing numerous long, stout, marginal setae. Tenth segment ventral, in the form of a pseudopod (fig. 52). *Legs* strongly sclerotised, extremely long and visible from above (fig. 52);

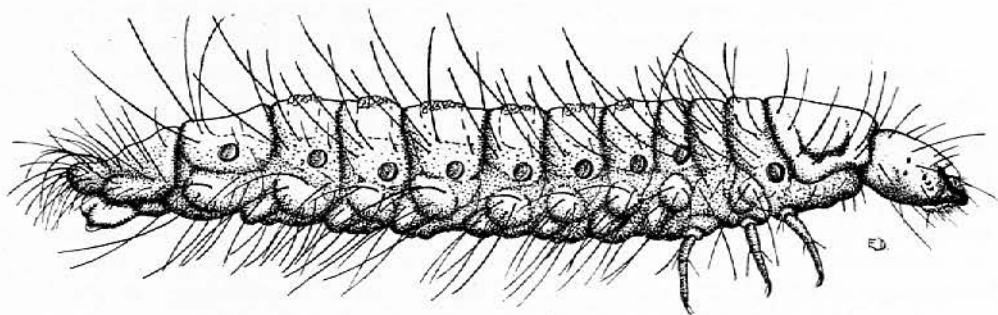


Fig. 52. *Acmaeops collaris* (Linnaeus). Mature larva. Lateral aspect.

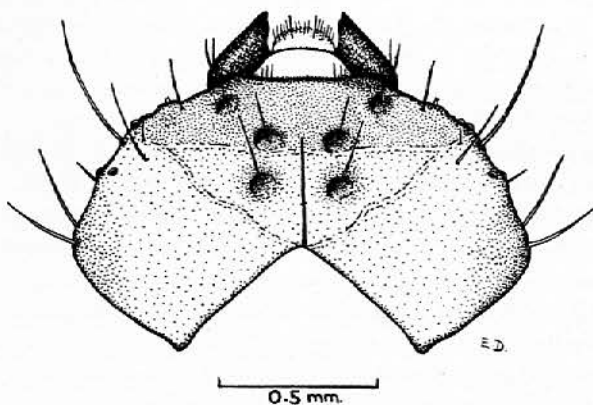


Fig. 53. *Acmaeops collaris* (Linnaeus). Mature larva. Head. Dorsal aspect.

unguiculus with ventral margin concave as far as basal third, which is parallel-sided (as in *Judolia*, fig. 99). *Spiracles* large, with peritreme round; marginal chambers in the form of a characteristic crescent (as in *Judolia*, fig. 100).

This larva shows strong affinities towards the curious larva of *Apiocephalus* (see p. 62).

*Pupa*. Xamheu (1898-1902) gives the following description: "Corps épais, charnu et cilié. Front et vertex couverts de poils roussâtres, arqués en avant; premier segment thoracique, à pourtour couvert de longs cils, dont quelques-uns en série transversale médiane; au tiers de chaque segment abdominal est une série transversale de poils roussâtres dirigés en arrière; segment anal inerme et velu; quelques poils sur chaque genou et sur le dernier article des tarse." "

Host plants: *Castanea* (Perris, 1877; Xambeu, 1898-1902); *Quercus* (M. G. Fraser and the writer). It is interesting to note that the American *A. tumida* Leconte feeds in roots of *Ranunculus* (Linsley, 1936).

*Biology.* Until the recent discovery of larvae by M. G. Fraser and the writer, very little was known of the biology of this species apart from the account by Perris (1877). After prolonged search in a known breeding-ground, six half-grown larvae were eventually discovered crawling about under the loose dry bark of the exposed rotten roots of an old overturned stump of *Quercus*. The inspection of numerous cut poles of *Castanea* in the same area proved fruitless. The size of these larvae (taken in June) suggested a two-year life-cycle, although the period probably varies considerably owing to the somewhat precarious larval habitat.<sup>1</sup>

So strange and unusual is the general appearance and behaviour of the larva that it could easily be mistaken for that of a Malacoderm or even a Lepidopteron. Its greyish colour, conspicuous setae, long legs and anal pseudopod, and above all its unusual method of progression are decidedly misleading. Larvae kept under observation proved to be extremely active, and crawled about with the speed and ease of a typical Lepidopterous larva, performing similar movements, and using the pseudopod for anchorage whenever the legs were raised. Not only did they crawl about both on top and beneath the bark but also over the soil to other stumps. Sometimes they were observed climbing up the practically smooth, vertical walls of the breeding cage, from which they could not readily be dislodged. On being turned over on its back, a larva would quickly regain its normal position by twisting the fore part of its body so that its legs were able to gain purchase on the ground.

Apparently no attempt is made by the larva to bore into the sapwood, nor is the wood itself consumed or even superficially grazed. It seems that larvae are only to be found under loose bark in old subcortical galleries of other larvae such as *Clytus arietis* (Linnaeus). Perris (1877) maintains that the larva feeds on the frass of former larvae, and the present writer has noticed similar behaviour in the larvae under observation, although whether in fact they consumed the frass or the fungal growths or both cannot be stated with certainty. This is apparently the only Cerambycid larva known to be able to exist without the support and protection of a gallery. The mortality of this species in the larval stage must surely be great, since it is so readily accessible to parasites and predators. In the late autumn the mature larva falls to the ground and enters the soil in which it constructs an earthen cocoon. Here the larva overwinters and pupates the following April or May. Adults emerge in May or June.

*Economic importance.* Although there have been reports of this species breeding in hop poles, it would seem evident that the damage was caused originally by other wood borers such as *Clytus arietis* (Linnaeus).

*Material studied.* 6 L, Worcestershire, Stourport, vi.1949, in exposed roots of *Quercus*, M.G.F. and D. leg., in coll. D. [Adults reared.]

*References.* Emden, 1939-1940 (L); Henriksen, 1914 (L fig.); Houlbert & Monnot, 1908 (L fig.); Linsley, 1936 (Biol.); Perris, 1877 (L fig., P, Biol.); Xambeu, 1898-1902 (L, P, Biol.).

<sup>1</sup> The larvae have since been reared within a two-year period.

**Rhagium (s.g. Rhagium) bifasciatum** Fabricius

*Mature larva* (figs. 54–62). Length up to 34 mm.; breadth (at prothorax) 7 mm. Form rather strongly depressed, but robust and parallel-sided. *Head* (fig. 54) slightly wider than prothorax, strongly depressed, strongly transverse (maximum head-width 6.1 mm.), with sides very strongly rounded; testaceous, shining, rather strongly sclerotised and sparsely covered with fine setae. Genae ferruginous, slightly rugose, keeled anteriorly and with a few moderately long setae. Mouthframe strongly sclerotised, smooth, ferruginous. Frons divided by a distinct transverse line (which is complete and widened medially) into an anterior ferruginous and a posterior testaceous area; two paramedian, shallow depressions present; front margin straight and

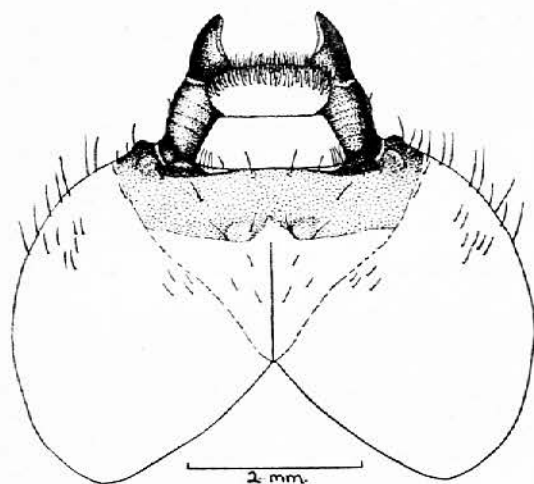


Fig. 54. *Rhagium bifasciatum* Fabricius. Mature larva. Head. Dorsal aspect.

fused medially into clypeus; at least ten epistomal setae present. Antenna (fig. 55) very small, apparently two-segmented; second segment bearing a stoutly conical, hyaline process. Mandible (viewed laterally) very slender, about three times as long as basal width; pitchy and strongly shining; deeply notched and widened apically with a distinct tooth behind proximal angle of emargination (fig. 56). Labrum transversely oval, testaceous, with fine dense setae. One pair of large ocelli present, but pigmented spot indistinct. Gular sutures indiscernible; ventral, white cleavage line present. Maxilla well extended, movable; palpus very slender, last segment acutely attenuated, shorter than first or second; lobe slender, cylindric, with setae as figured (fig. 57). *Prothorax* (fig. 58) depressed, at least twice as broad as long; dorsally sclerotised, testaceous, and with a pale, ferruginous, transverse band near front margin; lateral grooves and median cleavage line absent, so that pronotum is undefined; anterior half entirely smooth, and with a transverse row of short setae; posterior half slightly rugose, and with a transverse row of setae near hind margin. Eusternum triangular, smooth, shining, and with a few scattered setae. *Mesonotum* and *metanotum* dull, finely spiculate, and with several scattered setae. *Abdomen*

depressed, with dorsal and ventral ampullae on segments one to seven; each dorsal ampulla with a well-marked median furrow, strongly tuberculate, and moderately shining (fig. 59). Pleural tubercle (fig. 60) conspicuous, elongate-oval, smooth and bearing five setae; pleural discs undefined. Eighth and ninth terga smooth, sparsely setose, the latter broad, rather strongly sclerotised and bearing a conspicuous caudal

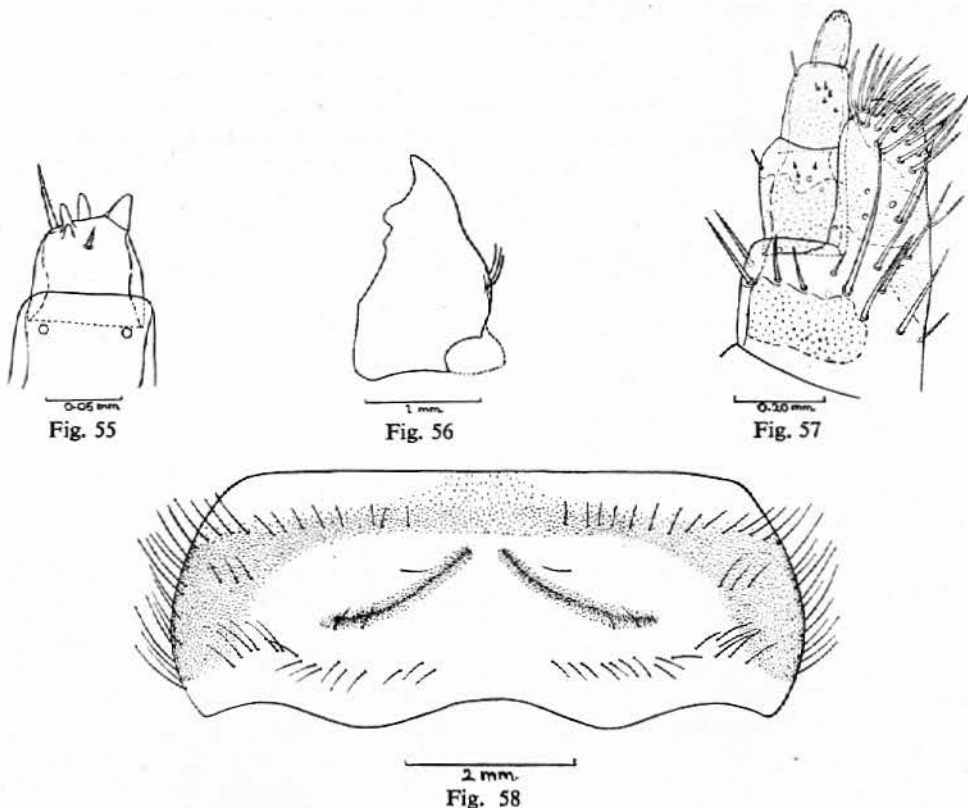


Fig. 55. *Rhagium bifasciatum* Fabricius. Mature larva. Apical part of antenna.

Fig. 56. *Rhagium bifasciatum* Fabricius. Mature larva. Right mandible. Dorsal aspect.

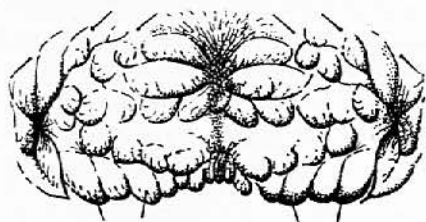
Fig. 57. *Rhagium bifasciatum* Fabricius. Mature larva. Apical part of right maxilla. Ventral aspect.

Fig. 58. *Rhagium bifasciatum* Fabricius. Mature larva. Prothorax. Dorsal aspect.

spine (often blunt), the angle between the sides of support of the spine being about  $100^\circ$  (fig. 61). Tenth segment trilobed, each lobe protuberant, smooth and bearing a few short setae. *Legs* well developed, longer than maxillary palpi, slender, testaceous; unguiculus feebly sclerotised, attenuated; femur and tibiotarsus each bearing a few long setae (fig. 62). *Spiracles* with peritreme orbicular, moderately thick and sclerotised, pale testaceous, and slightly raised above general level of cuticle.

*First-instar larva* (fig. 63). Length up to 1.6 mm. *Head* with five pairs of ocelli, each with a conspicuous black pigmented spot. Front margin of frons ferruginous and with proportionately longer epistomal setae. *Mesothorax*, *metathorax* and

abdominal segments one to eight with dorso-lateral egg-bursting spines (fig. 63); form short, bluntly triangular; pale testaceous. Ninth abdominal segment with terminal spine absent. *Legs* with unguiculus slightly curved. *Spiracles* biforous as in *R. mordax* (fig. 69).



2 mm.

Fig. 59



1 mm.

Fig. 60

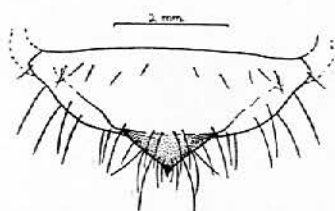


Fig. 61

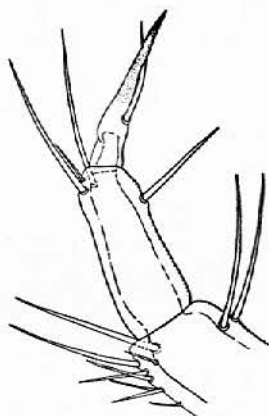
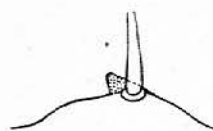


Fig. 62



0.03 mm.

Fig. 63

Fig. 59. *Rhagium bifasciatum* Fabricius. Mature larva. Dorsal ampulla of third abdominal segment.

Fig. 60. *Rhagium bifasciatum* Fabricius. Mature larva. Spiracle and pleural tubercle of first abdominal segment. Dorsal aspect.

Fig. 61. *Rhagium bifasciatum* Fabricius. Mature larva. Ninth abdominal segment. Dorsal aspect.

Fig. 62. *Rhagium bifasciatum* Fabricius. Mature larva. Apical part of right mesothoracic leg. Lateral aspect.

Fig. 63. *Rhagium bifasciatum* Fabricius. First-instar larva. Egg-bursting spine. Dorsal aspect.

*Pupa* (figs. 64-66). Length 14-21 mm.; maximum breadth 7.75 mm. *Head* strongly elongate, triangular, rugose; vertex with at least six long stout setae above each eye; frons with three to six stout setae near base of each antenna; base of clypeus with about six stout setae on each side. Antennae extending as far as first abdominal segment, where they are curved downward to terminate near base of each elytron. Mandible with a conspicuous dorso-lateral seta. Labrum transverse, rectangular, glabrous. *Pronotum* quadrate, with front margin strongly rounded and with a pair of large lateral tubercles; a row of erect, closely set, long, slender setae present along

front and hind margins and scattered finer setae present on lateral tubercles and disc. *Mesonotum* with two groups of fine, ferruginous setae and scutellum with similar setae, especially near base. *Metanotum* with a group of similar setae on each side of scutellar groove, which is shallow and transversely striate. Elytra and wings extending to third abdominal segment. Abdomen with tergites one to six each bearing a pair of transverse rows of short ferruginous spines (each with a long basal seta). Seventh and eighth tergites with a row of similar but stouter spines along posterior margin. Ninth tergite with a transverse row of smaller spines and terminating in a long, stout, ferruginous spine which is directed downward (fig. 66). Sternites with sublateral

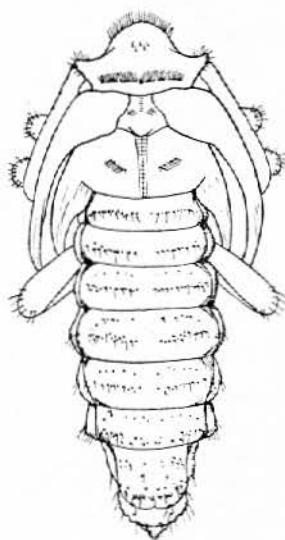


Fig. 64

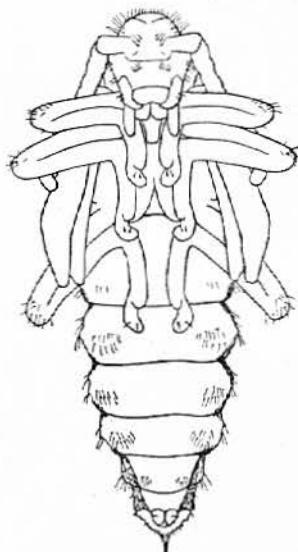


Fig. 65



Fig. 66

Fig. 64. *Rhagium bifasciatum* Fabricius. Male pupa. Dorsal aspect.

Fig. 65. *Rhagium bifasciatum* Fabricius. Female pupa. Ventral aspect.

Fig. 66. *Rhagium bifasciatum* Fabricius. Pupa. Terminal spine. Dorsal aspect.

groups of long, stout setae, except the ninth, which has only two setae, and the tenth, which is glabrous. *Legs* with numerous long, stout setae at apex of each femur, and paired setae near apex of each tarsus; hind femora extending to fourth abdominal segment. *Functional spiracles* present on first five abdominal segments, the sixth and seventh pairs being closed and vestigial; peritreme broadly oval, rather thin and level with general surface of cuticle.

*Host plants*: *Pinus*, *Abies*, *Picea*, *Larix*, *Castanea*, *Quercus*, *Betula*, *Fagus*, *Laurus*, *Fraxinus*, *Carpinus*, *Alnus*, *Populus*, *Salix*, *Pyrus malus*, *P. aucuparia*, *Sambucus nigra*, *Prunus cerasus*, and *Crataegus* (Duffy, 1945a, 1946c; Kaufmann, 1946; Prell, 1927b; Regnier, 1924; Reineck, 1919; Xamheu, 1898-1902). Larvae of this species are remarkably polyphagous, and there can be few species of our common trees which are incapable of supporting them.

*Biology*. The larval habitat is chiefly in felled boles, logs and stumps: occasionally in standing trees and roots. The larvae have a decided preference for moist rotting

wood, especially that which has previously become partly decayed through the ravages of other larvae such as those of *Asemum* and *Criocephalus* species. Although often remaining under the bark until mature, these larvae generally tunnel deeply into the sapwood where they make long broad galleries, which are loosely packed with shredded shavings and frass. They will readily bite any soft-bodied larva that intrudes upon their burrows, their comparatively long legs enabling them to move more freely than do the majority of Cerambycid larvae. The larval period is usually about two years. Pupation generally takes place in the outer sapwood, but often deep inside when the wood is very decayed. The pupal cell is elongate-oval, parallel to the grain of the wood and is plugged at the entrance with fine wooden shavings. Pupation occurs from July to September and eclosion from July to October. The adults remain inside their pupal cells throughout the winter months, and seldom attempt to gnaw their way out into the open until the following spring.

*Parasites.* Hymenoptera: *Coeloides initiator* F., *Bracon leucogaster* Zgrl., *Echthrus reluctator* L., *Xorides rufipes* Gr., *X. irrigator* F. (Reineck, 1919); *Ischnoceros filicornis* Kreichb. (Thompson, 1923).

The Nematode *Bradynema strasseni* Wülker has been found in *Rhagium* larvae (Wülker, 1921).

*Predators.* Coleoptera: *Nudobius lentus* Er., *Opilo mollis* L., *Thanasimus formicarius* L. (Reineck, 1919).

*Economic importance.* Owing to their decided preference for moist rotting wood larvae of this species are very seldom encountered in the timber industry. It has been the writer's experience that only very rarely are they to be found in a living tree, and then they are confined to the damaged or decaying parts. They are decidedly beneficial to forestry in so far as they speedily break down stumps and logs, thus enriching the soil and clearing the ground.

*Material studied.* 6 L, Hants, Crookham, 17.v.1944, in rotten *Quercus*, D. leg., in coll. D.; 2 L, Hants, Fleet, 1944, in *Fagus*, D. leg., in coll. D.; 3 L, Surrey, Mytchett, 17.x.1943, in stump of *Pinus*, A. W. McKenny Hughes, D. leg. in coll. D.; 4 L, Surrey, Hindhead, 18.ix.1944, in *Pinus*, D. leg., in coll. D.; 14 P, Surrey, Oxshott, x.1947, in *Pinus*, D. leg., in coll. D. [Adults reared.]

*References.* Della Beffa, 1931 (L, P, Biol. fig.); Dingler, 1925 (Biol. fig.); Duffy, 1946c (Biol.); Emden, 1939-1940 (L); Henriksen, 1914 (L); Heintz, 1927 (Physiol.); Kaltenbach, 1874 (Biol.); Kaufmann, 1946 (Biol.); Macdougall, 1929 (Biol. fig.); Perris, 1877 (L fig., P fig., Biol.); Prell, 1927 (Biol. fig.); Regnier, 1924 (Biol.); Reineck, 1919 (Biol.); Schiödte, 1876 (L); Wülker, 1921 (Paras.); Xambeu, 1896-1902 (L, P, Biol.).

### ***Rhagium* (s.g. *Rhagium*) *mordax* (Degeer)**

*Mature larva* (fig. 67). Similar to that of *R. bifasciatum*, from which it may be distinguished as follows. *Head* with transverse suture of frons faint, the area anterior to suture becoming gradually and only slightly darker than posterior area. Genae much darker than anterior part of frons and deeply transversely striate. Mandible as in fig. 67. *Abdomen* with dorsal ampullae dull, microscopically spiculate, without well-defined tubercles and with three distinct transverse furrows. Ninth segment with the

angle between sides of support of terminal spine about  $120^\circ$ . *Spiracles* almost twice as large as those of *R. bifasciatum*, with peritreme thicker, darker and more broadly oval.

*First-instar larva*. Extremely similar to that of *R. bifasciatum*, but with egg-bursting spines appreciably larger and attenuated (fig. 68). *Spiracle* as in fig. 69.

*Pupa*. This pupa is very similar to that of *R. bifasciatum* and, like the latter, rather variable in the number of spines present. In general, the majority of the spines in this species are appreciably shorter and more slender. The most obvious and constant difference appears to be the presence of several rather stout pale spines (each with a long fine basal seta) arranged in sublateral groups on the abdominal sternites four to eight, for in *R. bifasciatum* stout ferruginous setae only are present.



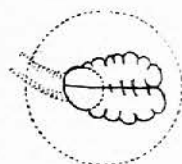
0.05 mm.

Fig. 67



0.05 mm.

Fig. 68



0.05 mm.

Fig. 69

Fig. 67. *Rhagium mordax* (Degeer). Mature larva. Right mandible. Dorsal aspect.

Fig. 68. *Rhagium mordax* (Degeer). First-instar larva. Egg-bursting spine. Dorsal aspect.

Fig. 69. *Rhagium mordax* (Degeer). First-instar larva. Abdominal spiracle.

*Egg*. Form strongly elongate, with ends slightly tapering. Chorion white, thick, and rather coarsely reticulated. Length 1.9 mm.; breadth 0.5 mm.

*Host plants*: *Quercus*, *Castanea*, *Pinus*, *Abies*, *Picea*, *Larix*, *Alnus*, *Betula*, *Fagus*, *Juglans*, *Sorbus*, *Fraxinus*, *Crataegus*, *Ilex*, *Carpinus*, *Tilia*, *Pyrus aucuparia*, *P. malus* (Duffy, 1946c; Kaufmann 1948; Reineck, 1919; Saalas, 1923; Xambeu, 1896-1902). The larva of this species is extremely polyphagous as the above records indicate.

*Biology*. The eggs are deposited chiefly in clusters under the bark of felled trees, boles, logs and stumps; occasionally in standing trees and roots. The incubation period is about fifteen days. These larvae prefer moist, decaying or rotten wood where they feed on the cambium and outer sapwood, seldom penetrating the latter to any appreciable depth. Like those of *R. bifasciatum*, they are very active and will readily bite when molested. Pupation takes place subcortically from July to September. The pupal cell is broadly oval, nest-like and comprises a very shallow concavity (usually in the inner wall of the bark), which is surrounded by a barrier of long, interlaced wooden fibres (Pl. IV, fig. 16). Ecdysis occurs from August to October. The adults overwinter inside their pupal cells, which they do not leave until the following spring.

*Parasites*. Hymenoptera: *Xorides filiformis* Grav., *Ephialtes tuberculatus* Grav. (Reineck, 1919; Xambeu, 1898-1902); *Ischnoceros rusticus* Fourc. (Thompson, 1923).

*Economic importance.* Similar to that of *R. bifasciatum*.

*Material studied.* 4 L, Sussex, Three Bridges, 14.iv.1945, D. leg., in coll. D.; 1 I, Essex, Epping Forest, K. G. Blair leg., in coll. B.M.; 2 L, Broxbourne, 6.ii.1937, in rotten *Quercus*, T. G. Howarth leg., in coll. B.M.; 6 P, Surrey, Ashstead, viii.1948, in *Quercus*, D. leg., in coll. D.; 4 L, Surrey, Effingham, v.1948, J. C. Ford leg., in coll. D. [Adults reared.]

*References.* Barbey, 1913 (Biol.); Della Beffa, 1931 (L, Biol.); Dingler, 1925 (Biol. fig.); Duffy, 1946c (Biol.); Emden, 1939-1940 (L); Henriksen, 1914 (L); Kaltenbach, 1874 (Biol.); Kaufmann, 1948 (Biol.); Kolbe, 1884 (L, P); Prell, 1927 (Biol.); Reineck, 1919 (Biol.); Rudow, 1912 (Biol.); Rothenburg, 1907 (Biol.); Saalas, 1923 (Biol.); Schiödt, 1876 (L fig., P); Trägårdh, 1939 (Biol.); Xambeu, 1898-1902 (L, P, Biol.).

***Rhagium* (s.g. *Hargium*) *inquisitor* (Linnaeus)**

[Sometimes imported from North America.]

*Mature larva* (figs. 70, 71). Rather similar to those of preceding species, from which it differs as follows. Length up to 27 mm.; breadth (at prothorax) 6.1 mm. Form more slender. Cuticle rather thin and more hairy. *Head* (fig. 70) much more strongly depressed, more strongly transverse (maximum head-width 5.75 mm.) and

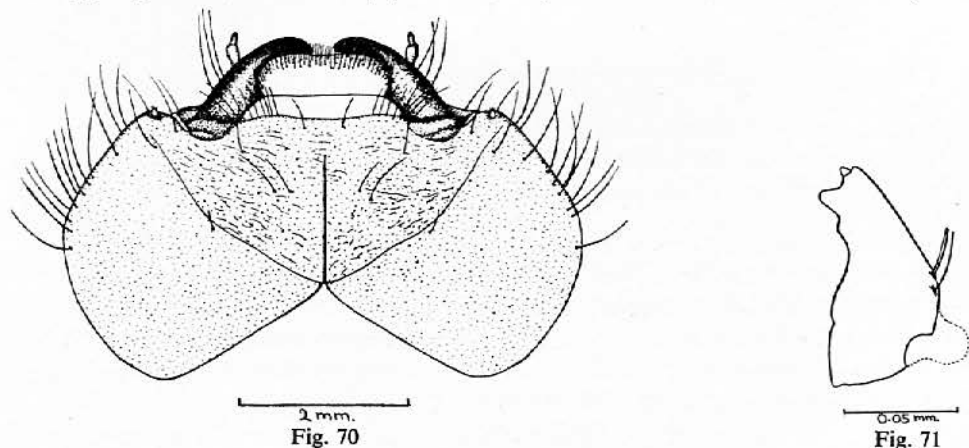


Fig. 70. *Rhagium* (*Hargium*) *inquisitor* (Linnaeus). Mature larva. Head. Dorsal aspect.

Fig. 71. *Rhagium* (*Hargium*) *inquisitor* (Linnaeus). Mature larva. Right mandible. Dorsal aspect.

with sides more strongly rounded; completely ferruginous and rather dull dorsally. Genae ferruginous, with numerous long fine setae; temples with a distinct longitudinal keel beneath antennae. Median adfrontal suture black and complete for basal three-fourths. Frons without a transverse line, but paramedian depressions present. About twenty epistomal setae present. Mandible more slender and more strongly produced, with cutting edge much shorter (fig. 71). Maxilla with basal segment of palpus strongly broadened apically. *Prothorax* uniformly testaceous without a ferruginous band near front margin. *Abdomen* with ampullae less strongly tuberculate, dull and

microscopically spiculate. Ninth tergite feebly sclerotised and without a terminal spine. *Legs* with unguiculus more slender and attenuated.

*Pupa* (fig. 72). This pupa closely resembles those of the preceding species, and all the obvious differences are listed in the key, p. 89.

Host plants: *Pinus*, *Picea*, *Larix*, *Betula* and *Quercus* (Reineck, 1919; Saalas, 1923; Xamheu, 1898-1902); *Cedrus atlantica* (Peyerimhoff, 1919). Unlike those of the preceding species, these larvae are more discriminating, and show a decided preference for coniferous wood.

*Biology*. The larval habits are similar to those of *R. mordax*, although perhaps more strictly subcortical. The larvae usually keep themselves more or less protected

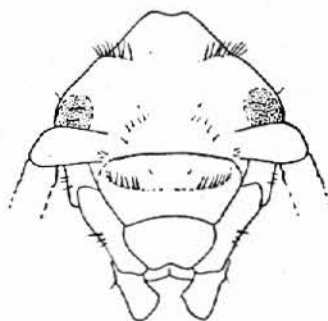


Fig. 72

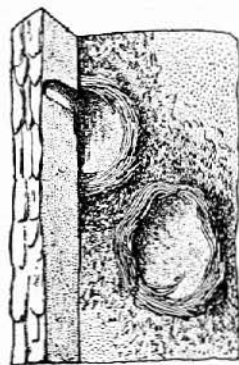


Fig. 73

Fig. 72. *Rhagium (Hargium) inquisitor* (Linnaeus). Pupa. Head. Ventral aspect.

Fig. 73. *Rhagium (Hargium) inquisitor* (Linnaeus). Pupal cells beneath bark of *Pinus*. (Craig-head, 1923b)

by barriers of frass and fibres which they break down and rebuild from time to time as they move about for food. The larval period varies from one to three years. The pupal habitat is similar to that of *R. mordax* (fig. 73). Pupae are normally to be found during September and October, but sometimes not until the spring. Adults eclose during October and November, but the adults overwinter in their pupal cells, and do not emerge until the following spring.

*Parasites*. Hymenoptera: *Coeloides initiator* F., *Doryctes leucogaster* Nees (Xamheu, 1898-1902); *Bracon simplex* Creeson (Hess, 1920); *Ephialtes dux* Tschek., *E. tuberculatus* Fourc., *E. terebrans* Ratz., *Ischnoceros seticornis* Kr., *Xorides irrigator* F., *Deutoxorides collaris* Gr. (Seyrig, 1924); *Sichelia filiformis* Grav., *Ephialtes abbreviatus* Thoms. (Thompson, 1923).

*Predators*. Coleoptera: Larvae of the Staphylinid *Nudobius lentus* Er. (Xamheu, 1898-1902).

*Natural enemies*. Woodpeckers (*Gecinus* spp.). Hess (1920) mentions that eggs and first-instar larvae are sometimes carried off by ants.

*Economic importance*. These larvae would seem to prefer less decayed wood than do those of the preceding species, which probably accounts for their not infrequent importation in softwoods from North America.

*Material studied.* 9 L, Aberdeen, viii.1920, in bark of fallen *Pinus*, F. Laing leg., in coll. B.M.; 2 P, Germany, Hanover, K. Jordan leg., in coll. B.M.; 3 P, North America, Mass., 27.ix.1904, G. Dimmock leg., in coll. U.S.N.M.; 1 P, Denmark, Gribso, 18.ix.1927, S. G. Larsson leg., in coll. U.Z.M.C.

*References.* Barbey, 1913 (Biol. fig.); Boas, 1923 (Biol. fig.); Della Beffa, 1931 (L, Biol.); Craighead, 1923b (L fig., P, Biol. fig.), 1950 (Biol.); Emden, 1939 (L); Felt, 1906 (Biol.); Hardy & Preece, 1926 (Biol.); Henriksen, 1914 (L); Hess, 1920 (E fig., L fig., P fig., Biol. fig.); Houlbert & Monnot, 1908 (L fig.); Kaltenbach, 1874 (Biol.); Kolbe, 1884 (L, P); Packard, 1890 (L fig., Biol.); Pečírka, 1906 (Biol.); Peyerimhoff, 1919 (Biol.); Prell, 1927 (Biol.); Reineck, 1919 (Biol.); Rothenburg, 1907 (Biol.); Rudow, 1912 (Biol.); Saalas, 1923 (Biol.); Schauderl, 1942 (Physiol.); Schiödte, 1876 (L fig., P); Seyrig, 1924 (Paras.); Trägårdh, 1918 (P fig., Biol. fig.), 1939 (Biol. fig.); Trappen, 1908 (Biol.); Xambeu, 1898-1902 (L, P, Biol.).

### *Stenocorus meridianus* (Linnaeus)

*Mature larva.* Very similar to those of *Rhagium* species, from which it may be separated by the characters given in the key, p. 67.

*First-instar larva.* This so closely resembles those of *Rhagium* species that no reliable differences have yet been found.

*Pupa.* A pupa of this species has recently been obtained from larvae reared under laboratory conditions. From those of *Rhagium* species it may be distinguished by the following characters: Ampullae bilobed, very strongly protuberant, and bearing numerous long, stiff setae. Tarsi each with about 10 scattered, stiff setae. Ninth tergite with subcontiguous urogomphi.

*Egg.* Length 3.4 mm.; breadth 1.75 mm. Form extremely elongate, cylindrical, more or less parallel-sided, with bluntly rounded ends. Chorion extremely delicate, soft, dull, pale green, and very distinctly and finely reticulated.

*Host plants:* *Prunus cerasus* (Perris, 1877); *Fraxinus*, *Salix* (Reineck, 1919). [The present writer recently placed adults in a cage containing various stumps, including *Quercus*, *Pinus*, *Fagus*, *Populus*, *Alnus*, *Pyrus malus* and *Betula*. The beetles eventually oviposited on all these hosts (although *Populus nigra* seemed to be the most popular) and appear to be amphixylophagous.]

*Biology.* The eggs are deposited in batches, cemented together side by side. At least 84 eggs were laid by a captive adult under observations, but about one-third of these collapsed and went mouldy owing to humid conditions. The incubation period is about fourteen days. The larvae apparently feed in stumps and underground roots and require two years in which to mature. Pupation takes place in the soil alongside roots, and adults emerge during May and June.

*Material studied.* 6 L (from eggs laid by captive adults), J. Cowley leg., in coll. D.; 8 L (first instar), from eggs laid by captive adult, Surrey, Cut Mill, vii.1946, D. leg., in coll. D. [Adults reared.]

*References.* Emden, 1939-1940 (L); Mjöberg, 1906 (Biol.); Perris, 1877 (L fig., Biol.); Reineck, 1919 (Biol.). [It is now evident that these references must concern some other species.]

**Grammoptera ruficornis** (Fabricius)

*Mature larva* (figs. 74, 75). Length up to 11 mm.; breadth (at prothorax) 2.25 mm. Form rather strongly depressed, slender and slightly tapering. *Head* slightly narrower than prothorax, very strongly depressed, strongly transverse (maximum head-width 2.1 mm.), with sides very strongly rounded; testaceous, shining, moderately strongly



Fig. 74

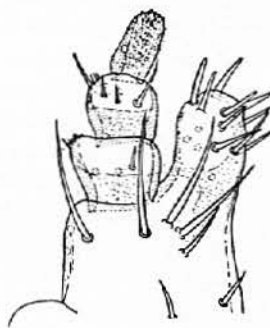


Fig. 75

Fig. 74. *Grammoptera ruficornis* (Fabricius). Mature larva. Right mandible. Dorsal aspect.

Fig. 75. *Grammoptera ruficornis* (Fabricius). Mature larva. Apical part of right maxilla. Ventral aspect.

sclerotised and sparsely setose. Genae ferruginous, slightly rugose, with a few long setae; temples not keeled. Frons with transverse line very indistinct or absent, but with a transverse ferruginous band immediately behind front margin. Antenna minute, entirely retractile; apparently two-segmented, the second segment bearing an elongate, acutely tapering, hyaline process and a long slender hyaline process. Mandible (viewed laterally) rather short and stout; scarcely widened or notched apically, cutting edge scarcely sinuate (fig. 74); bearing two or three setae on outer face near base. Labrum semicircular, rather sparsely setose. Three pairs of ocelli present, each with a very distinct ocellar lens and pigmented spot. Gula as in *Rhagium*. Hypostoma short, strongly transverse, about four times as wide as median length, with sutures straight and diverging. Maxilla with sides of palpal segments, rounded and constricted basally; third segment as long as second, and at least twice as long as basal width; lobe with setae as figured (fig. 75). Labial palpi distant by twice their own width or more. *Prothorax* as in *Rhagium* except for absence of a wide, transverse ferruginous band. *Abdomen* with dorsal ampullae on segments one to seven. Ninth segment without a terminal spine. *Legs* with femur shorter than tibiotarsus; unguiculus long, slender and entirely testaceous.

*Pupa* (fig. 76). Length 4-7.5 mm.; maximum breadth 2.75 mm. *Head* elongate, triangular, smooth; vertex visible from above, simple, with six very long slender setae; front with three similar setae opposite base of each antenna and with a shallow depression above; clypeus with a transverse row of six shorter setae, the middle pair usually being placed rather higher than the rest. Antennae extending as far as second abdominal segment, where they are strongly recurved to terminate near apices of

mid tibiae. Eyes large, convex and bearing a few short setae. Mandibles with two small setae near middle of outer face. Labrum strongly transverse, more or less rectangular, glabrous and with basal margin usually somewhat indistinct. *Pronotum* much broader at base, with hind angles strongly produced, and front margin strongly rounded; scattered long, fine, pale setae present especially along lateral margins. *Mesonotum* glabrous, but a pair of short setae present on scutellum, which is triangular and rather depressed. *Metanotum* usually with two short setae. Elytra and wings extending to fourth abdominal segment. *Abdomen* with tergites one to six each with a row of six to ten widely separated short setae, the outer pair being the longest. Seventh and eighth tergites each with a row of much larger setae. Ninth tergite very short, with sides converging posteriorly, glabrous and terminating in a pair of horizontal, very slender, excurved urogomphi, which are strongly sclerotised for apical third. Sternites three to eight almost glabrous. Ninth tergite with about six fine setae on each lateral margin. Tenth sternite glabrous (the paired tubercles, present only in the female, each bearing a dome-shaped process). Pleura strongly protuberant each bearing two pairs of long fine setae. *Legs* with a row of long fine setae on outer face of each femur near apex; hind tibiae each with paired apical spurs; tarsi slightly shorter than tibiae and each bearing a single seta near apex; hind femora extending almost to sixth abdominal segment. *Functional spiracles* present on first five abdominal segments; peritreme annular, moderately thick and raised above general level of cuticle.

Host plants: *Crataegus*, *Hedera*, *Hibiscus syriacus*, *Populus*, *Ilex*, *Pyrus malus*, *Aesculus*, *Prunus cerasus*, *Fraxinus*, *Ulmus*, *Quercus*, *Pyrus aucuparia*, *Salix*, *Acer pseudoplatanus*, *Prunus spinosa*, *Corylus*, *Sambucus nigra*, *Rhamnus* (Duffy, 1945a, 1945c; Kaufmann, 1948; Perris, 1847; Xambeu, 1898–1902). Larvae of this species are extremely polyphagous, although there appear to be no records from Coniferae.

*Biology.* Oviposition occurs on slender, recently dead, or slightly decaying twigs and branches. The larva feeds subcortically, superficially grazing the cambium and outer sapwood, and reaches maturity within one year. The pupal cell, which is subcortical, consists of a shallow excavation, usually in the outer sapwood but sometimes in the inner wall of the bark or both. Larvae pupate during March and April, and adults emerge from April to June.

*Natural enemies.* Adults of this species are accepted by the Arachnid *Amaurobius atropos* Walck. (Bristowe, 1941).

*Material studied.* 6 L, 2 P, Surrey, Effingham, 22.iv.1946, D. leg., in coll. D.; 18 L, Surrey, Ashted, 14.x.1945, in dead *Crataegus*, D. leg., in coll. D.; 2 P, Surrey, Box Hill, 23.iv.1946, from *Aesculus*, D. leg., in coll. D.; 6 L, 2 P, 1 I, Surrey, Effingham,

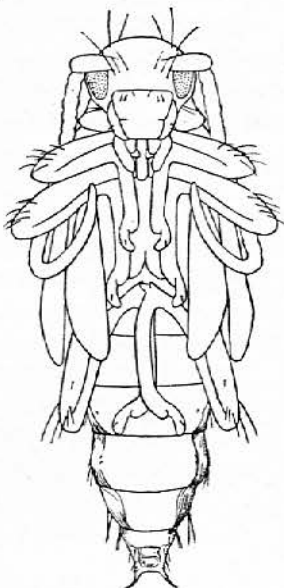


Fig. 76.  
*Grammoptera ruficornis* (Fabricius). Male pupa. Ventral view.

22.iv.1946, D. leg., in coll. D.; 26 L, 7 P, Surrey, Ashtead, iii.1948, in dead *Sambucus*, D. leg., in coll. D. [Adults reared.]

*References.* Bristowe, 1941 (Paras.); Duffy, 1945a (Biol.), 1946c (Biol.); Emden, 1939-1940 (L); Kaltenbach, 1874 (Biol.); Kaufmann, 1948 (Biol.); Perris, 1847 (L fig., Biol.); Reineck, 1919 (Biol.); Xamheu, 1898-1902 (L, P, Biol.).

#### ***Grammoptera variegata* (Germar)**

*Mature larva.* Extremely similar to that of *G. ruficornis*, from which it may be distinguished as follows. Form slightly more robust; breadth (at prothorax) 2.5 mm. Head slightly less depressed and more strongly sclerotised. Ocelli with lens less distinct and pigmented spot indistinct, deep beneath cuticle. Maxillary palpi with third segment less than twice as long as basal width.

Host plants: *Quercus* and *Castanea* (Duffy, 1946c; Perris, 1877; Xamheu, 1898-1902).

*Biology.* The larval habitat is in recently dead or decaying twigs and slender branches. The larvae feed subcortically until almost mature; they then bore into the sapwood to pupate. This takes place during March and April. The pupal cell is elongate, slightly curved and usually lies obliquely to the grain of the wood. Adults emerge from April to June.

*Material studied.* 2 L, Surrey, Bookham, 22.ii.1946, in fallen twigs of *Quercus*, D. leg., in coll. D.; 3 L, Surrey, Ashtead, i.1946, in rotten branch of *Quercus*, D. leg., in coll. D. [Adults reared.]

*References.* Duffy, 1946c (Biol.); Henriksen, 1914 (L); Perris, 1847 (L fig.), 1877 (Biol.); Xamheu, 1898-1902 (Biol.).

#### ***Grammoptera ustulata* (Schaller)**

*Mature larva.* This has been described by Perris (1877), but the description is not sufficiently detailed to permit of a comparison with that of *G. ruficornis*.

*Pupa.* The description by Perris (1877) is too vague to provide reliable specific characters.

Host plants: *Quercus*, *Castanea* (Perris, 1877).

*Biology.* Similar to that of *G. ruficornis*.

*Material studied.* None available.

*References.* Della Beffa, 1931 (L, Biol.); Henriksen, 1914 (L fig.); Houlbert & Monnot, 1908 (L fig.); Perris, 1877 (L fig., P, Biol.); Xamheu, 1898-1902 (L, P, Biol.).

#### ***Grammoptera holomelina* Pool**

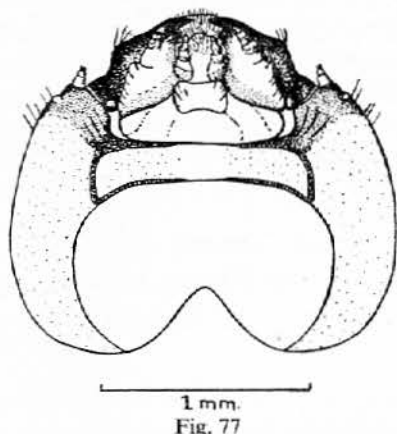
No material or references are available. There is some controversy as to whether or not this species is distinct from *G. ruficornis* (see Duffy, 1952).

#### ***Alosterna tabacicola* (Degeer)**

*Mature larva* (figs. 77, 78). Rather similar to those of *Grammoptera* species, from which it differs as follows. Head (fig. 77) only moderately depressed. Hypostoma

much shorter and more strongly transverse; more than four times as wide as long, with sutures parallel in posterior half. One pair of ocelli present; lens large and pigmented spot distinct. Antenna (fig. 78) similar to that of *Grammoptera* species. *Abdomen* with ampullae present only on segments one to six.

*Pupa*. Similar to those of *Grammoptera* species, from which it differs as follows. Length 6-9.5 mm.; maximum breadth 2.25 mm. *Head* with setae on clypeus and mandibles nearly as long as those on vertex. *Pronotum* with front margin only slightly



1 mm.

Fig. 77



0.05 mm.

Fig. 78

Fig. 77. *Alosterna tabacicolor* (Degeer). Mature larva. Head. Ventral aspect.

Fig. 78. *Alosterna tabacicolor* (Degeer). Mature larva. Apical part of antenna.

rounded and nearly as broad as hind margin. *Metanotum* with eight to twelve long fine setae and scutellar groove very distinct. *Abdomen* with tergites each bearing a row of long fine setae. Ninth tergite terminating in a pair of short, stout urogomphi. *Legs* with tarsi as long as or longer than tibiae; hind femora extending to fourth abdominal segment.

*Egg*. Length 0.9 mm.; breadth 0.2 mm. Form elongate, cylindrical, with poles evenly rounded. Chorion milky white, dull, smooth.

Host plants: *Acer campestre* (Reineck, 1919). The present writer has found larvae and pupae in stumps of *Pinus*, *Quercus* and *Corylus*.

*Biology*. Eggs are laid usually in old rotten stumps, especially those in damp, shady situations. The incubation period is about fifteen days. The larvae make irregular galleries, often deep in the sapwood, later pupating in the outer sapwood. The pupal cell is similar to those of *Grammoptera* species. Pupation occurs from March to May, and emergence from April to June.

*Material studied*. 5 L, Surrey, Bookham, 24.ii.1946, in stump of *Corylus*, D. leg., in coll. D.; 12 P, Surrey, Effingham, v.1948, in *Quercus*, R. C. H. Sweeney leg., in coll. D. [Adults reared.]

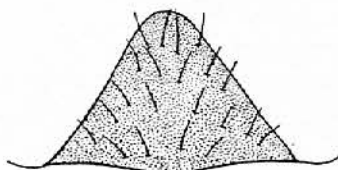
*References*. Emden, 1939-1940 (L); Henriksen, 1914 (L); Reineck, 1919 (Biol.); Xamheu, 1898-1902 (E, Biol.).

### Larval Characters of the genera *Leptura* and *Strangalia*

*Head* not depressed, and widest about middle. Mandible rather short, triangular in lateral view, with dorsal angle of cutting edge toothed or flattened into a striated plate, and cutting edge obliquely truncate. Labrum transverse. One, two, or three pairs of indistinct ocelli present. Antenna very small, but distinctly three-segmented; second segment bearing a conical, hyaline, supplementary process. Hypostoma moderately to strongly transverse, about two and one-half to four times as wide as median length; edge broadly curved. Gula indistinct (except in North American species). Labial palpi usually separated by about their own width, but sometimes more. *Thorax* with proeusternum, mesonotum, metanotum and sterna dull, pubescent, glabrous or tuberculate. *Abdomen* with ampullae with well-defined tubercles arranged in transverse rows. *Legs* rather slender; tibiotarsus not or hardly longer than femur; unguiculus usually slender, attenuate.

#### *Strangalia quadrifasciata* (Linnaeus)

*Mature larva* (figs. 79, 80). Length up to 24 mm.; breadth (at prothorax) 5.5 mm. Form subcylindrical, moderately robust and very slightly tapering. *Head* appreciably



2 mm.

Fig. 79



2 mm.

Fig. 80

Fig. 79. *Strangalia quadrifasciata* (Linnaeus). Mature larva. Proeusternum.

Fig. 80. *Strangalia quadrifasciata* (Linnaeus). Mature larva. First dorsal ampulla.

narrower than prothorax; rather thick, robust, moderately transverse (maximum head-width 4.25 mm.); temples rugose and ferruginous behind ocellus and genae with a deep, transverse furrow immediately in front of ocellus. Six epistomal setae present. Antenna with third segment subquadrate, moderately sclerotised and bearing a few stout setae; second segment with supplementary process short, stoutly conical, and as long as third. Mandible with cutting edge without an oblique, striated plate but with at least four setae on outer face near base. Labrum with numerous setae along front margin and a row of longer setae across middle. One pair of ocelli present; lens large and rather protuberant towards sides; pigmented spot indistinct. Hypostoma about four times as wide as median length; bearing numerous fine setae; sutures slightly curved; anterior margin ferruginous. Gula narrow; sutures slightly raised. Maxilla with sides of palpal segments not strongly rounded or constricted basally; third segment shorter than second, quadrate; lobe with numerous long setae. Labial palpi separated by slightly more than their own width. *Prothorax* scarcely

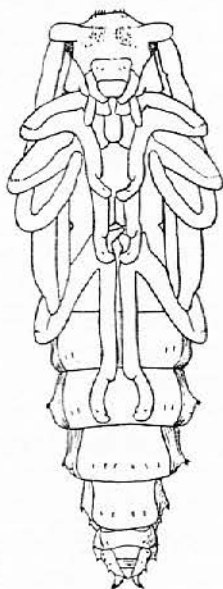


Fig. 81

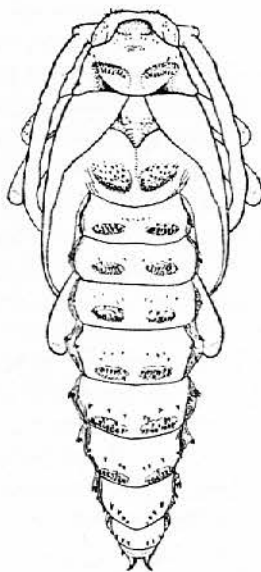


Fig. 82

Fig. 81. *Strangalia quadrifasciata* (Linnaeus). Male pupa. Ventral aspect.

Fig. 82. *Strangalia quadrifasciata* (Linnaeus). Female pupa. Dorsal aspect.

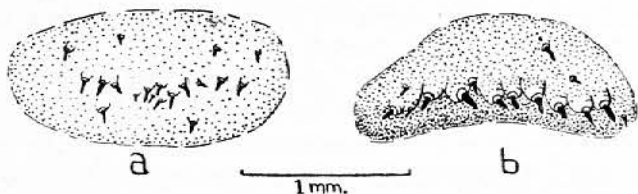


Fig. 83. (a) *Strangalia quadrifasciata* (Linnaeus) and (b) *Strangalia aurulenta* (Fabricius). Pupae. Right halves of third abdominal tergites.

depressed, about twice as wide as long; dorsally sclerotised, testaceous and with a very pale, ferruginous band across front margin; lateral grooves distinct only for basal third; anterior part of pronotum transversely rugose, posterior part vermiculate-rugose. *Proeusternum* (fig. 79), *mesonotum*, *metanotum* and *sterna* dull, velvety spiculate. *Abdomen* with ampullae present on tergites one to six and sternites one to seven (the seventh being very much smaller); each dorsal ampulla (fig. 80) with two deep, transverse furrows, and four transverse rows of bead-like tubercles.

*Pupa* (figs. 81-83). Length 13-35 mm.; maximum breadth 6.5 mm. *Head* elongate, triangular, very faintly rugose; vertex visible from above, with a group of at least six short stout setae on a protuberance above base of each antenna; front with numerous

similar setae opposite base of each antenna and with a deep transverse impression above; clypeus with a transverse row of four to six setae. Antennae extending as far as second abdominal segment where they are strongly curved downward to terminate near apex of mid tibiae. Eyes large, convex and bearing a few small setae. Mandible with two small setae near middle of outer face. Labrum strongly transverse, more or less rectangular, usually glabrous, but occasionally with a few minute setae. *Pronotum* quadrate, broadest at base and with hind angles acute and slightly produced; front margin with a raised, tubercular protuberance bearing small scattered setae; basal half with two oblique, elongate, tuberculate areas, each bearing a row of long stout setae; disc with several much smaller setae. *Mesonotum* with two groups of short stout setae. *Metanotum* with two oval tuberculate areas, each bearing numerous short stout setae. Elytra and wings extending to fourth abdominal segment. *Abdomen* (fig. 83) with tergites one to six each equipped with paired transverse, oval protuberances (each bearing a row of closely set papillae which bear stout apical setae); seventh and eighth tergites elongate, with scattered stout setae on posterior half. Ninth tergite short, with sides converging posteriorly; bearing a few scattered short setae, and terminating in a pair of horizontal, excurved urogomphi, which are strongly sclerotised in their apical third. Sternites three to seven each with a transverse group (interrupted medially) of minute setae. Eighth sternite with two to four setae. Ninth sternite with about six stout setae on each lateral margin. Tenth sternite glabrous (the paired tubercles, present only in the female, are each produced into an acute, conical process). Pleura strongly protuberant, each with a pair of short stout setae. *Legs* with a row of minute setae at apex of outer face of each femur; hind tibiae each with large paired apical spurs; tarsi longer than tibiae, each with a single seta near apex; hind femora extending to fourth abdominal segment. *Functional spiracles* present on first five abdominal segments; peritreme broadly oval, very thick, but scarcely raised above general level of cuticle.

*Egg.* Length 2.05 mm.; breadth 1.75 mm. Form elongate, cylindrical. Chorion thick, leathery, buff and rather coarsely reticulated.

*Host plants:* *Quercus*, *Alnus*, *Populus canadensis*, *Betula*, *Fagus*, *Salix*, *Picea* (Duffy, 1945a, 1946c; Kawall, 1867; Nördlinger, 1848; Reineck, 1919; Xambeu, 1898-1902).

*Biology.* The larval habitat is in dead or decaying wood, especially stumps in rather damp situations. The larvae usually feed deep in the sapwood, in which they make meandering galleries, which are tightly packed with fibrous shavings. Pupation takes place during April and May in the outer sapwood, the pupal cell being elongate oval and parallel to the grain of the wood. Emergence occurs from May to July.

*Parasites.* Hymenoptera: *Helcon ruspator* L. (Xambeu, 1898-1902).

*Material studied.* 4 L, Surrey, Ash Green, 5.xi.1942, in stump of *Quercus*, D. leg., in coll. D.; 9 L, Surrey, Mytchett, 28.ii.1945, in stump of *Alnus*, A. W. McKenny Hughes leg., in coll. D. [Adults reared.]

*References.* Aue, 1925 (Biol.); Duffy, 1945a (Biol.), 1946c (Biol.); Emden, 1939-1940 (L); Henriksen, 1914 (L fig.); Kaltenbach, 1874 (Biol.); Kawall, 1867 (Biol.); Kolbe, 1896 (Biol.); Nördlinger, 1848 (Biol.); Reineck, 1919 (Biol.); Rudow, 1912 (Biol.); Schiödte, 1876 (L, P); Xambeu, 1898-1902 (L, Biol.).

*Strangalia maculata* (Poda)

*Mature larva* (figs. 84, 85). Similar to that of preceding species, from which it differs as follows. *Head* with ocellar lens not protuberant towards side. Third segment of antenna elongate; supplementary process of second segment shorter than third segment (fig. 84). *Hypostoma* moderately transverse, about three times as wide as median length. *Labial palpi* separated by about their own width. *Prothorax* with



Fig. 84

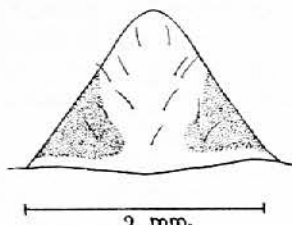


Fig. 85

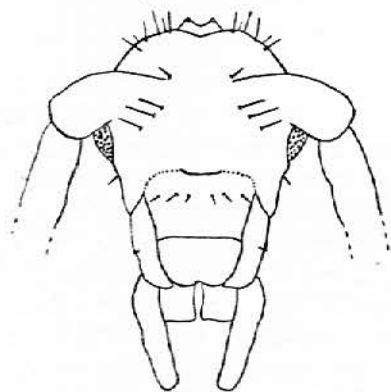


Fig. 86

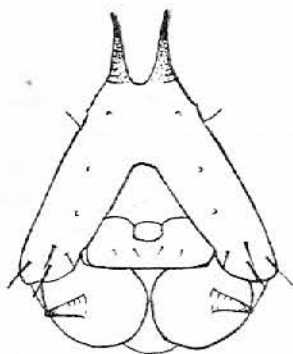


Fig. 87

Fig. 84. *Strangalia maculata* (Poda). Mature larva. Apical part of antenna. Ventral aspect.

Fig. 85. *Strangalia maculata* (Poda). Mature larva. Proeusternum.

Fig. 86. *Strangalia maculata* (Poda). Pupa. Head. Ventral aspect.

Fig. 87. *Strangalia maculata* (Poda). Female pupa. Ninth and tenth abdominal segments showing urogomphi. Caudal aspect.

eusternum smooth and shining (at least in middle) and with a conspicuous triangular, velvety-spiculate or pubescent area near each basal angle (fig. 85). *Abdomen* with ampullae present on tergites one to seven.

*Pupa* (figs. 86, 87). Similar to that of preceding species, from which it differs as follows. Length 11–18 mm.; maximum breadth 7 mm. *Head* (fig. 86) with a bifurcated, tuberculate process on vertex immediately in front of anterior margin of pronotum; setae on vertex of head long and slender (about two-thirds length of mandible); front with only four long setae opposite base of each antenna. *Pronotum* with front margin without a raised tuberculate process and with at least median part fringed with long slender setae; basal half with tuberculate areas less protuberant and

with setae long and slender. *Metanotum* with two small groups of very short fine setae. *Abdomen* (fig. 87) with ninth tergite very short and with urogomphi slender, vertical and excurred. Pleura bearing long slender paired setae. *Legs* with setae near apex of each femur slender.

Host plants: *Betula*, *Quercus*, *Salix*, *Fagus*, *Fraxinus*, *Populus tremula*, *Carpinus* (Duffy, 1945a; Kaufmann, 1948; Reineck, 1919; Xamheu, 1898-1902). The present writer has recently found larvae in *Corylus*, *Pinus* and *Castanea* on several occasions. Bargagli (1882) records the discovery of a larva which was feeding in a pine-cone, in which it was successfully reared.

*Biology*. Similar to that of *S. quadifasciata*.

*Material studied*. 3 L, Hants, Crookham, 17.v.1944, in rotten branch of *Quercus*, D. leg., in coll. D.; 7 L, 2 P, Surrey, Ashted, v.1948, in stump of *Betula*, D. leg., in coll. D. [Adults reared.]

*References*. Bargagli, 1882 (Biol.); Duffy, 1945a (Biol.); Emden, 1939-1940 (L); Kaufmann, 1948 (Biol.); Reineck, 1919 (Biol.); Saalas, 1923 (Biol.); Westwood, 1839 (L fig.); Xamheu, 1898-1902 (L, Biol.).

#### *Strangalia aurulenta* (Fabricius)

*Mature larva*. Similar to that of *S. quadrifasciata*, from which it differs as follows. *Head* with genae with a deep transverse furrow immediately in front of ocellus. Hypostoma very strongly transverse, more than four times as wide as median length. Gular sutures slightly raised. Antenna as in *S. maculata*. Labial palpi separated by about their own width. *Prothorax* with eusternum entirely covered with very short pubescence. *Abdomen* with ampullae present on segments one to seven.

*Pupa* (fig. 83). Extremely similar to that of *S. quadrifasciata*, from which it differs as follows. Length 14-22 mm.; maximum breadth 7.5 mm. *Abdomen* with setae on tergites stouter and more closely set on larger papillae (fig. 83). Eighth sternite completely glabrous. *Spiracles* with peritreme more strongly sclerotised and protuberant.

Host plants: *Quercus*, *Alnus*, *Fagus*, *Salix*, *Betula*, *Populus tremula*, *Prunus cerasus*, *Ulmus*, *Aesculus*, *Castanea* and *Juglans* (Kaufmann, 1948; Mendizabal, 1943; Perris, 1840; Xamheu, 1898-1902).

*Biology*. Similar to that of *S. quadrifasciata*.

*Parasites*. Hymenoptera: *Histeromerus mystacinus* Wesmael (Donisthorpe, 1929).

*Material studied*. 11 L, 5 P, France, Aisne, Forêt de Villers-Cotterets, 26.vi.1904, in dead *Fagus*, in coll. M.H.P.

*References*. Donisthorpe, 1929 (Paras.); Kaufmann, 1948 (Biol.); Mendizabal, 1943 (Biol.); Perris, 1840 (L fig., Biol.); Perris, 1877 (L, Biol.); Xamheu, 1898-1902 (L, P, Biol.).

#### *Strangalia melanura* (Linnaeus)

*Mature larva* (fig. 88). Similar to that of *S. quadrifasciata*, from which it may be distinguished as follows. Length up to 16 mm.; breadth (at prothorax) 3.25 mm. Form more slender, and tapering posteriorly. *Head* with temples pale behind ocellus (maximum head-width 2.75 mm.). Ocellus with lens very strongly protuberant

anteriorly and slightly compressed; pigmented spot very distinct and granular. Hypostoma about three times as wide as median length. *Prothorax* with band across anterior margin pale testaceous. Eusternum finely reticulate, with a few scattered setae (fig. 88). *Abdomen* with ampullae present on tergites one to six and sternites one to seven, the seventh being greatly reduced.

*Pupa* (fig. 89). Similar to that of *S. quadrifasciata*, from which it differs as follows. Length 6-9.25 mm.; maximum breadth 3.5 mm. *Head* with vertex bearing a pair of long, stout setae above base of each antenna; front with five similar setae opposite

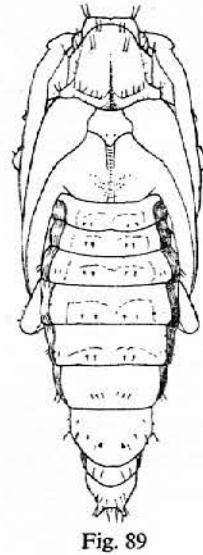
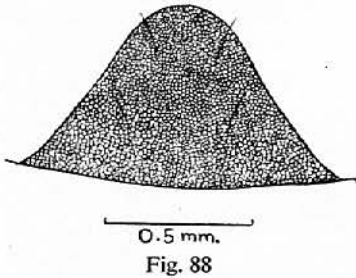


Fig. 88. *Strangalia melanura* (Linnaeus). Mature larva. Proeusternum.

Fig. 89. *Strangalia melanura* (Linnaeus). Female pupa. Dorsal aspect.

base of each antenna. Mandible with a single stout seta near middle of outer face. *Pronotum* with hind angles more strongly produced; basal half with a deep longitudinal impression; front and lateral margins bearing numerous long setae; hind margin with a transverse row (interrupted medially) of long, stout setae; disc glabrous. *Mesonotum* with four short, stout setae. *Metanotum* flat, with a few minute setae. *Abdomen* with tergites one to seven almost flat and equipped with paired groups of two or three stout setae. Eighth tergite short and with about six long, fine setae. Ninth tergite short and fringed with numerous long setae. Urogomphi excurved, short, stout and testaceous. Sternites three to seven with a posterior row of long, fine setae. Eighth sternite with a pair of very long setae. Pleura with long, slender, paired setae. *Legs* with one stout seta, and sometimes two or three smaller setae near apex of each femur.

*Egg*. Xamheu (1896) gives the following description: "L. 1.2 mm.; diam. 0.1-2 mm. Allongé, fusiforme, blanchâtre, luisant, finement pointillé, très atténué aux deux pôles qui sont arrondis."

Host plants: *Cytisus*, *Quercus* (Mulsant, 1864; Xamheu, 1896). The present writer as found larvae in *Acer pseudoplatanus*.

*Biology.* Oviposition occurs on very rotten, fallen, slender branches. Xambeu (1896) stipulates "underground roots" of *Cytisus*. In other respects the biology appears to be very similar to that of *S. quadrifasciata*.

*Material studied.* 4 L, Surrey, Box Hill, 6.viii.1941, K. G. Blair leg., in coll. B.M.; 8 L, Surrey, Oxted, 12.x.1945, in dead branch of *Acer pseudoplatanus*, D. leg., in coll. D. [Adults reared.]

*References.* Mulsant, 1862 (Biol.); Mulsant, 1864 (Biol.); Xambeu, 1896 (L, P, Biol.); Xambeu, 1899 (E, Biol.).

#### ***Strangalia revestita* (Linnaeus)**

*Mature larva.* No material available.

Host plant: *Prunus avium* (Mendizabal, 1943).

*References.* Mendizabal, 1943 (Biol.).

#### ***Strangalia nigra* (Linnaeus)**

No material or references available.

#### **\**Strangalia attenuata* (Linnaeus)**

[Very rarely in imported timber.]

*Mature larva.* No material available. The larval description by Perris (1877) is too superficial to be of any value.

Host plant: *Aesculus* (Perris, 1877).

*References.* Perris, 1877 (L fig.); Xambeu, 1896 (L).

#### ***Leptura scutellata* Fabricius**

*Mature larva* (fig. 90). Similar to that of *S. quadrifasciata*, from which it differs as follows. *Head* with genae with a deep transverse furrow immediately in front of ocellus. Antenna as in *S. maculata*. Labrum with a semicircular transverse impression behind front margin, which is densely setose (fig. 90). Hypostoma with anterior margin pitchy. Labial palpi separated by about twice their width. *Prothorax* with eusternum without spicules or pubescence, but surface coarsely rugose and bearing a few scattered setae. *Abdomen* with ampullae present on segments one to seven.

*Pupa* (figs. 91, 92). Similar to those of *Strangalia* species, from which it differs as follows. Length 14-19 mm.; maximum breadth 6.5 mm. *Head* with vertex bearing a group of three to five long, stout setae above each eye; front with about nine to eleven long, stout setae opposite base of each antenna and with a deep transverse impression above. Antennae extending as far as first or second abdominal segment, where they are recurved to terminate near middle of hind tibiae or apex of mid tibiae. Eyes with a single large seta on upper margin. Labrum glabrous; base with a deep transverse impression. *Pronotum* (fig. 91) quadrate to very slightly elongate, with hind angles almost right-angled; front margin with a pair of paramedian protuberances, each bearing four to six short, stout setae; hind margin with a transverse row (interrupted medially) of stout setae; remainder of pronotum with widely scattered

setae. Abdomen with tergites one to six each bearing paired oval papillate protuberances. Seventh tergum elongate, with a transverse row of shorter setae near hind margin. Eighth tergum similar but shorter. Ninth tergum short, with sides converging posteriorly, practically glabrous and terminating in a pair of slender, excurved urogomphi, which are directed downward. Sternites three to seven sometimes with minute setae. Eighth sternite glabrous. Ninth sternite (fig. 92) with three or four pairs of short setae. *Legs* with a row of small setae (above which are a few finer setae) on outer face of each femur; tarsi as long as tibiae. *Functional spiracles* with peritreme very broadly oval, thin and slightly raised above general level of cuticle.

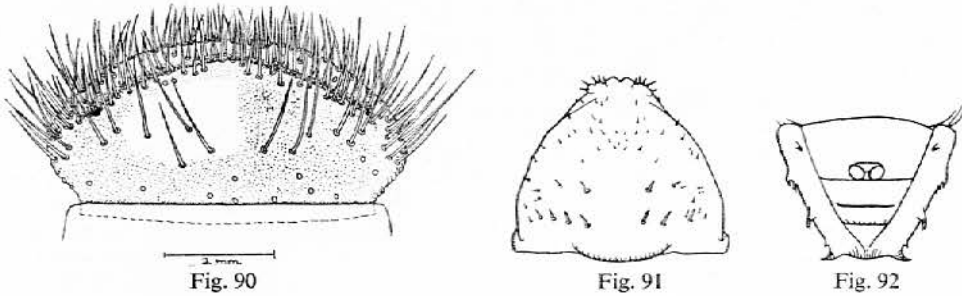


Fig. 90. *Leptura scutellata* Fabricius. Mature larva. Labrum. Dorsal aspect.

Fig. 91. *Leptura scutellata* Fabricius. Pupa. Pronotum.

Fig. 92. *Leptura scutellata* Fabricius. Male pupa. Ninth and tenth sternites.

Host plants: *Carpinus*, *Fagus*, *Betula* (Bond, 1833b; Reineck, 1919; Xamheu, 1898–1902). Also recently taken in *Quercus* (Forster).

*Biology*. Similar to that of *S. quadrifasciata*.

*Parasites*. Hymenoptera: *Histeromerus mystacinus* Wesmael (Donisthorpe, 1929).

*Material studied*. 8 L, Essex, Epping Forest, 3.v.1947, from a dead standing bole of *Carpinus*, H. W. Forster leg., in coll. D.; 2 L, Berks., Windsor Forest, from *Betula*, H. Donisthorpe leg., in coll. B.M.; 1 P, Denmark, Dyrehavn, Schiödte leg., in coll. U.Z.M.C. [Adults reared.]

*References*. Barbey, 1913 (Biol. fig.); Bond, 1833b (Biol.), 1838 (L, P, Biol); Donisthorpe, 1929 (Paras.); Emden, 1939–1940 (L); Kaltenbach, 1874 (Biol.); Reineck, 1919 (Biol.); Schiödte, 1876 (P); Xamheu, 1898–1902 (L, P, Biol.).

### ***Leptura rubra* (Linnaeus)**

*Mature larva* (figs. 93, 94). Similar to that of *S. quadrifasciata*, from which it differs as follows. Length up to 33 mm.; maximum breadth (at prothorax) 6.5 mm. *Head* with genae with a shallow but conspicuous transverse furrow in front of ocellus. Mouthframe pithy. Antenna with third segment elongate; second segment strongly transverse; supplementary process slightly shorter than third segment. Mandible with cutting edge with an oblique, dull, striated plate (fig. 93). Ocellus with lens rather protuberant anteriorly. Hypostoma (fig. 94) about three times as broad as median length; anterior margin pithy. Gula (fig. 94) broad, with sutures slightly raised. Maxillary palpi with third segment shorter than second, elongate. *Prothorax* with

eusternum microscopically reticulate, smooth and shining in middle, and with a triangular, though rather inconspicuous, pubescent or spiculate area near each basal angle as in *S. maculata*. *Abdomen* with ampullae present on segments one to seven.

*Pupa* (figs. 95, 94). Similar to that of *L. scutellata*, but rather more robust. Length 12–21 mm.; maximum breadth 7.25 mm. *Head* with vertex bearing two short setae above each eye; front with only three setae opposite base of each antenna. *Pronotum* (fig. 95) with front margin glabrous and without paired protuberances. *Abdomen* (fig. 96) with ninth tergite bearing very small urogomphi, which are scarcely

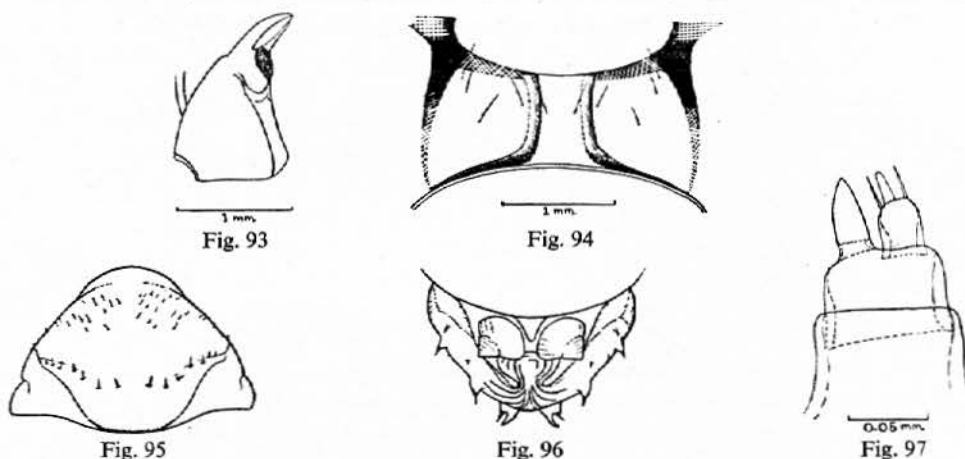


Fig. 93. *Leptura rubra* (Linnaeus). Mature larva. Left mandible. Dorsal aspect.

Fig. 94. *Leptura rubra* (Linnaeus). Mature larva. Hypostoma and gula.

Fig. 95. *Leptura rubra* (Linnaeus). Pupa. Pronotum.

Fig. 96. *Leptura rubra* (Linnaeus). Female pupa. Ninth and tenth sternites.

Fig. 97. *Leptura sanguinolenta* Linnaeus. Mature larva. Apical part of antenna. Lateral aspect.

distinguishable from the remaining spines along the hind margin. Sternites three to eight glabrous. *Tarsi* with subapical setae minute.

*Egg*. Length 1.5 mm.; breadth 0.3 mm. Elongate, fusiform, rounded at both ends, one end being slightly more attenuated than the other. Chorion milky white and very finely reticulated (Xambeu, 1899).

*Host plants*: *Larix*, *Picea*, *Pinus* (Meissner, 1908; Reineck, 1919; Trappen, 1908; Xambeu, 1898–1902); *Abies numidica* (Peyerimhoff, 1917).

*Biology*. Similar to that of *S. quadrifasciata*.

*Economic importance*. Eckstein (1936) discusses the damage to telegraph poles by this species.

*Material studied*. 12 L, Germany, nr. Berlin, K. Eckstein leg., in coll. B.M.; 2 L, 2 P, Germany, in coll. D.

*References*. Eckstein, 1936 (Biol. fig.); Emden, 1939–1940 (L fig.); Henriksen, 1914 (L); Hintz, 1927 (Physiol.); Mell, 1907 (Biol.); Meissner, 1908 (Biol.); Nördlinger, 1880 (Biol.); Perris, 1856 (L); Peyerimhoff, 1917 (Biol.); Reineck, 1919 (Biol.); Saalas, 1923 (Biol.); Schiödt, 1876 (L fig., P); Trägårdh, 1939 (Biol. fig.); Trappen, 1908 (Biol.); Xambeu, 1898–1902 (L, P, Biol.), 1899 (E).

**Leptura sanguinolenta** Linnaeus

*Mature larva* (fig. 97). Similar to that of *S. quadrifasciata*, from which it differs as follows. *Head* with genae with a deep, transverse furrow immediately in front of ocellus; sclerotisation of gena not surrounding ocellus behind. Antenna (fig. 97) with third segment elongate, second segment strongly transverse, with supplementary process much longer than third segment. Mandible with an oblique, dull, sculptured plate. Labial palpi distant by their own width. Maxillary palpi with third segment elongate, tapering, and as long as second. Gular sutures distinctly raised. Hypostoma about three times as wide as median length; anterior margin pithy. *Prothorax* with pronotum coarsely rugose. Eusternum smooth, sparsely setose, without velvety pubescence, but micro-reticulate. *Metanotum* with a few tubercles near middle. *Abdomen* with ampullae on segments one to seven.

*Pupa*. No material available. It has been described by Schiödte (1876) and Xambeu (1898-1902).

Host plants: *Pinus* and *Abies* (Saalas and 1923; Xambeu, 1898-1902).

*Biology*. The eggs are laid in stumps and boles, usually below ground-level. Young dead pines, especially those of which the bark has been charred by fire, are particularly susceptible to infestation. In other respects the biology is similar to that of *S. quadrifasciata*.

*Predators*. Diptera: *Dasyopogon diadema* F. (Xambeu, 1898-1902).

*Material studied*. 2 L, Finland, Sammatti, Junninsuo, 8.vi.1912, from *Pinus*, U. Saalas leg., in coll. U.Z.M.C.

*References*. Emden, 1939-1940 (L?); Henriksen, 1914 (L); Reineck, 1919 (Biol.); Saalas, 1923 (Biol.); Schiödte, 1876 (L, P); Xambeu, 1898-1902 (L, P, Biol.), 1900 (Biol.).

**Leptura sexguttata** Fabricius

No material or references available.

**Leptura livida** Fabricius

No material or references available.

**Leptura fulva** Degeer

No material or references available.

**Judolia cerambyciformis** (Schrank)

*Mature larva* (figs. 98-100). Rather similar to those of *Strangalia* species, from which it differs as follows. Length up to 19 mm.; maximum breadth (at prothorax) 4 mm. *Head* with antenna (fig. 98) with third segment cylindrical, elongate (at least twice as long as basal diameter); second segment with supplementary process conical, elongate, extending at least as far as apex of third segment. Mandible without an oblique striated plate on cutting edge. Ocellus with lens slightly protuberant anteriorly; pigmented spot rather indistinct. Hypostoma about four and one-half times as wide as median length; sutures almost straight; anterior margin ferruginous. Gular sutures

very slightly raised. Maxillary palpi with third segment elongate, slightly longer than second. Labial palpi separated by slightly more than their width. *Prothorax* with eusternum very feebly rugose, reticulate, shining and with a few scattered setae; never spiculate or pubescent. *Abdomen* with ampullae on segments one to seven, the seventh being very small, feebly tuberculate, but distinctly spiculate. *Legs* with unguiculus (fig. 99) very long and slender; ventral margin concave for about apical two-thirds;

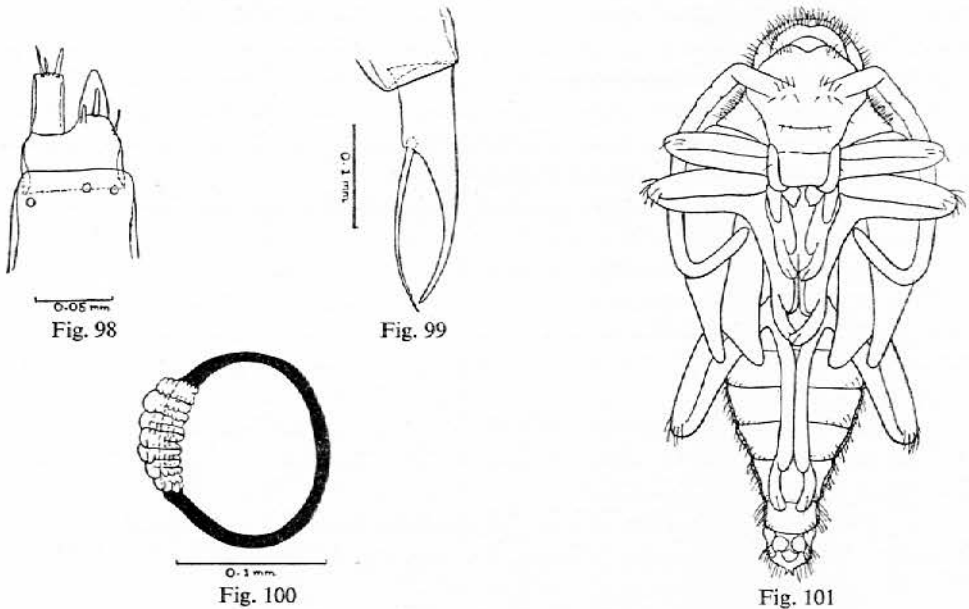


Fig. 98. *Judolia cerambyciformis* (Schrank). Mature larva. Apical part of antenna. Lateral aspect.

Fig. 99. *Judolia cerambyciformis* (Schrank). Mature larva. Apical part of mesothoracic right leg. Lateral aspect.

Fig. 100. *Judolia cerambyciformis* (Schrank). Mature larva. Peritreme of abdominal spiracle.

Fig. 101. *Judolia cerambyciformis* (Schrank). Female pupa. Ventral aspect.

basal third parallel-sided. *Spiracles* with marginal chambers forming a characteristic crescent (fig. 100).

*Pupa* (fig. 101). Rather similar to those of *Strangalia* species, but differs in the following respects. Length 7–12 mm.; maximum breadth 3.25 mm. *Head* with vertex bearing five or six pairs of short setae. *Pronotum* strongly bent downward so that it is almost at right angles to the meso- and metanotum; rather densely covered with scattered ferruginous setae. *Metanotum* with a pair of raised oval tuberculate areas, each bearing numerous setae. *Abdomen* with setae on all tergites long, pale and slender. Ninth sternite with short, stout urogomphi. *Legs* with hind femora very long, their apices being considerably higher than general dorsal level of body; hind tarsi long, extending as far as seventh abdominal segment.

Host plants: *Quercus*, *Betula* and *Castanea*. (There are no previous records.)

*Biology.* The larval habitat has recently been discovered by the writer to be in exposed roots of recently dead trees, especially those which have been blown over by the wind. The larvae seem to prefer the moister parts of the roots which have been protected from the sun by adhering soil. The larvae make longitudinal galleries, often for a foot or more along the root, which is sometimes completely hollowed as a consequence. When the roots are partly covered with earth, the larvae are apparently capable of moving from one root to another, as is the case with certain Prionine larvae. During April or May, by which time they are full grown, they leave the root and enter the soil to pupate. The earthen cocoon is usually several inches deep in the soil, alongside rotten roots. It is elongate-oval, about half an inch in length, and is lined internally with a shiny secretion. The cocoons are extremely fragile since they are generally constructed in light, dry soil. The adults are apparently capable of tunnelling for a foot or more to make their escape. Emergence takes place in May and June.

*Material studied.* 6 L, Kent, Sevenoaks, ix.1948, in exposed roots of dead *Betula*, D. leg., in coll. D.; 5 L, 2 P, Surrey, Effingham, v.1948, in exposed roots of dead *Quercus*, R. C. H. Sweeney and D. leg., in coll. D.; 2 L, Surrey, Effingham, 8.v.1949, in exposed roots of dead *Castanea*, D. M. Duffy and D. leg., in coll. D. [Adults reared.]

*References.* Xambeu, 1903 (E).

#### *Judolia sexmaculata* (Linnaeus)

*Mature larva.* From the inadequate material at hand, this larva would appear to be extremely similar to that of the preceding species, from which it may be distinguished as follows. *Head* with ocellus with pigmented spot very conspicuous, black and bead-like. *Legs* unusually long, each three to four times the length of maxillary palpi; femur at least twice as long as basal width; tibiotalarsus at least four times as long as basal width.

*Pupa.* No material or descriptions available.

*Host plants:* *Pinus* and *Abies*.

*Biology.* The larval habitat is probably in old exposed roots. In other respects the biology is probably similar to that of *J. cerambyciformis*, except that the adults emerge later, from June to August.

*Material studied.* 2 L (very old and dry), Inverness-shire, Nethy Bridge, 1908, D. Sharp leg., in coll. B.M.

*References.* None available.

#### \*Necydalini

##### \**Ulochaetes leoninus* Leconte

[Occasionally in imported timber from North America.]

*Mature larva* (fig. 102). Length up to 42 mm.; maximum breadth (at prothorax) 10.5 mm. Form robust, cylindrical. *Head* subcordate, widest just behind middle (maximum head-width 7.1 mm.); mouthframe pitchy; front margin of frons with a small pair of paramedian tubercles. Six epistomal setae present. Antenna three-segmented,

with a large fleshy basal membrane. Mandibles rugose basally, and with an oblique sulcus on apical dorsal face. Labrum transversely oval. Ocelli indiscernible. Hypostoma at least four times as wide as median length; gular sutures parallel, strongly protuberant. Maxillary lobe broad at apex, rather sparsely setose; third segment of maxillary palpi about equal in length to second, and conical. Labial palpi widely separated. *Prothorax* (fig. 102) with pronotum glabrous anteriorly and finely asperate posteriorly; front margin with a very distinct, transverse, ferruginous band; lateral grooves distinct for basal two-thirds. Proeusternum finely asperate and setose.

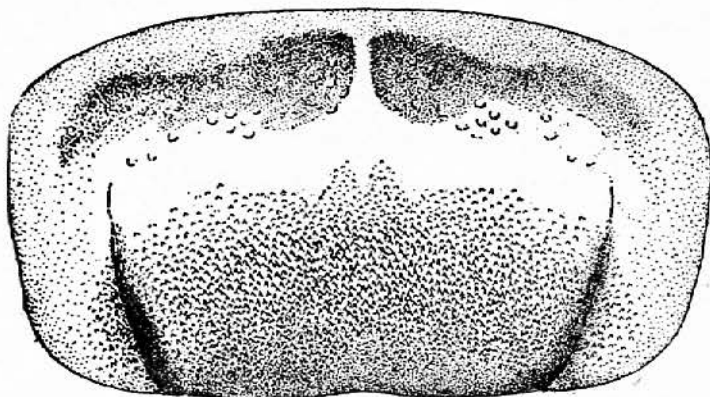


Fig. 102

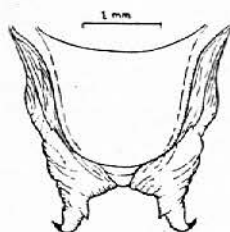


Fig. 103

Fig. 102. *Ulochaetes leoninus* Leconte. Mature larva. Pronotum. (Craighead, 1923b)

Fig. 103. *Ulochaetes leoninus* Leconte. Pupa. Eighth and ninth tergites.

*Mesonotum* and *metanotum* very finely asperate. *Abdomen* with dorsal ampullae non-tuberculate and finely asperate, each with two pairs of curved lateral sutures. *Legs* fleshy, five-segmented; tarsus stout, pitchy apically. *Spiracles* with peritreme broadly oval, with about fifteen marginal chambers.

It is only with difficulty that this larva can be retained in the LEPTURINAE, possessing as it does many affinities towards the ASEMINAE, such as the non-tuberculate, asperate ampullae, the asperate pronotum and the protuberant gular sutures.

*Pupa* (fig. 103). Similar to those of *Leptura* and *Strangalia* species, from which it differs as follows. Length up to 34 mm. *Head* with labrum quadrate to slightly elongate. *Pronotum* with hind angles rounded. *Abdomen* with spines on tergites bearing subapical setae. Ninth tergite with urogomphi very stout and strongly excurved (fig. 103). *Legs* with femora glabrous or with extremely fine setae; hind tarsi shorter than hind tibiae. Spurs of tibiae short; tarsi with a pair of minute setae. *Functional spiracles* present on abdominal segments one to seven.

The pupa of this species, although not at all typical of the LEPTURINAE, does not show any marked affinities towards those of the ASEMINAE as is the case in the larval stage.

Host plants: *Pseudotsuga*, *Pinus*, *Picea* (Craighead, 1923b; Kevan, 1945); *Abies grandis* (Hardy & Preece, 1926).

*Biology.* The larval galleries extend through the sapwood deep into the heartwood; they are tightly packed with fine shredded frass. Pupation occurs in May or June (Craighead, 1923b).

*Parasites.* Diptera: *Dasyliis astur* O.S. (Hardy & Preece, 1927).

*Material studied.* 2 L, 2 P, U.S.A., California, Placerville, 6.iii.1916, from *Pinus lambertiana*, F. B. Herbert leg., in coll. U.S.N.M.; 1 P, U.S.A., Oregon, Albee, 2.viii.1913, from *Pinus*, W. D. Edmonston leg., in coll. U.S.N.M.

*References.* Craighead, 1923b (L fig., P, Biol.); Hardy & Preece, 1926 (Biol.), 1927b (Biol.); Kevan, 1945 (Biol.).

#### 4. ASEMINAE

##### Larval Characters

Form subcylindrical, with caudal urogomphi. *Head* transverse, with posterior margin nearly straight or, at most, very slightly emarginate; dorsal margins of epicranial halves fused behind frons almost to base and rounded behind; tentorial cross-arm internal, in a plane at right angles to hypostoma (the occipital foramen thus not apparently divided); front margin of frons never projecting or carinate. Epistoma never produced over clypeus; at least ten epistomal setae present. Clypeus trapezoidal, as broad at base as epistoma. Labrum transverse, semicircular or subcordate. Mandibles wedge-shaped, with cutting edge oblique, broadly emarginate, and apex acutely produced; outer face bearing numerous setae. Ocelli present or absent. Antennae frail, short and very retractile; three-segmented (except *Nothorrhina muricata* Dalm.<sup>1</sup>); antennal ring distinctly open to frontal suture. Ventral mouthparts attached to hypostoma for nearly its entire breadth. Maxillae movable; cardo visible, maxillary articulating area swollen; palpifer bearing lobe and with outer margin straight. *Prothorax* with transverse and sublateral grooves very distinct; posterior region dull, microscopically asperate; eusternum distinct, triangular; presternum and epipleurum fused; coxal lobe small, opposite sternellum. *Abdomen* with ampullae dull, microscopically asperate (never tuberculate), and with two lateral impressions on each side; regions bearing spiracles distinctly defined, elliptical; epipleurum protuberant on segments seven, eight and nine only; ninth segment with a pair of very short urogomphi; pleural discs never present. *Legs* moderate in size and slender. *Spiracles* of mesothorax not protruding into prothorax; abdominal spiracles with two or more small marginal chambers.

##### *Arhopalus ferus* (Mulsant) (= *Criocephalus polonicus* Motschulsky)

*Mature larva* (figs. 104–110). Length up to 34 mm.; breadth (at prothorax) 9 mm. Form rather robust, slightly depressed anteriorly. *Head* (fig. 105) depressed, transverse (maximum head-width 6.6 mm.), widest behind middle, with sides moderately strongly rounded; smooth, orange-testaceous, shining, moderately strongly sclerotised. Genae testaceous, with rather dense, long, reddish setae, which are distributed beyond level of posterior end of frontal sutures. Frontal sutures distinct as pale lines, each extending to a gap in antennal ring; median adfrontal suture complete and very distinct.

<sup>1</sup> See Kemner, 1918b.

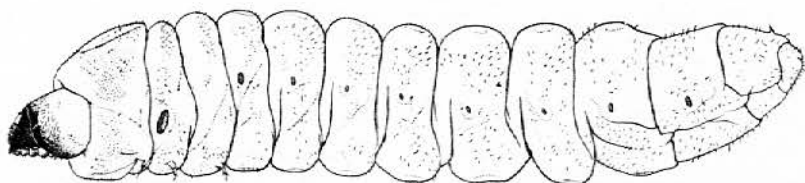
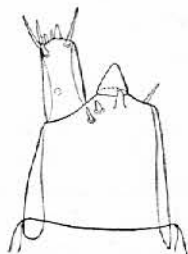
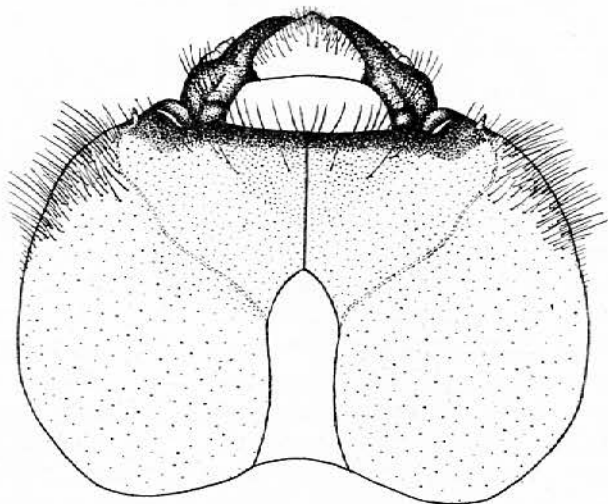


Fig. 104



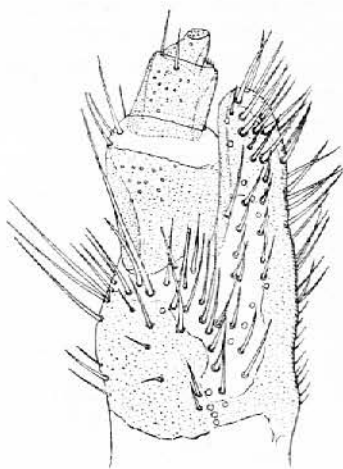
0.05 mm.

Fig. 106



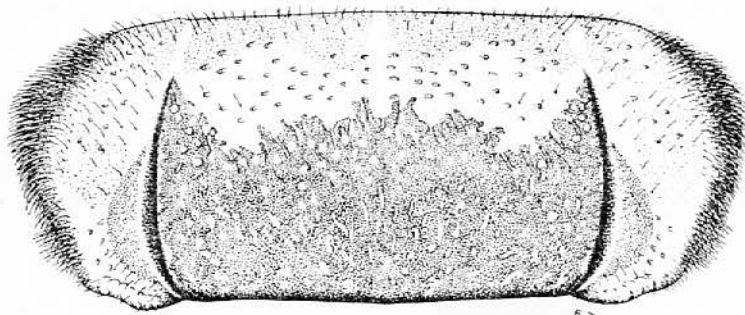
2 mm.

Fig. 105



0.20 mm.

Fig. 107



2 mm.

Fig. 108

- Fig. 104. *Arhopalus ferus* (Mulsant). Mature larva. Lateral aspect.  
 Fig. 105. *Arhopalus ferus* (Mulsant). Mature larva. Head. Dorsal aspect.  
 Fig. 106. *Arhopalus ferus* (Mulsant). Mature larva. Apical part of antenna. Lateral aspect.  
 Fig. 107. *Arhopalus ferus* (Mulsant). Mature larva. Apical part of right maxilla. Ventral aspect.  
 Fig. 108. *Arhopalus ferus* (Mulsant). Mature larva. Prothorax. Dorsal aspect.

Mouthframe strongly sclerotised, pitchy. Frons with front margin very slightly curved and roundly declivous; at least sixteen epistomal setae present. Antenna (fig. 106) with second segment bearing a conical supplementary process, which is as long as, or slightly longer than, its basal width; third segment very elongate. Mandible pitchy, shining, with a transverse group of numerous setae across basal half; inner part of dorsal surface with a large oblique plate. Labrum cordate, about as long as wide; ferruginous, with numerous short setae apically and with a few longer setae medially.

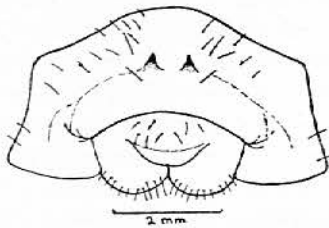


Fig. 109



Fig. 110

Fig. 109. *Arhopalus fesus* (Mulsant). Mature larva. Urogomphi and anal lobes. Caudal aspect.

Fig. 110. *Arhopalus fesus* (Mulsant). Mature larva. Apical part of mesothoracic right leg. Dorsal aspect.

Ocelli absent. Gula narrow, testaceous, with sutures not raised; hypostomal plates large, trapezoidal, ferruginous, with anterior margin thick and pitchy. Ventral mouthparts fleshy; apical segment of maxillary palpi about half as long as second, and as long as apical segment of labial palpi; lobe (fig. 107) slender, cylindrical, with setae as figured. *Prothorax* (fig. 108) depressed, trapezoidal, widest in front; lateral setae very dense and ferruginous. Pronotum sparsely setose, pale and shining anteriorly posteriorly orange yellow, finely asperate, with numerous interspaced glabrous spots. Eusternum and sternellum finely asperate and setose. *Abdomen* with ampullae on segments one to seven. Pleural tubercle broadly oval and bearing about five setae. Urogomphi (fig. 109) of ninth segment acutely conical, seldom separated by more than twice their basal diameter, usually less. *Legs* (fig. 110) distinct, three-segmented; unguiculus very long, attenuate and imbricately spinose. *Spiracles* of prothorax large, about twice as broad as those on first abdominal segment; obsolescent meta-thoracic spiracle visible; abdominal spiracles with peritreme broadly oval, and with at least six small contiguous chambers on posterior margin.

*Pupa* (fig. 111). Length 10–30 mm.; breadth 4.2–7.7 mm. *Head* bent beneath pronotum which almost conceals it from above; quadrate, with sides strongly rounded,

rugose, and with at most a few short pale spines and setae. Antennae transversely rugose, densely spiculate, and with four to six rather stout, ferruginous spines near apex of basal segment only; extending to just beyond middle of metathorax, where they are curved downward to terminate near the front coxae. Labrum triangular, transversely rugose and glabrous. Maxillary palpi spiculate and with a few fine pale setae. *Pronotum* very slightly transverse, with sides strongly rounded, and disc with two paramedian striated areas (often in the form of depressions); with scattered pale papillae of varying length. *Mesonotum* glabrous, or almost so; scutellum rather broad, fleshy and with a few fine setae. *Metanotum* with a papillate area on each side of scutellar groove, each papilla being equipped with a spine-like seta. Elytra and wings extending as far as fourth abdominal segment. *Abdomen* with tergites one to six each bearing four transverse groups of long straight spines near hind margin. Seventh tergite with a transverse group of scattered spines and eighth tergite with only a few spines. Ninth tergum rather short, glabrous, and terminating in a pair of urogomphi, which are widely separated, slender and strongly curved inward. Sternites with lateral groups of spines, except the last three, which are glabrous. *Legs* with several ferruginous spines near apex of each femur; hind femora with a large basal tubercle, almost at right angles to longitudinal axis of body and extending to between second and third abdominal segments. *Functional spiracles* present on first seven abdominal segments; peritreme broadly oval, moderately thick and slightly raised for anterior half.

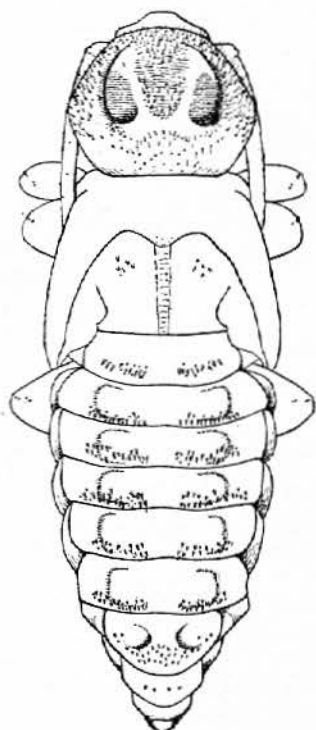


Fig. 111.  
*Arhopalus ferus* (Mulsant).  
Male pupa. Dorsal aspect.

Host plants: *Pinus* and *Picea* (Duffy, 1946c). Xambeu (1898-1902) also records *Prunus cerasus*.

*Biology.* The eggs are laid in the scales of bark in slightly decaying or recently dead stumps and standing boles, especially those the roots of which have been

scorched by fire. Approximately sixty eggs are laid by a single adult. Larvae of this species evidently prefer the large exposed roots, and seldom tunnel for more than a foot or so up the bole. First they bore downward, making winding galleries until about two-thirds grown; they then tunnel in an upward direction. Larvae of *Asemum striatum*, which make similar galleries, are often present. Pupation occurs during June and July in exposed or underground roots or in the base of standing boles. The pupal cell is elongate-ovoid and packed at both ends with coarse wooden shavings (Pl. V, fig. 24). When in a root, it is usually near the surface, parallel to the grain of the wood, but if the bark is very thick, pupation often takes place in the bark itself. Pupae of this species are very active, and frequently move up and down the cell while performing gyrotory movements. The emergence period is from July to August.

*Parasites.* Diptera: Many of the pupae obtained by the writer were almost fully matured when they suddenly turned dark brown and soft. Dipterous larvae emerged, and by July 19 had pupated around and in the desiccated pupal integument. The resulting adults were kindly identified as *Megaselia rufipes* Mg. (Phoridae) by C. N. Colyer (1950).

*Natural enemies.* Both larvae and pupae have been taken from stumps tenanted by large colonies of the ant *Lasius niger* L. As soon as the roots were split open and the larvae and pupae exposed, the ants would swarm over them and cling on to them by their mandibles.

*Economic importance.* This species will occasionally attack growing and apparently quite healthy trees.

*Material studied.* 6 L, Surrey, Mytchett, 5.iii.1945, in stump of *Pinus*, A. W. McKenny Hughes and D. leg., in coll. D.; 8 L, 28 P, Surrey, Pirbright, 30.vii.1945, in stump of *Pinus*, E. W. Classey & D. leg., in coll. D. [Adults reared.]

*References.* Colyer, 1950 (Paras.); Duffy, 1946c (Biol.); Emden, 1939-1940 (L); Fabre, 1891 (Biol.); Harris, 1952 (Biol. fig.); Smith, 1905 (L fig., Biol.); Xamheu, 1895 (Biol.), 1898-1902 (L, Biol.).

#### *Arhopalus rusticus* (Linnaeus) (= *Criocephalus rusticus* Linnaeus)

*Mature larva.* Very similar to that of *A. ferus*, from which it may apparently be distinguished as follows. *Head* with frons faintly obliquely striate; genal setae less numerous, shorter, pale testaceous and not occurring beyond level of posterior end of frontal sutures. *Antenna* with supplementary process distinctly shorter than its basal width. *Prothorax* with lateral setae pale golden-yellow; posterior part of pronotum pale yellow and slightly more finely asperate. *Abdomen* with urogomphi smaller and separated by three or four times their basal diameter.

Like the adults, larvae of both these species are extremely variable, and until long series of both species are available the above distinguishing characters must be regarded as merely provisional. The size and position of the urogomphi usually provide a ready means of identification, though even here there are exceptions; for instance, a small percentage of *A. ferus* larvae examined had small, widely separated urogomphi. The most reliable difference would appear to be that of the shape of the antennal supplementary process.

*Pupa.* Extremely similar to that of the preceding species. For differences, see the key, p. 91.

*Egg.* Length 1.5 mm. Form elongate-oval. Chorion smooth and white (ex. Xamheu, 1898-1902).

*Biology.* According to Xamheu (1898-1902) the incubation period varies from fifteen to twenty days. In other respects the biology is very similar to that of *A. ferus*.

*Parasites.* Hymenoptera: *Chasmodon motatorius* F., *Odontocolon appendiculatus* Gr. (Reineck, 1919); *Meteorus neesi* Marsh (Schimitschek, 1929); *Odontomerus pinetorum* Thoms. (Thompson, 1943).

*Economic importance.* This species has occasionally been found infesting structural timbers in France. According to Houlbert (1912) roof timbers have been seriously damaged, and zinc plating and even solder were bored through by emerging adults.

*Material studied.* 1 P, Denmark, Tisvilde, 7.vi.1896, in coll. U.Z.M.C.; 1 L, England, in coll. B.M.; 1 L, 3 P, Hannover, from stump of *Pinus*, K. Jordan leg., in coll. B.M.; 1 L, Finland, Karjalohja, Haapajärvi, viii.1929, from stump of *Pinus*, U. Saalas leg., in coll. U.Z.M.C.

*References.* Collet, 1930 (Biol.); Decaux, 1890 (Biol.), 1891 (Biol.); Emden, 1939-1940 (L); Henriksen, 1914 (L fig.); Houlbert, 1912 (Biol.); Perris, 1856 (L fig., P); Reineck, 1919 (Biol.); Röthenberg, 1907 (Biol.); Saalas, 1923 (L fig.); Schimitschek, 1929 (Biol.); Schiödte, 1876 (L fig., P); Sharp, 1905 (Biol.); Thompson, 1943 (Paras.); Trägårdh, 1939 (Biol. fig.); Trappen, 1908 (Biol.); Xamheu, 1898-1902 (E, L, P, Biol.).

### *Asemum striatum* (Linnaeus)

*Mature larva.* Similar to those of *Arhopalus* species, from which it differs as follows. Length up to 20 mm.; breadth (at prothorax) 5.8 mm. *Head* less depressed (maximum head-width 4.9 mm.), with sides more strongly diverging behind middle; genal setae shorter, finer, testaceous. Labrum slightly wider than long. Gular sutures slightly raised and almost as darkly pigmented as hypostomal sutures. Maxillary palpi with apical segment almost as long as second segment. *Prothorax* with lateral setae only moderately dense; pronotum with posterior part pale testaceous and much more finely asperate. *Abdomen* with urogomphi longer and stouter, subcontiguous at base and with apical third (at most) strongly sclerotised.

*First-instar larva* (fig. 112). Length up to 1.5 mm.; breadth 0.45 mm. *Abdomen* with urogomphi indiscernible. Egg-bursting spines present on meso- and metathorax, and on abdominal segments one to eight; form rather as in *Rhagium bifasciatum* (fig. 63). *Legs* with unguiculus extremely attenuated (fig. 112). *Spiracles* biforous.

*Pupa* (figs. 113, 114). The pupa of this species is rather similar to those of *Arhopalus* species, from which it differs as follows. Length 10-18 mm.; maximum breadth 7 mm. *Head* with vertex with two groups of short spines intermingled with numerous short pale setae; front with a transverse row of short spines above base of clypeus. Antennae transversely rugose, densely spiculate and with at least three short spines on each segment; extending to just beyond middle of metathorax, where they are strongly curved downward to terminate near bases of elytra. Maxillary palpi spiculate and with a few short pale setae. *Pronotum* strongly transverse, with sides strongly rounded, and with scattered stout, ferruginous spines and long fine setae, especially along front margin. *Mesonotum* with a few fine setae; scutellum broad, rather depressed and glabrous or almost so. *Metanotum* with a few scattered minute spines on each side of scutellar groove. *Abdomen* with tergites one to six each bearing four transverse groups of numerous thorn-like, ferruginous spines. Seventh and eighth tergites with scattered stout spines. Sternites with lateral groups of spines, except the ninth, which bears only two stout spines, and the tenth, which is glabrous. *Functional spiracles* with peritreme rather thick and raised above general level of cuticle.

*Egg.* Length 1.4 mm.; breadth 0.5 mm. Form elongate, cylindrical, with rounded ends. Chorion thin, smooth, shining, white to very pale green.

*Host plants:* *Pinus*, *Picea*, *Abies* and *Larix* (Duffy, 1946c; Reineck, 1919; Trappen, 1908). Kaufmann (1948) records *Quercus*.

*Biology.* The eggs are inserted between the scales of bark of stumps, boles and roots of slightly decaying or recently dead trees, especially those which have been scorched round the roots by fire. The young larva feeds on the bark itself and then proceeds to tunnel straight into the outer sapwood in a downward direction, making a winding gallery which is tightly packed with frass and shavings. When about half-

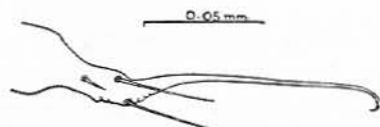


Fig. 112

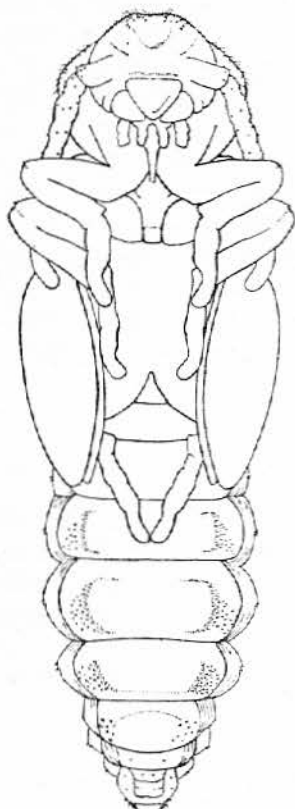


Fig. 113

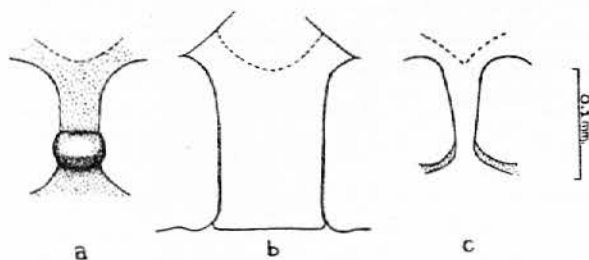


Fig. 114

Fig. 112. *Asemum striatum* (Linnaeus). First-instar larva. Apical part of mesothoracic right leg. Lateral aspect.

Fig. 113. *Asemum striatum* (Linnaeus). Male pupa. Ventral aspect.

Fig. 114. (a) *Asemum striatum* (Linnaeus); (b) *Arhopalus ferus* (Mulsant) and; (c) *Tetropium gabrieli* Weise. Female pupae. Mesosterna.

grown, the larva usually connects the gallery with the exterior by means of one or more small perforations and then continues in a more inward direction, at the same time forcing the frass through the perforation; it then enlarges the end of the gallery, which may be from 8 to 15 inches below the surface of the stump. The larva then changes its direction and bores upward, excavating a straight tunnel (which is kept completely clear of debris) almost up to the surface of the wood, where it constructs its pupal cell (Smith, 1905). Pupation takes place in April and May. The pupal cell is elongate and parallel to the grain of the wood. If in a stump, it is usually just below

the flat surface, through which the adult emerges (Pl. VII, figs. 32, 34). The pupa is quite active and frequently travels up and down the cell. Adults emerge during June and July.

*Economic importance.* This species sometimes attacks standing trees, but only when the tree's vitality has been impaired by damage. A number of telegraph poles have been seen by the writer to be severely damaged by larvae of this species.

*Material studied.* 1 P, Sweden, Nord Sjelland, Meinert leg., in coll. U.Z.M.C.; 6 L, Surrey, Mytchett, 5.xii.1942, in stumps of *Pinus*, E. W. Classey and D. leg., in coll. D.; 14 L, Surrey, Mytchett, iv.1947, in roots of *Pinus*, A. W. McKenny Hughes and D. leg., in coll. D. [Adults reared.]

*References.* Boas, 1923 (Biol. fig.); Chapius & Candèze, 1853 (L); Duffy, 1945a (Biol.), 1946c (Biol.); Emden, 1939-1940 (L); Ganglbauer, 1881 (Biol.); Henriksen, 1914 (L fig.); Hoffbauer, 1892 (Biol.); Kaltenbach, 1874 (Biol.); Kaufmann, 1948 (Biol.); Nördlinger, 1880 (Biol.); Perris, 1877 (L fig., P); Reineck, 1919 (Biol.); Röthenberg, 1907 (Biol.); Schiödte, 1876 (L fig., P); Sedlaczek, 1818 (Biol.); Smith, 1905 (L fig., Biol.); Trägårdh, 1939 (Biol. fig.); Trappen, 1908 (Biol.); Xambeu, 1898-1902 (E, L, P, Biol.).

#### \**Spondylis buprestoides* Linnaeus

[Very occasionally in imported timber from the Continent.]

*Mature larva.* Very similar to those of *Arhopalus* species, from which it may be distinguished by the characters given in the key, p. 70.

*Pupa* (fig. 115). Similar to those of *Arhopalus* species, from which it may be distinguished by the characters given in the key, p. 91.

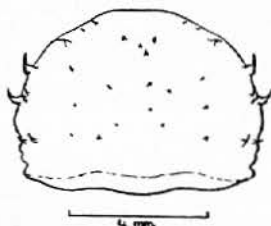


Fig. 115. *Spondylis buprestoides* Linnaeus. Pupa. Pronotum.

Host plants: Coniferae.

*Biology.* Very similar to that of *Arhopalus* species.

*Parasites.* Hymenoptera: *Ephialtes manifestator* L., *Odontomerus pinetorum* Thoms. (Thompson, 1943).

*Material studied.* 1 P, Denmark, Seeland, from *Pinus*, E. Rosenberg leg., in coll. U.S.N.M.; 15 L, Holland, Arnhem, 8.vi.1950, E. T. G. Elton leg., in coll. D. (ex coll. E.).

*References.* Barbey, 1913 (Biol.); Kemner, 1922 (Biol.); Nördlinger, 1880 (Biol.); Mjöberg, 1905 (Biol.); Perris, 1856 (L fig., Biol.), 1877 (Biol.); Polozhentzev, 1929 (Biol. fig.); Ratzeburg, 1839 (Biol. fig.); Reineck, 1919 (Biol.); Thompson, 1943 (Paras.); Westwood, 1839 (Biol. fig.); Xambeu, 1898-1902 (L, Biol.).

**Tetropium gabrieli** Weise

*Mature larva* (figs. 116, 117). Rather similar to those of *Arhopalus* species, from which it differs as follows. Length up to 19 mm.; breadth (at prothorax) 5 mm. *Head* transverse (maximum head-width 3.1 mm.), with sides only slightly wider behind middle; genal setae mostly arising from ferruginous basal dots, which give the genae a spotted appearance. Frons distinctly darker than epicranial halves. Antenna with apical segment quadrate to transverse. Mandible without an oblique plate along

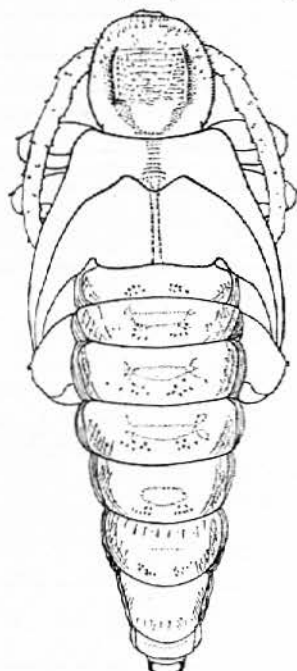
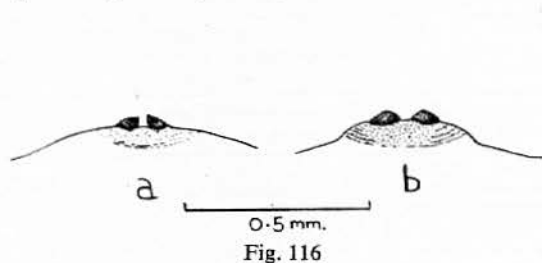


Fig. 118

Fig. 116 (a) *Tetropium castaneum* Linnaeus; (b) *Tetropium gabrieli* Weise. Mature larvae. Urogomphi. Dorsal aspect.

Fig. 117. *Tetropium gabrieli* Weise. Mature larva. Peritreme of abdominal spiracle.

Fig. 118. *Tetropium gabrieli* Weise. Pupa. Dorsal aspect.

edge of dorsal surface and bearing fewer setae. Labrum transversely ovate, about twice as wide as long. Gula much shorter, not more than half as long as hypostomal sutures. Maxillary palpi with apical segment almost as long as second segment. *Prothorax* as in *Asemum*. *Abdomen* with urogomphi (fig. 116) very short, stunted, and subcontiguous. *Legs* with femur and tibiotarsus distinctly ferruginous. *Spiracles* (fig. 117) of abdomen with peritreme subcircular and with two protuberant subcontiguous tubes on posterior margin.

*Pupa* (fig. 118). This pupa resembles that of *Asemum striatum*, from which it differs as follows. Length 10–16 mm.; maximum breadth 3.75 mm. *Head* with two to six short pale spines on vertex. Antennae transversely rugose, densely spiculate, the basal segment with about six testaceous spines near apex of basal segment, and



remaining segments with scattered, much smaller spines; extending as far as second abdominal segment. Maxillary palpi broadly truncate at apex. *Pronotum* elongate, with sides moderately rounded, and vertex with a pair of paramedian, longitudinal furrows; vertex and front margin with numerous conical papillae (each with an apical seta). *Mesonotum* glabrous; scutellum with a few minute setae. *Metanotum* sometimes with a few minute pale setae on each side of scutellar groove. *Abdomen* with tergites one to six bearing two oval groups of spines (each with a subapical seta). Seventh tergite with a few scattered spines. Eighth tergite often, and ninth always, glabrous. *Legs* with a row of spines (with apical setae) near apex of each femur. *Functional spiracles* with peritreme slightly raised in anterior half.

*Egg*. Length 1.25 mm.; breadth 0.25 mm. Form elongate, subcylindrical, with rounded ends. Chorion milky white (sometimes with a greenish tinge), thin, smooth, shining.

Host plants: *Larix*, *Pinus*, *Picea* and *Abies* (Crawshay, 1907; Duffy, 1946c; Kaufmann, 1948; Schimitschek, 1929). *Larix* is undoubtedly the preferred host.

*Biology*. The eggs are laid between the scales of the outer bark, usually in batches of about six. A dissected adult was found to contain 130 eggs. Usually only injured, sickly, or recently felled trees are attacked. The young larva seldom penetrates the inner bark until it is two or three weeks old. It then starts to consume the soft bast, the cambium layer itself and, sometimes, the outer sapwood. The larva moults at least seven times (fig. 120), the moults occurring at intervals of eight to fourteen days (Crawshay, 1907). If pupation takes place in the sapwood, the larva enters the wood through an elliptical hole (the ellipse usually being vertical) and excavates a horizontal, slightly curved gallery for a distance of 1-2½ in., and then turns abruptly, burrowing in a downward direction for about the same distance. Symbiosis in this and the following species of this genus has been discussed by Schimitschek (1929).

The pupal habitat is under the surface of the outer bark, or in the outer sapwood. If the latter, the cell is constructed by enlarging the end of the larval gallery; this is kept clear, the excavated wood fibre being used to fill up the remainder of the burrow in the bark right up to the elliptical entrance hole (Pl. I, fig. 1).

Crawshay (1907) has shown that the life-cycle of this species, although usually one year, may be considerably shortened by unusually high temperatures, with a result that there are two emergence periods in the same year (see fig. 119). This has been verified by the present writer, who observed that in 1947, after an unusually warm summer, there was a second emergence of this species in late August (see also p. 8).

The pupal period is normally from April to May. The pupa is always in a vertical position, head upward. It continuously performs gyrotory movements (see also p. 20). Adults generally emerge during May and June.

*Parasites*. Hymenoptera: *Atanycolus denigrator* L., *A. initiator* Nees, *A. sculpturatus* Thoms., *Meteorus neesi* Marsh, *Doryctes obliterated* Nees, *Helcon aequator* Nees, *Ephialtes mesocentrus* Grav., *Rhyssa persuasoria* L., *Clistopyga sauberi* Brauns, *Xorides brachylabris* Kriechb., *X. irrigator* F., *Deuteróxorides collaris* Grav., *Pyracmon lucidus* Clément (Schimitschek, 1929).

*Predators*. Neuroptera: *Rhaphidia notata* F. Coleoptera: *Malachius bipustulatus* L., *Thanasimus formicarius* L. Dermaptera: *Forficula auricularia* L. (Schimitschek, 1929).

*Natural enemies.* The Green Woodpecker (*Gecinus viridis*).

*Economic importance.* Larvae of this species will quickly kill a sickly tree. Widespread depredations on larch plantations in the Isle of Wight have recently been seen by the writer. From the commercial point of view, although there is appreciable injury to the wood, it is relatively superficial. Perfectly healthy trees appear to be immune from attack. Laing (1919) records this species damaging lead (see also p. 39).

*Material studied.* 14 L, 4 P, Surrey, Chelsham, 17.iv.1945, in stump of *Pinus*, D. M. Duffy and D. leg., in coll. D.; 8 L, 15 P, Surrey, Effingham, from recently cut *Larix*, J. C. Ford leg., in coll. D. [Adults reared.]

*References.* Chrystal & Skinner, 1931 (Paras.); Crawshay, 1907 (E, L fig., P fig., Biol. fig.); Duffy, 1946c (Biol.); Emden, 1939-1940 (L fig.); Forestry Commission, 1923 (L fig., Biol. fig.); Kaufmann, 1948 (Biol.); Laing, 1919 (Biol.); Osmaston, 1914 (Biol. fig., Contr.); Schimitschek, 1929 (E fig., L fig., P fig., Biol. fig.); Skinner, 1928 (Paras.).

#### \**Tetropium fuscum* Fabricius

[Occasionally in imported timber from the Continent.]

*Mature larva.* A meticulous examination of the supposed larva of this species has furnished no characters whereby it can be distinguished from that of *T. gabrieli*; it is possible, however, that the material has been misidentified.

Host plants: *Picea* and *Pinus* (Reineck, 1919; Schimitschek, 1929).

*Biology.* Similar to that of *T. gabrieli*.

*Parasites.* Hymenoptera: *Atanycolus initiator* Nees, *A. denigrator* L., *Helcon aequator* Nees, *Ephialtes terebrans* Ratz., *E. mesocentrus* Grav., *Xorides brachylabris* Kriechb., *Deuteroxorides collaris* Grav., *Pyracmon xoridiformis* Hlgr., *P. xoridoideus* Strobl., *Deuteraenia hircana* F. (Schimitschek, 1929). *Atanycolus neesi* Marsh, *Ephialtes dux* Tschek., *Helcon dentator* Nees (Thompson, 1943).

*Predators.* Neuroptera: *Inocellia crassicornis* Schummel. Coleoptera: *Malachius bipustulatus* L., *Thanasimus formicarius* L. Dermaptera: *Forficula auricularia* L. (Schimitschek, 1929).

*Economic importance.* Similar to that of *T. gabrieli*.

*Material studied.* 6 L, Denmark, 20.ix.1939, from *Larix*, J. P. Kryger leg., in coll. B.M.; 2 L, Denmark, 12.vi.1898, from *Pinus*, E. Rosenberg leg., in coll. U.S.N.M.

*References.* Henriksen, 1914 (L); Nüsslin, 1905 (Biol.); Reineck, 1919 (Biol.); Schimitschek, 1929 (Biol. fig.); Schiödtte, 1876 (L, P); Thompson, 1943 (Paras.); Trappen, 1908 (Biol.); Xamheu, 1898-1902 (L, P, Biol.).

#### (\*) *Tetropium castaneum* Linnaeus

[Occasionally in imported timber from the Continent.]

*Mature larva* (fig. 116). Very similar to that of *T. gabrieli*, from which it may be distinguished by the characters given in the key, p. 70.

*Pupa.* Very similar to that of *T. gabrieli*, from which it may be distinguished by the characters given in the key, p. 92.

Host plants: *Pinus* (Xambeu, 1898–1902). Mulsant (1862) records also *Pinus* and *Quercus*, and Reineck (1919) mentions *Juglans*.

*Biology.* Similar to that of *T. gabrieli*, except that pupation rarely takes place in the bark.

*Parasites.* Hymenoptera: *Helcon aequator* Nees, *Coeloides initiator* Nees, *Doryctes oblitteratus* Nees, *Xorides brachylabris* Kriechb., *Deuteroxorides collaris* Grav., *Helcon dentator* Nees, *Mesoleptus teredo* Htg., *Pyracmon austriacus* Tschek., *Xorides nitens* Grav. (Thompson, 1943).

*Economic importance.* Similar to that of *T. gabrieli*.

*References.* Ahlemenn, 1863 (Biol.); Barbey, 1913 (Biol. fig.); Baudisch, 1896 (Biol.); Della Beffa, 1931 (Biol. fig.); Döbner, 1862 (Biol.); Fehse, 1921 (Biol.); Henriksen, 1914 (L fig.); Judeich & Nitsche, 1889 (L); Kemner, 1918b (L, P); Köppen, 1880 (Biol.); Mulsant, 1862 (Biol.); Nördlinger, 1880 (Biol.); Nüsslin, 1905 (Biol.); Pauly, 1888 (Biol.); Perris, 1877 (L); Ratzeburg, 1839 (L, P), 1863 (Biol.); Reineck, 1919 (Biol.); Saalas, 1923 (Biol.); Schiödt, 1876 (L fig., P); Sedlaczek, 1918 (Biol.); Thompson, 1943 (Paras.); Trägårdh, 1918 (Biol. fig.), 1929 (Biol. fig.), 1939 (Biol. fig.); Xambeu, 1898–1902 (L, P, Biol.).

#### \**Tetropium cinnamopterum* Kirby

[Occasionally in imported timber from North America.]

*Mature larva* (fig. 121). No material is available, but according to Craighead (1923b) this larva may be distinguished from those of other species by the fact that the urogomphi are connate conical, becoming bifurcated apically (fig. 121).

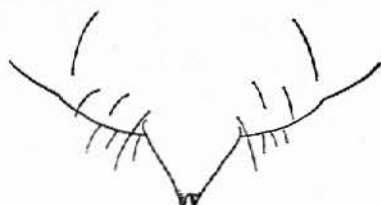


Fig. 121. *Tetropium cinnamopterum* Kirby. Mature larva. Urogomphi. Dorsal aspect. (Craighead, 1923b)

Host plants: *Abies*, *Pinus* and *Picea* (Craighead, 1923b).

*Biology.* Apparently very similar to that of *T. gabrieli*.

*References.* Craighead, 1923b (L fig., P, Biol.), 1950 (Biol.); Felt, 1906 (Biol. fig.).

### 5. CERAMBYCINAE

#### Larval Characters

Form subcylindrical. *Head* transverse to subquadrate, wider behind middle (except *Smodicum*); dorsal margins of epicranial halves fused for some distance behind frons; tentorial bridge (i.e. cross-arm) in same plane as hypostoma, the occipital foramen thus apparently divided into an anterior and posterior portion. Epistoma not produced

over clypeus (except in a few tropical species); four epistomal setae present. Clypeus narrow, not as wide at base as epistoma and never filling space between dorsal articulations of mandibles. Labrum small, narrow, usually more or less circular. Antennae salient, rarely entirely retractile; distinctly three-segmented. Mandible short, trapezoidal, with cutting edge gouge-like, never with apex or dorsal angle produced. Ocelli absent, or one, two, or three pairs present. Maxillae movable; cardo distinct; maxillary articulating area swollen. Ventral mouthparts attached to hypostoma by little more than width of gula; maxillae with palpi and lobes curved upward against ventral part of mandibles; palpifer small, with outer margin strongly rounded; lobe borne on stipes and often setose on inner margin; labial palpi narrowly separated at base. *Prothorax* having presternum and epipleurum often fused, but sometimes distinctly separated; eusternum rarely distinct. Postnotal fold usually present. *Abdomen* having elliptical region surrounding spiracle protruding and well defined; epipleurum protuberant only on last three segments; pleural discs present. *Legs* small or absent. *Spiracles* of mesothorax not protruding into prothorax.

\**Smodicini*

\**Smodicum cucujiforme* Say

[Occasionally in imported timber from North America.]

*Mature larva* (figs. 122, 123). Length up to 13 mm.; maximum breadth (at prothorax) 2.2 mm. Form cylindrical, very slender, scarcely tapering. *Head* salient, quadrate, broadest before middle, very pale testaceous, and very feebly sclerotised.

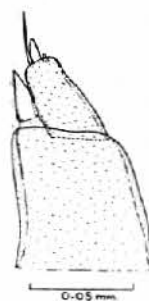


Fig. 122

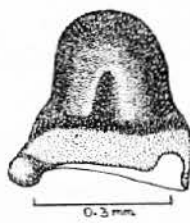


Fig. 123

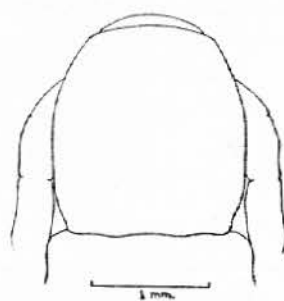


Fig. 124

Fig. 122. *Smodicum cucujiforme* Say. Mature larva. Apical part of antenna. Lateral aspect.

Fig. 123. *Smodicum cucujiforme* Say. Mature larva. Mandible. Lateral aspect.

Fig. 124. *Smodicum cucujiforme* Say. Pupa. Head and pronotum. Dorsal aspect.

Genae smooth, pale, sparsely setose. Mouthframe pale testaceous, feebly sclerotised. Antenna (fig. 122) pale, fleshy: second segment slightly elongate; third segment stout, slightly tapering; supplementary process as long as third segment and strongly attenuated. Mandible (fig. 123) short, basal third yellowish, apical two-thirds pitchy, with a longitudinal groove on outer face. Labrum strongly transversely oval, fleshy, and sparsely setose. One pair of ocelli present; lens convex, protuberant; pigmented spot distinct. Hypostoma smooth, pale; sutures pale, indistinct. Gula narrow, raised;

sutures concave, pale. Maxilla white, fleshy; third segment of maxillary palpi one and one-half times length of second; process of palpifer minute. Labial palpi with third segment elongate, one and one-half times length of second. *Prothorax* quadrate, dull, testaceous; pronotum with posterior half shining and finely longitudinally striate; median cleavage line indistinct. Eusternum distinct, triangular, without spines or setae but with several distinct striae. *Abdomen* with ampullae prominent, small, shining, alutaceous; pleural discs on segments one to three slightly granulate. Tenth segment barrel-shaped, strongly protuberant. *Legs* distinctly three-segmented but shorter than maxillary palpi. *Spiracles* minute, peritreme broadly oval, thin and pale.

*Pupa* (fig. 124). Length up to 11 mm.; maximum breadth 2.5 mm. *Head* (fig. 124) with vertex visible from above; round, glabrous. Antennae extending as far as second abdominal segment, where they are recurved to terminate near apical third of elytra. Eyes strongly convex, glabrous. *Pronotum* (fig. 124) elongate, depressed, and with at most a few scattered pale papillae. *Mesonotum* and *metanotum* bearing a few fine short setae. Elytra and wings extending as far as fourth abdominal segment. *Abdomen* with tergites one to seven micro-pubescent and bearing scattered pale spines arising from small tubercles. Sternites without spines or setae. *Legs* with hind femora extending as far as fourth abdominal segment. *Functional spiracles* present on first seven abdominal segments; peritreme thin and pale.

Host plants: *Quercus*, *Fagus*, *Ulmus*, *Gleditschia* (Craighead, 1923b); *Celtis* (Vogt, 1949); *Hicoria* (Snyder, 1927).

*Biology*. Larvae feed in the heartwood of very old, dry and seasoned timber, excavating winding galleries which are tightly packed with granular frass. Adults emerge in July and August (Craighead, 1923b, 1950). According to Snyder (1927) freshly cut timber is also attacked.

*Economic importance*. Stored lumber is frequently infested, and this species sometimes attacks seasoned timber which has been utilised in the construction of furniture, etc. Blair (1948) suggests there is a possibility of this species becoming established in this country.

*Material studied*. 2 L, 22.vi.1933, from American *Quercus*, in coll. F.P.R.L.; 3 L, 2 P, U.S.A., Pennsylvania, 15.vi.1908, from *Quercus*, R. W. Van Horn leg., in coll. U.S.N.M.

*References*. Blair, 1948 (Biol.); Chamberlin, 1949 (Biol.); Craighead, 1923b (L fig., Biol.), 1950 (Biol., Contr.); Riley, 1880 (Biol.); Snyder, 1927 (Biol.); Vogt, 1949 (Biol.).

#### \*Saphanini

##### \**Zamium incultum* Pascoe

See p. 222.

##### \**Achryson surinamum* Linnaeus

[Occasionally in imported timber from North America.]

*Mature larva* (fig. 125). Length up to 23 mm.; maximum breadth (at prothorax) 5.5 mm. Form subcylindrical, slightly tapering. *Head* with sides diverging posteriorly;

genae smooth, pale, sparsely setose. Mouthframe ferruginous and completely sclerotised beneath antennae. Antenna with third segment at least three times as long as basal width and about half length of second: supplementary process short, about one-fourth length of third segment. Mandible pithy, with a shallow fovea which is sometimes longitudinally produced. Labrum roundly trapezoidal, bearing short setae. One pair of ocelli present, contiguous with base of antennae: lens very strongly protuberant; pigmented spot indistinct. Hypostoma transversely rugose, with front margin narrowly ferruginous; sutures distinct, almost straight; gula narrow, with sutures protuberant. Maxilla with third segment of maxillary palpi as long as second; process of palpifer distinct but very short. *Prothorax* trapezoidal, with lateral regions

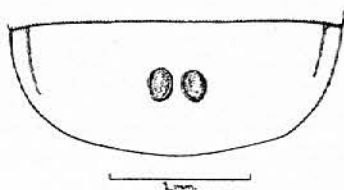


Fig. 125. *Achryson surinamum* Linnaeus. Mature larva. Ninth abdominal tergite.

bearing fine, slender setae. Pronotum strongly and regularly punctate anteriorly; finely reticulate and irregularly, longitudinally striate posteriorly; median cleavage line distinct. *Mesonotum* and *metanotum* finely granulate. Prosternum bisected by a strongly raised, longitudinal ridge. *Abdomen* with dorsal ampullae shining, finely reticulate and with two pairs of lateral impressions. Ninth tergite (fig. 125) with a pair of paramedian, oval, testaceous, carinae or tubercles which are rather faint in some specimens. Pleural discs granulate and distinct on first three abdominal segments. *Legs* four-segmented, testaceous, about as long as maxillary palpi. *Spiracles* small, broadly oval, with peritreme thin and pale.

Host plants: *Cercidium*, *Acacia*, *Prosopis* (Craighead, 1923b); *Ulmus*, *Celtis* (Vogt, 1949).

*Material studied.* 7 L, U.S.A., in coll. U.S.N.M.

*References.* Craighead, 1923b (L., Biol.); Vogt, 1949 (Biol).

### Cerambycini

#### Larval Characters

*Head* rectangular or only slightly narrowed anteriorly; posteriorly straight or very slightly emarginate. Three pairs of ocelli present. Labrum transverse. Ligula wide. Labial palpi distinctly separated. Palpifer and first segment of maxillary palpi each with a small rounded process; lobe with several stout setae on inner margin. *Prothorax* with eusternum triangular (the apex often being fused with presternum); hypopleurum distinct, triangular; postnotal fold present. *Abdomen* with dorsal ampullae having two distinct, transverse furrows. *Legs* distinctly four-segmented. *Spiracles* sometimes with distinct marginal chambers.

(\*) *Cerambyx scopolii* Füssly

[Sometimes imported from the Continent.]

*Mature larva.* Length up to 50 mm.; breadth (at prothorax) 7.5 mm. Form rather slender. *Head* narrower than prothorax, slightly transverse (maximum head-width 5.25 mm.), with sides slightly diverging posteriorly; testaceous, shining, rather strongly sclerotised and very sparsely setose. Genae rugose, ferruginous; temples with a well-marked, transverse carina immediately behind ocelli and a strongly raised, elongate-oval area at posterior end of sclerotised part; dorsal boundary of antennal foramen slightly raised, produced, dentate and pitchy. Front margin of head broadly ferruginous, becoming pitchy anteriorly, the pigmented band being at least as wide as length of labrum. Front margin of frons with upper boundary strongly marked and cariniform for each lateral third. Mouthframe entirely sclerotised beneath antennae. Antenna short; third segment elongate, cylindrical, about two and one-half times as long as its basal width; second segment with a conical supplementary process. Mandible with basal part pitchy red and feebly separated from black apical part, which is about two-thirds as wide as length of mandible. Labrum transversely oval, densely fringed with rather long, golden setae. Three ocelli present; closely set and arranged in a straight transverse row laterad and ventrad of antenna; ocellar lens rather large and convex; pigmented spot distinct. Hypostoma roughly triangular, smooth; front margin and sutures ferruginous. Gular sutures well defined, raised. Maxilla with lobe setose on inner margin; maxillary palp with third segment slightly shorter than second. *Prothorax* rather sparsely setose laterally; posterior part of pronotum very coarsely and longitudinally rugose. *Abdomen* with dorsal ampullae bearing four rows of large, flat, oval tubercles; ventral ampullae with two rows of similar tubercles. Anal lobes sparsely setose. *Legs* with unguiculus long, slender and imbricately spinose.

*Pupa* (figs. 126, 127). Length 18–30 mm.; maximum breadth 10.5 mm. *Head* with vertex not visible from above; elongate moderately rugose and glabrous. Antennae with basal segment rugose; extending (in female) as far as fifth abdominal segment, where they are strongly recurved to terminate near apical third of elytra. Eyes feebly convex, glabrous. Labrum quadrate, with sides converging apically and with a longitudinal median depression; glabrous. *Pronotum* elongate, with front margin as broad as hind margin and sides bearing a pair of tubercles; strongly rugose, with scattered conical papillae, which are each equipped with a fine apical seta. *Mesonotum* transversely rugose and glabrous; scutellum moderately protuberant. *Metanotum* glabrous and smooth, except for scutellar groove which is faintly transversely striate and bears two small conical protuberances near base. Elytra and wings extending as far as fourth abdominal segment. *Abdomen* with first tergite with a short stout spine near each lateral margin and several much smaller, scattered spines. Tergites two to six bearing a transverse group of short, stout spines (each with a longer basal seta) which arise from pale papillate bases (fig. 127). Seventh tergite elongate, with hind margin produced medially into a right angle; posterior half with numerous scattered spines. Eighth tergite less than half as long as seventh, with hind angles rounded and explanate; a few pale papillae present. Ninth tergite much smaller and glabrous; sides,

which are longitudinally striate, produced posteriorly into two lobes. Sternites completely glabrous. *Legs* with hind femora with a stout, blunt tubercle near base, and extending to fifth abdominal segment. *Functional spiracles* present on first seven abdominal segments; peritreme narrowly oval, moderately thick and situated in an oval depression.

*Host plants:* *Prunus cerasus*, *P. avium*, *Pyrus malus*, *Quercus*, *Ulmus*, *Castanea*, *Fagus*, *Ribes* (Escherich, 1923; Reineck, 1919; Xamheu, 1898-1902, 1899); *Carpinus*, *Acer*, *Fraxinus* (Rudnev, 1931).

*Biology.* The larval habitat is in branches, boles and, occasionally, roots of mature deciduous trees, especially those growing in rather isolated positions. The larvae feed for only a short period under the bark and soon enter the sapwood and, later, the heartwood, in which they excavate broad, irregular galleries. The larval period is generally two to three years. Pupation occurs either during August and September or in the spring. The pupal cell is large, elongate-oval, and about 3-4 cm. long and 1 cm. broad. It is usually partitioned off from the remainder of the strongly curved gallery by a calcareous operculum, which is secreted by the larva (see also p. 13). Adults emerge from April to July.

*Parasites.* Hymenoptera: *Mesoleptus coxalis* Bris. (Thompson, 1943).

*Economic importance.* These larvae excavate broad galleries deep in the heartwood of mature and often perfectly healthy trees. This species is of decided economic importance, especially in orchards.

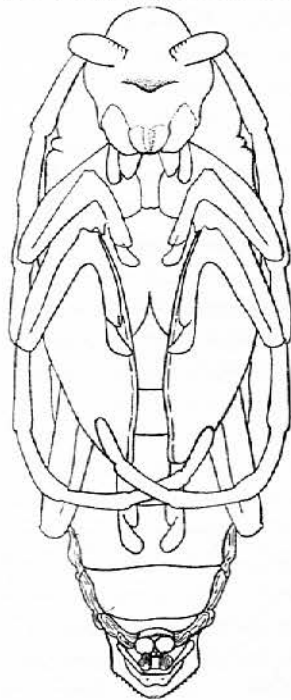


Fig. 126.  
*Cerambyx scopoli* Füssly.  
Female pupa. Ventral aspect.

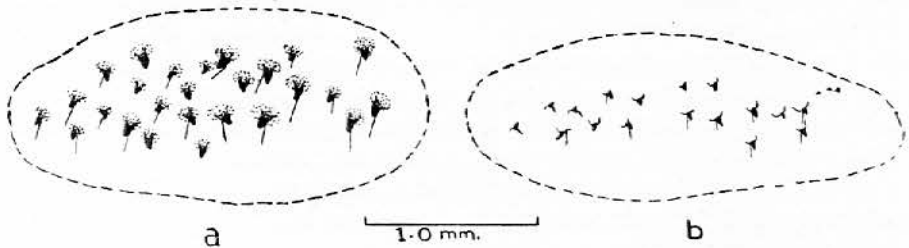


Fig. 127. (a) *Cerambyx cerdo* Linnaeus and (b) *Cerambyx scopoli* Füssly. Pupae. Left section of second abdominal tergites.

*Control.* Bruneteau (1935) recommends the cutting off of infested branches, and the setting of trap-pans baited with molasses to catch adults.

*Material studied.* 2 L, Germany, Klingenberg-on-Main, vi.1938, from *Pyrus malus*, W. Döhler leg., in coll. D.; 2 L, Germany, Munden from *Pyrus malus*, K. Jordan leg. in coll. B.M.; 1 P, no data, in coll. N.H.P.

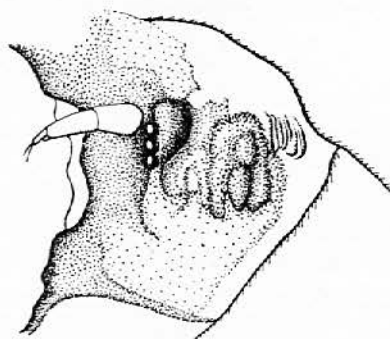
*References.* Bruneteau, 1935 (Biol., Contr.); Chapuis & Candèze, 1853 (L);

Emden, 1939-1940 (L); Escherich, 1923 (Biol. fig.); Fabre, 1891 (Biol.); Lataste, 1931 (Biol.); Lunardoni 1889 (L, Biol.); Reineck, 1919 (Biol.); Roos, 1937 (Biol. fig.); Rudnev, 1931 (Biol.); Thompson, 1943 (Paras.); Xambeu, 1898-1902 (L, P, Biol.), 1899 (Biol.).

(\*) *Cerambyx cerdo* Linnaeus

[Sometimes in imported timber from the Continent.]

*Mature larva* (fig. 128). Very similar to that of *C. scopoli*, from which it may be distinguished as follows. Length up to 100 mm.; breadth (at prothorax) up to 18 mm. Form robust. *Head* (fig. 128) with genae coarsely but more evenly rugose; temples with postocular carina less marked and the elongate-oval area at the posterior end of the sclerotised part scarcely raised. Dorsal boundary of antennal foramen not raised. Front margin of head less broadly sclerotised, the pigmented band being about two-thirds as wide as the labrum is long. Front margin of frons with upper boundary at most feebly carinate (rounded in small larvae). Hypostoma with front margin and sutures pitchy. *Prothorax* with pronotum less coarsely sculptured.



1 mm.  
Fig. 128

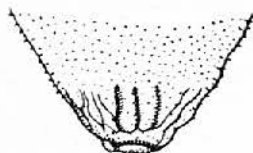


Fig. 129

Fig. 128. *Cerambyx cerdo* Linnaeus. Mature larva. Head. Lateral aspect, showing position of ocelli.

Fig. 129. *Cerambyx cerdo* Linnaeus. Egg.

*Pupa* (fig. 127). Similar to that of *C. scopoli*, from which it differs as follows. Length 30-70 mm.; maximum breadth 15 mm. *Pronotum* slightly transverse and strongly transversely striate. *Mesonotum* with scutellum broader and depressed. *Metanotum* with scutellar groove distinct, strongly striate and without basal protuberances. *Abdomen* with tergites two to six with oval groups of much stouter spines, which arise from ferruginous papillate bases, which are each surrounded by a pigmented disc (fig. 127).

*Egg* (fig. 129). Length 2.5-4 mm.; breadth 1.5-2 mm. Chorion yellowish and bearing scattered, small, stout spinules, except at the poles, which are smooth and marked with numerous longitudinal irregular impressions (Rudnev, 1935).

Host plants: *Quercus*, *Pyrus malus*, *Ulmus*, *Fagus* (Reineck, 1919; Rudnev, 1935; Xambeu, 1898-1902, 1899); *Robinia* (Lavauden, 1935); *Salix*, *Carpinus* (Morley, 1943). *Quercus* is undoubtedly the preferred host plant.

**Biology.** The larvae feed in boles of mature deciduous trees, especially those growing in rather isolated positions. The pupal habitat is similar to that of *C. scopolii* (see Pl. II, fig. 9). According to Barbey (1915), the calcareous operculum is sometimes absent. Pupation occurs in August, and adults eclose during August and September. Emergence usually takes place the following spring (May onwards), the adult having overwintered in the pupal cell. Rudnev (1935) found that fungi infested 73 per cent of immature adults, 49 per cent of larvae, and 36 per cent of pupae examined in the field. According to Linstow (1905) larval galleries of *Cerambyx* species have been found in brown coal (lignite).

**Parasites.** Hymenoptera: *Ephialtes manifestator* L. (Xambeu, 1898-1902); *Odontocolon appendiculatus* Grav. (Reineck, 1919); *Tynandricus rudnevi* Novicki<sup>1</sup> (Novicki, 1928); *Ephialtes tuberculatus* Fourc., *Rhyssa amoena* F., *R. persuasoria* L., *Megarhyssa superba* Schrk. (Kleine, 1909); *Doryctes longicaudis* Giraud (Lavauden, 1935). Arachnida: *Psocides* sp. (Tippmann, 1949).

**Predators.** Lepidoptera: *Cossus cossus* L. These larvae are frequently to be found in association with those of *C. cerdo*, and although not strictly predatory, they will readily bite and injure the more delicate larvae of *Cerambyx*.

**Economic importance.** Similar to that of *C. scopolii*. Reinfestation may continue year after year in the same tree. Barbey (1913) quotes an instance of an oak which was known to be infested with this species for thirty years. Although this species would seem to prefer isolated trees, it has been known to cause considerable damage in plantations. Rudnev (1935) includes several photographs which clearly show the enormous amount of damage these larvae can cause to the bole of a tree. Fraser (1948b) refers to an oak log in which there were eight pupal cells, each about three inches long and one inch in diameter, formed at random throughout the thickness of the heartwood.

**Material studied.** 2 L, Germany, Mörtitz, nr. Eilenburg, K. Dorn leg., in coll. B.M.; 1 P, no data, in coll. N.H.P.

**References.** Barbey, 1913 (Biol. fig.), 1915 (Biol. fig.); Boas, 1923 (Biol. fig.); Brinck, 1943 (Biol. fig.); Chalaux, 1934 (Biol.); Curten, 1935 (Biol.); Della Beffa, 1931 (Biol. fig.); Doebner, 1850 (Biol.); Emden, 1939-1940 (L); Escherich, 1923 (Biol. fig.); Fraser, 1948b (Biol.); Greze, 1928 (Biol.); Henriksen, 1914 (L fig.); Houlbert & Monnot, 1908 (L fig.); Kaltenbach, 1874 (Biol.); Kleine, 1909 (Paras.); Lavauden, 1935 (Biol.); Linstow, 1905 (Biol.); Lucas, 1881 (Biol.); Lunardon, 1889 (L fig., Biol.); Mayet, 1881 (Biol.); Morley, 1943 (Biol.); Novicki, 1928 (Paras.); Ratzeburg, 1839 (L, P); Reineck, 1919 (Biol.); Rudnev, 1928 (Biol. fig.), 1935 (E fig., L fig., P fig., Biol. fig.); Schiödt, 1876 (L fig.); Tippmann, 1949 (Paras.); Unzicker, 1911 (Biol.); Westwood, 1839 (L, P); Xambeu, 1898 (Biol.); 1898-1902 (L, P, Biol.), 1899 (Biol.).

<sup>1</sup> According to Rudnev (1935) this species parasitises up to 50 per cent of the eggs of *C. cerdo* in the Ukraine.

**\**Plocaederus viridipennis* Hope**

[Regularly in imported timber from West Africa.]

*Mature larva.* Rather similar to those of *Cerambyx* species, from which it may be distinguished as follows. Length up to 42 mm.; breadth (at prothorax) 11 mm. *Head* with genae ferruginous, rugose; temples without carinae or raised areas. Dorsal boundary of antennal foramen not raised, scarcely produced, ferruginous. Front margin of frons with upper boundary less strongly marked, straight. Antenna longer; third segment about four times as long as basal width. Hypostoma transversely striate near front margin. *Prothorax* with front margin rather densely fringed with reddish setae. *Abdomen* with ampullae without tubercles, spiculate. Anal lobes rather densely setose. *Spiracles* with about nine distinct marginal chambers.

In mature larvae the milky white calcium fluid is visible through the larval integument. Larvae which have already constructed their calcareous cocoons will have become reduced to about half their original length.

*Pupa.* This pupa is very similar to those of *Cerambyx* species, from which it differs as follows. *Head* with antennae shorter, the segments slightly pectinate on outer margin. Labrum with a row of spinules across base. *Mesonotum* and *metanotum* with a few scattered spinules. *Abdomen* with tergites two to six with spines simple at base. Eighth tergite acutely produced posteriorly (as in *Aromia*); a few ferruginous spines present. Ninth tergite with a few scattered ferruginous spinules.

*Egg* (fig. 130). No eggs are available, but they are probably very similar to those of *P. obesus* Gahan, described by Gardner (1925) as follows: "Length 4.1 mm.; width 1.4 mm. Elongate, rounded, curved at each end, stouter towards one end, with no distinct terminal prominences; surface dull, covered with minute spines."

Host plants: *Khaya*, *Chlorophora excelsa* (Fraser, 1949c). *Terminalia superba* (reported by C. R. Cannons).

*Biology.* The larva feeds subcortically for its entire existence in the boles of mature trees. The broad, tortuous galleries are in the outer sapwood, and are packed with loose powdery frass (Pl. I, fig. 3): the inner bark is untouched. Several small holes in the bark are made at intervals along the larval gallery; these are always kept entirely clear of debris. The larva appears to have little resistance to excessive moisture. When molested it ejects from the anus a liberal quantity of dark brown fluid of an acid nature. In making its cocoon (see p. 13), the larva undergoes a marked change: eventually it is reduced to about half its original size, having lost its transparency and become creamy yellow and opaque (Fraser, 1949c). The larva pupates from July to September, usually in the sapwood, but sometimes in the heartwood. The gallery, which is tightly packed with shavings, extends through the wood at right angles to the surface and turns more or less abruptly towards the base of the bole; the depth at which this bend is made varies considerably. The gallery is then slightly enlarged and kept free from debris. Here a lozenge-shaped calcareous cocoon, which is rough

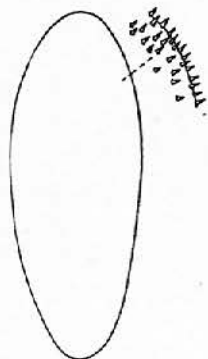


Fig. 130. *Plocaederus obesus* Gahan. Egg. (Gardner, 1925)

and white externally and smooth and light brown internally, is cemented to the walls of the pupal cell (fig. 131). This cocoon (see also p. 45) is about 4 cm. long and 1.5 cm. broad; it is fragile and porous (Pl. IV, fig. 15). A considerable time elapses between the completion of the cocoon and pupation.

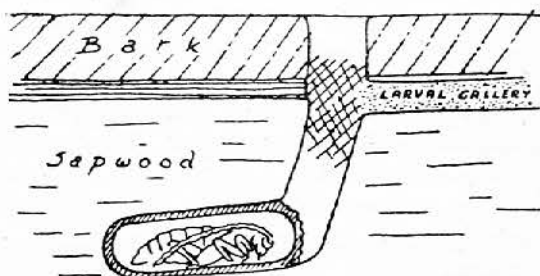


Fig. 131. *Plocaederus viridipennis* Hope. Pupal cell and cocoon. (Fraser, 1949c)

*Economic importance.* This species is of decided economic importance, despite the fact that the heartwood is seldom attacked. Boles are frequently heavily infested for their entire length.

*Material studied.* 12 L, 2 P, Lancashire, viii.1948, under bark of *Khaya* imported from West Africa, M.G.F. leg. in coll. D. [Adults reared.]

*References.* Blair, 1948 (Biol.); Duffy, 1949b (Biol. fig.); Fraser, 1949c (Biol. fig.); Gahan, 1906 (Biol.).

**\**Plocaederus basalis* Gahan**

[Occasionally in imported timber from West Africa.]

No material or references available.

Host plant: *Aucoumea klaincaria*.

**\**Plocaederus fucatus* Thompson**

[Recently in imported timber from West Africa.]

No material or references available.

Host plant: *Lovoa klaineana* (recorded by C. W. Henderson).

**\**Plocaederus denticornis* Fabricius**

[Occasionally in imported timber from West Africa.]

*Mature larva.* No material or references available.

Host plant: ? *Pynanthus kombo*.

**\**Pachydissus hector* Kolbe**

[Occasionally in imported timber from West Africa.]

*Mature larva* (figs. 132, 133). Rather similar to those of *Cerambyx* species, from which it differs as follows. Length up to 45 mm.; maximum breadth (at prothorax)

12 mm. *Head* with genae rugose; temples very strongly transversely striate and with the raised ridge at posterior end of sclerotised part much more protuberant than postocular carina. Dorsal boundary of antennal foramen not raised and scarcely produced. Hypostoma strongly rugose anteriorly, with front margin feebly tuberculate. *Abdomen* with ampullae rugose and glabrous. Anal lobes encircled by a fringe of short reddish setae, behind which are scattered, longer setae (fig. 132). *Spiracles* with about nine distinct marginal chambers (fig. 133).

*Pupa*. Very similar to those of *Cerambyx*, from which it differs as follows. *Abdomen* with spines on tergites two to six simple at base. Seventh tergite with a pair of small

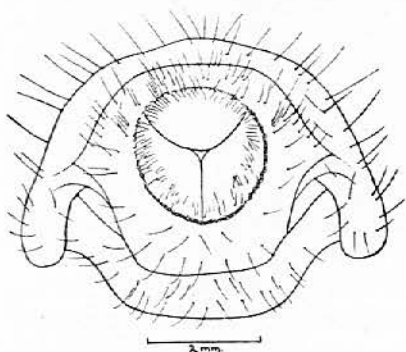


Fig. 132



Fig. 133

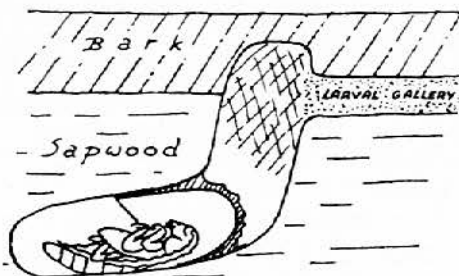


Fig. 134

Fig. 132. *Pachydissus hector* Kolbe. Mature larva. Ninth and tenth abdominal segments. Caudal aspect.

Fig. 133. *Pachydissus hector* Kolbe. Mature larva. Peritreme of abdominal spiracle.

Fig. 134. *Pachydissus hector* Kolbe. Pupal cell and operculum. (Fraser, 1949c)

oval tuberculate protuberances (each bearing numerous stout spines) near hind margin. Eighth tergite with a few ferruginous spines. Ninth tergite strongly bilobed and protuberant; not concealed from above by eighth.

Host plant: *Azelia africana* (Fraser, 1949c).

*Biology*. The larva feeds subcortically in the boles of mature trees until ready to pupate. The pupal cell (fig. 134) is deep in the sapwood or heartwood. It is about 5 cm. long and 1.5 cm. broad, and is constructed parallel to the grain of the wood. The entrance to the cell itself is closed by a calcareous operculum; this is built out from the walls of the cell (which are not completely lined as in *Plocaederus*) in the form of a dome-shaped cap (Fraser, 1949c). Pupation takes place during July and August, and the adults emerge about a month later.

*Economic importance*. Recently several imported hardwood logs have been seen by the writer to be heavily infested with this species, the sapwood and hardwood in some cases being so severely damaged as to be no longer of any commercial value.

*Material studied*. 2 L, 1 P, 1 I, Lancashire, viii.1948, under bark of *Azelia* logs imported from Portuguese East Africa, M.G.F. leg., in coll. D.

*References*. Eichelbaum, 1913 (L, P); Fraser, 1949c (Biol. fig.).

**\*Pachydissus regius** Aurivillius

[Recently in imported timber from West Africa.]

*Mature larva.* No material or references available.Host plants: *Tectona grandis*.**\*Hesperophanini****\*Aphoplistes pilosellus** Chevrolat

[Occasionally in imported timber from West Africa.]

*Mature larva.* No material or references available.**\*Tylonotus bimaculatus** Haldeman

[Occasionally in imported timber from North America.]

*Mature larva* (figs. 135–137). No material available. The following description has been extracted from Craighead's work (1923b): "Form subcylindric, elongate, slender; integument rather firm, shining, sparsely covered with short, light yellowish hairs. *Head* (fig. 135) roundly rectangular, almost suborbicular; mouthframe corneous,

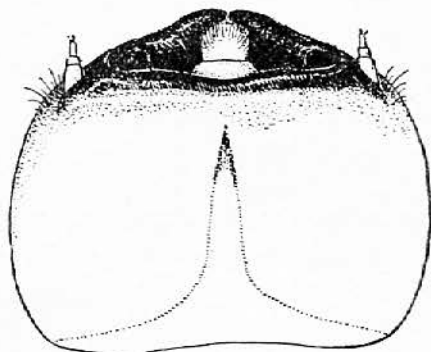


Fig. 135. *Tylonotus bimaculatus* Haldeman. Mature larva. Head. Dorsal aspect. (Craighead, 1923b)

smooth, greenish brown; clypeus long as labrum, latter transversely oval, somewhat stalked, ciliate in front; mandibles rather slender, entirely black, basal piece about one-half length of distal; antenna slender, first and second joints subequal, or first a little shorter, third shorter; supplementary minute; ocellus large, clear, projecting, continuous to antennae, not enclosed by gena (i.e. gena not shouldered). Ventral mouthparts: palpi slender, last joint of maxillary palpus slightly longer than second, about equal to or slightly shorter than last labial; process of palpifer distinct. *Prothorax* (fig. 136) about two-thirds wider than long, four tergal plates distinct, ochraceous; pronotum slightly wider than long, anteriorly sparsely hairy, hairs short, posteriorly finely and regularly striate, median suture not impressed; sternum narrow,

eusternal spots contiguous, glabrous, wrinkled, shining; ventro-lateral suture a mere notch; sternellar fold not passing spiracles, distinct at extremities. Mesonotum having scutellum distinct; metanotum with a transverse impression. Legs very short, three-jointed, basal joints transverse, shorter than maxillary palpi. *Abdominal* segments elongate, space between ampullae (intersegmental skin) twice wider than ampullae; dorsal ampullae projecting, oval, finely alutaceous, shining, marked by two lateral and two transverse impressions, setting off a fusiform area (fig. 137). Pleural discs indistinct. Spiracles broadly oval to orbicular, peritreme distinct.

*Pupa.* Craighead (1923b) gives the following description: "Pronotum beset with a few short stiff hairs on a papilla-like base; mesonotum glabrous, metanotum having a few very small points on posterior half; two groups of small conical points on the posterior half of each abdominal tergum, becoming larger posteriorly and very large on seventh and eighth, the latter having six on the hind margin."

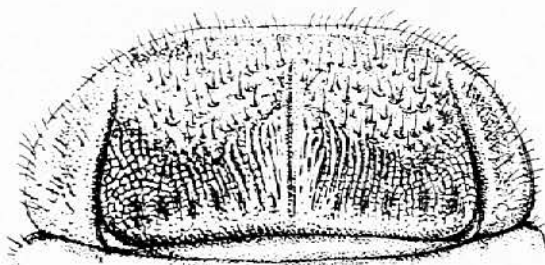


Fig. 136

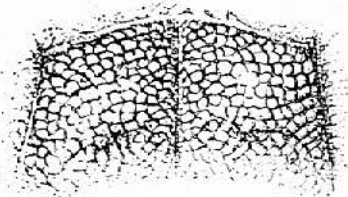


Fig. 137

Fig. 136. *Tylonotus bimaculatus* Haldeman. Mature larva. Pronotum. (Craighead, 1923b)

Fig. 137. *Tylonotus bimaculatus* Haldeman. Mature larva. Dorsal ampulla. (Craighead, 1923b)

Host plants: *Fraxinus* and *Ligustrum* (Craighead, 1923b).

*Biology.* The larval habitat is under the bark in the sapwood of living branches and boles. The larvae mine first in the larger branches and then in the main trunk. The life-cycle extends over several years (Craighead, 1923b).

*Economic importance.* This species is of some economic importance, since it attacks living ash trees, and has been known to kill privet hedges.

*References.* Craighead, 1923b (L fig., P, Biol.), 1950 (Biol., Contr.).

#### \**Stromatium barbatum* Fabricius

[Occasionally in imported timber from India, Ceylon, and Burma.]

*Mature larva* (figs. 138-141). Length up to 38 mm.; breadth (at prothorax) 9.5 mm. Form robust. *Head* (fig. 139) subquadrate, somewhat wider behind middle, the posterior margin with a very slight median emargination; shouldered behind each antenna. Genae with setae short and sparse. Front margin of frons weakly concave, and not strongly pigmented. Hypostoma (fig. 140) with front margin distinctly tuberculate, the tubercles often brownish. Gula narrow, not raised. One pair of ocelli present; lens oval, indistinct; pigmented spot usually indiscernible. Antenna

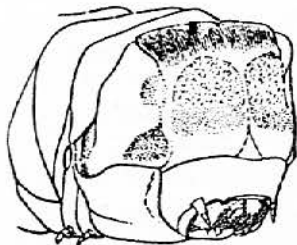


Fig. 138

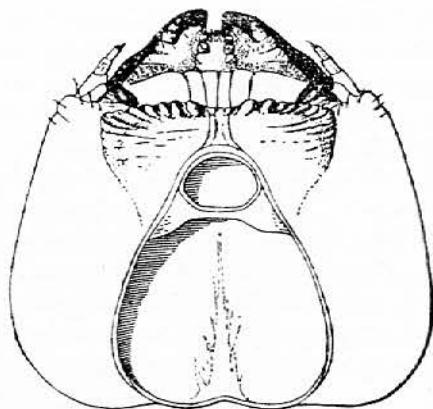


Fig. 139

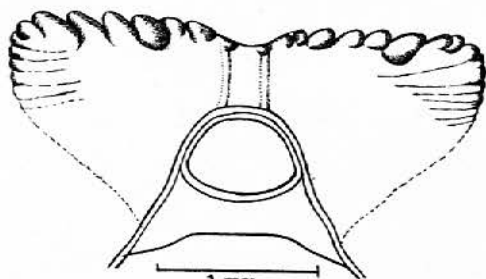


Fig. 140

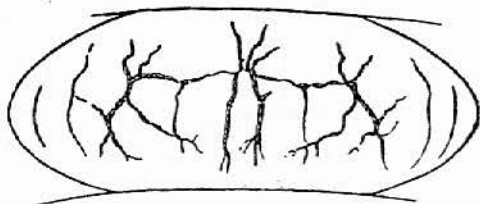


Fig. 141

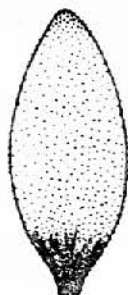


Fig. 142

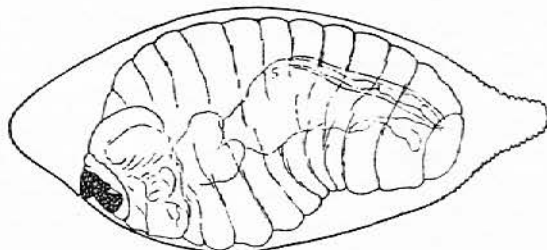


Fig. 143

Fig. 138. *Stromatium barbatum* Fabricius. Mature larva. Oblique aspect of anterior portion. (Gardner, 1927)

Fig. 139. *Stromatium barbatum* Fabricius. Mature larva. Head. Ventral aspect. (Gardner, 1927)

Fig. 140. *Stromatium barbatum* Fabricius. Mature larva. Hypostoma.

Fig. 141. *Stromatium barbatum* Fabricius. Mature larva. Third abdominal tergite. (Gardner, 1927)

Fig. 142. *Stromatium barbatum* Fabricius. Egg. (Gardner, 1927)

Fig. 143. *Stromatium barbatum* Fabricius. Egg, showing larva just about to hatch. (Beeson & Bhatia, 1939)

protuberant, with a long basal membrane; second segment cylindrical, more than one and one-half times as long as third segment; third segment wider in basal half, tapering apically; supplementary process elongate, conical. Labrum moderately transverse, with anterior margin straight medially and with numerous setae. Maxilla and labium with brownish sclerotisation basally to the segment; lobe of maxilla broad, fleshy. *Prothorax* (fig. 138) with pronotum subrectangular, with anterior area narrowly yellowish, shining; posterior area elevated, soft, striate, except for a posterior finely reticulate area. Postnotal fold present. Eusternum not distinctly limited, shining, rugulose, with a weak, oblique depression on each side. *Abdomen* with ampullae non tuberculate, and with surface reticulate and wrinkled; transverse furrows indistinct (fig. 141). *Legs* well developed. *Spiracles* with peritreme oval and pale.

*First-instar larva.* Gardner (1927) gives the following description: "Length about 1.8 mm. Spiracles biforous. Antennae short; lateral to each antenna is a distinct pigmented spot. Anterior margin of hypostoma not tuberculate. Legs short, distinct."

*Egg* (figs. 142, 143). Gardner (1927) gives the following description: "Average length 2.1 mm.; width about 0.8 mm. Elongate ovoid, one end with a slight blunt thickening, the opposite end with a more distinct blunt prominence. White, the surface minutely granulate except towards the more prominent end where the granules are much coarser and more closely placed."

*Host plants.* Larvae of this species are extremely polyphagous, and over 300 hosts have been recorded by Beeson & Bhatia (1939), including those belonging to the following genera: *Abies*, *Acacia*, *Acer*, *Acrocarpus*, *Aegle*, *Aesculus*, *Alangium*, *Albizzia*, *Alnus*, *Anogeissus*, *Anona*, *Anthocephalus*, *Ardisia*, *Artocarpus*, *Averrhoa*, *Balanites*, *Bambusa*, *Bassia*, *Bauhinia*, *Beaumontia*, *Betula*, *Bischofia*, *Bombax*, *Bowellia*, *Bridelia*, *Broussonetia*, *Butea*, *Canarium*, *Carallia*, *Carapa*, *Carpinus*, *Cassia*, *Casuarina*, *Cedrela*, *Cedrus*, *Celtis*, *Chloroxylon*, *Cinnamomum*, *Citrus*, *Clausena*, *Clerodendron*, *Coffea*, *Cordia*, *Cornus*, *Corylus*, *Cotoneaster*, *Crataegus*, *Cryptomeria*, *Cudrania*, *Cupressus*, *Dalbergia*, *Debregeasia*, *Dendrocalamus*, *Desmodium*, *Deutzia*, *Diospyros*, *Dipterocarpus*, *Elaeagnus*, *Elaeocarpus*, *Eriobotrya*, *Eriolobus*, *Erythrina*, *Eucalyptus*, *Eugenia*, *Euonymus*, *Eurya*, *Excaecaria*, *Feronia*, *Ficus*, *Fraxinus*, *Gamblea*, *Garcinia*, *Gardenia*, *Garuga*, *Glochidion*, *Gmelina*, *Gouania*, *Grevillea*, *Grewia*, *Gynocardia*, *Hedera*, *Helicia*, *Helicteres*, *Heritiera*, *Heteropanax*, *Hiptage*, *Holigarna*, *Holmskioldia*, *Holoptelea*, *Hopea*, *Hypercium*, *Ilex*, *Indigofera*, *Jambosa*, *Juglans*, *Kydia*, *Lagerstroemia*, *Lannea*, *Larix*, *Lasiosiphon*, *Leucomeris*, *Litsaea*, *Machilus*, *Magnolia*, *Mallotus*, *Mangifera*, *Mappia*, *Meliosma*, *Michelia*, *Millettia*, *Mimusops*, *Morus*, *Murraya*, *Myrica*, *Myrsine*, *Ougeinia*, *Oxyspora*, *Parkinsonia*, *Parrotia*, *Pentacme*, *Phlogacanthus*, *Photinia*, *Picea*, *Pinus*, *Piptadenia*, *Piptanthus*, *Pistacia*, *Pithecolobium*, *Pittosporum*, *Plecosperrum*, *Poinciana*, *Polygala*, *Pongamia*, *Populus*, *Premna*, *Prinsepia*, *Prosopis*, *Prunus*, *Pterocarpus*, *Pyrus*, *Quercus*, *Randia*, *Rhamnus*, *Rhododendron*, *Rhus*, *Ribes*, *Rosa*, *Rubus*, *Salix*, *Salvadora*, *Sapium*, *Saurauja*, *Semecarpus*, *Sesbanis*, *Shorea*, *Siphonodon*, *Sonneratia*, *Sorbus*, *Spatholobus*, *Spiraea*, *Spondias*, *Staphylea*, *Sterculia*, *Styrax*, *Tectona*, *Terminalia*, *Toddalia*, *Torricellia*, *Trewia*, *Turpinia*, *Ulmus*, *Viburnum*, *Woodfordia*, *Wrightia*, *Xylosma*, *Zizyphus* (from India); *Acer*, *Aesculus*, *Alnus*, *Betula*, *Carpinus*, *Fagus*, *Populus*, *Tilia*, *Ulmus* (from Europe); and *Cordyline*, *Gaya*, *Olearia*, *Pittosporum*, *Rapanea* (from New Zealand).

*Biology.* The eggs are deposited in small holes and cracks in wood (with or without bark) and in thin battens, planks and plywood; other sites are fissures formed by imperfect carpentry joints and rough, splintery surfaces. They may be laid singly or in batches of about half a dozen. The extrusion of each egg takes on an average 25 seconds. The maximum number known to have been laid by a single female is 246, the average being about 100. The incubation period is from five to thirteen days (Beeson & Bhatia, 1939).

The larval tunnels, which are tightly packed with very fine powdery frass, extend into the wood very irregularly, without conforming to any particular pattern or direction. If the wood is heavily infested, the galleries cross and interlace so that almost all the interior of the wood is reduced to powder, the external surfaces only being left intact as thin protective sheets.

The essential constituents of the larval food have apparently not yet been isolated. The larval gut probably contains the enzyme cellulase (which has been found present in *S. fulvum* Villiers), and may thus have the capacity for digesting cellulose (Beeson & Bhatia, 1939).

No special cell appears to be constructed for pupation, which occurs at various depths in the wood. The adults excavate separate tunnels to the surface. Pupation takes place during May and June and adults emerge during June and July. The life-cycle is completed in from one to several years, the maximum period recorded being ten years. The following chart (fig. 144) (from Beeson & Bhatia, 1939) shows a typical sequence of emergence of a single brood:

*Emergence of Stromatium barbatum ex Albizzia stipulata, Dehra Dun.*

| 1st year. | 2nd year. | 3rd year. | 4th year. | 5th year. | 6th year. | 7th year.     |
|-----------|-----------|-----------|-----------|-----------|-----------|---------------|
| 1         | 28        | 42        | 23        | 4         | 1.5       | 0.5 per cent. |

Fig. 144. Chart showing emergence of *Stromatium barbatum* Fabricius at Dehra Dun. (Beeson & Bhatia, 1939)

The chart opposite (fig. 145) shows the correlation of the rainfall and the percentage of the total annual population of adults which emerged (after Beeson & Bhatia, 1939). This shows, for example, that if only one inch of rain has fallen, about 30 per cent of the beetles will have emerged.

*Economic importance.* This species is of considerable economic importance, not only on account of its extremely polyphagous nature, but also because of its preference for seasoned timbers. It is perhaps most notorious as a pest of plywood packing-cases, and in this country it has been recorded infesting tea-chests imported from India (Emden, 1937). It is also known readily to attack furniture, wooden structures, rafters, door- and window-frames, shelves, panels, wooden tentpins, museum wood specimens, etc. Sometimes several years elapse before the concealed depredations are noticed.

In woodland areas this species will usually oviposit only on dry wood, such as the dead crowns of trees. There are apparently no authentic records of this species attacking living, healthy trees, except that by Khare (1916), who reports that living trees of *Citrus Aurantium* have been attacked by this species.

### EMERGENCE PERIOD OF *STROMATIUM BARBATUM*

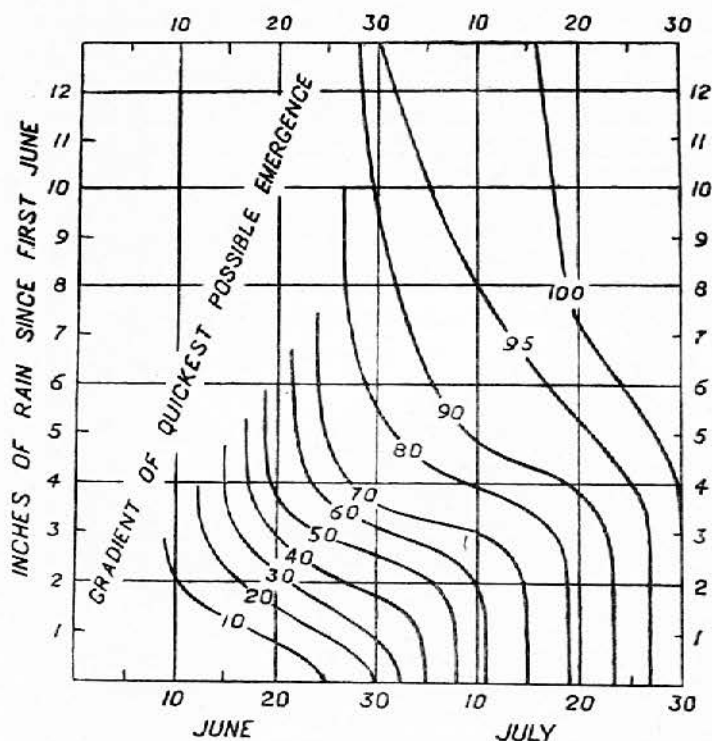


Fig. 145. Chart showing the emergence period of *Stromatium barbatum* Fabricius. The zones of emergence per cent reach the quickest possible rate in the gradient on the right. Thus on June 30th, if 10 inches of rain has fallen about 90 per cent of the beetles will have emerged; if only 1 inch of rain has fallen about 30 per cent of the beetles will have emerged. (Beeson & Bhatia, 1939)

**Control.** The usual methods of impregnating timber with solutions of naphthalene in benzene and zinc chloride in water have proved totally inadequate. The most effective means of control, so far as wooden structures are concerned, would appear to be the meticulous avoidance of rough surfaces and roughly constructed joints, and a thorough varnishing of all surfaces.

**Material studied.** 3 L, 1 I, Glasgow, 13.x.1928, D. Ellis leg., in coll. B.M.; 5 L, 1 I, London, 10.xi.1936, in wood of Indian tea-cases, in coll. B.M. [Adults reared.]

**References.** Beeson, 1919c (Biol.); Beeson & Bhatia, 1939 (E fig., Biol. fig.); Duffy, 1949b (Biol.); Emden, 1937 (Biol. fig.); 1939-1940 (L); Khare, 1916 (Biol.); Saalas, 1939 (L fig., Biol.); Stebbing, 1914 (Biol.).

**\*Stromatium longicorne** Newman

[Occasionally imported from the Orient.]

*Mature larva.* No material available.

*Host plants:* *Cassia fistula*. Stebbing's record of this species from living *Tectona* is erroneous (Beeson & Bhatia, 1939).

*Biology.* Similar to that of *S. barbatum*. Oviposition occurs at night. The incubation period is eight to twelve days and the larval period two to three years (Yashiro, 1940).

*Economic importance.* This species has been recorded as a borer of furniture in the Netherlands Indies, Java, and Sumatra (Beeson & Bhatia, 1939).

*References.* Beeson & Bhatia, 1939 (Biol.); Kalshoven, 1939 (L, Biol. fig.); Stebbing, 1914 (Biol.); Yashiro, 1940 (Biol. fig.).

**\*Stromatium fulvum** Villiers

[Occasionally in timber imported from the Mediterranean region and South America.]

*Mature larva.* No material available.

*Host plants:* *Hicoria* (from records of F.P.R.L.); *Ulmus* (Lichtenstein, 1918); *Cytisus spinosus*, *Pistacia lentiscus*, *Quercus ilex* (Silantjev, 1908).

*Biology.* Similar to that of *S. barbatum*.

*Parasites.* Hymenoptera: *Sclerodermus domesticus* Latr. (Shafik, 1938).

*Economic importance.* There have been many reports of this species severely damaging furniture. It has also been reported by the War Office to have damaged a consignment of skis.

*Control.* Fumigation of infested wood with hydrocyanic acid gas generated from Zyklon has been found to be the most satisfactory method (Shafik, 1938).

*References.* Lichtenstein, 1918 (Biol.); Schiödte, 1876 (L fig.); Shafik, 1938 (L fig., P fig., Biol. fig.); Silantjev, 1908 (E fig., L fig., P fig., Biol. fig.).

**\*Chion cinctus** Drury

[Occasionally in imported timber from North America.]

*Mature larva* (figs. 146, 147). This larva is similar to that of *Stromatium barbatum*, from which it may be distinguished as follows. *Head* with front margin of frons convex, and ferruginous above each antenna (fig. 146). *Hypostoma* with front margin less strongly tuberculate. *Ocellus* with lens large, round, convex and very distinct; pigmented spot indiscernible. *Antenna* (fig. 147) with second segment only slightly longer than third; third segment cylindrical. *Abdomen* with transverse furrows of dorsal ampullae very distinct.

*Pupa* (fig. 148). Similar to those of the Cerambycini, from which it may be distinguished by the characters given in the key, p. 92.

Host plants: *Hicoria*, *Quercus*, *Juglans*, *Castanea*, *Parkinsonia* (Craighead, 1923b); *Sapindus*, *Salix* (Vogt, 1949); *Pyrus malus* (Riley, 1880); *Celtis* (Blackman & Stage, 1924).

**Biology.** The eggs are laid in cracks in decaying or in recently cut, rather dry, barkless branches. Although this larva tunnels subcortically, it is chiefly in the sapwood that it excavates. According to Blackman & Stage (1924) the gallery is filled with coarse pellets of frass, but Craighead (1923b) maintains that it is kept more or less clear of debris, much frass being ejected. Galleries up to two feet in length have been observed. Pupation takes place deep in the outer sapwood, either in the

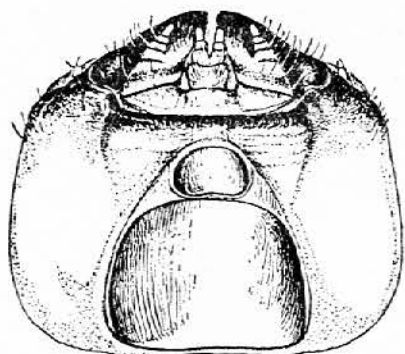


Fig. 146

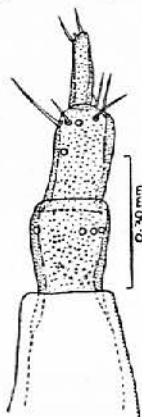


Fig. 147

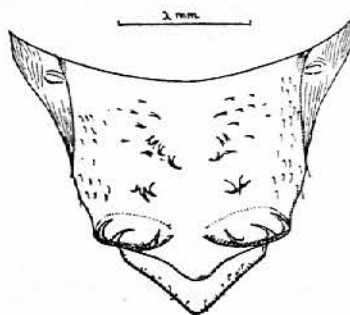


Fig. 148

Fig. 146. *Chion cinctus* Drury. Mature larva. Head. Ventral aspect. (Craighead, 1923b)

Fig. 147. *Chion cinctus* Drury. Mature larva. Antenna. Lateral aspect.

Fig. 148. *Chion cinctus* Drury. Female pupa. Seventh and eighth tergites.

autumn or in the spring; if the former, the adult overwinters in the pupal cell. Emergence takes place in May and June. The life-cycle is usually two years, but sometimes three or more (see p. 9).

**Control.** Craighead (1950) recommends the cutting of timber early in the autumn and seasoning it well through the winter under cover and off the ground, so that it has become thoroughly dried by the time the beetles appear in the following spring.

**Material studied.** 1 L, North America, Champion leg., in coll. B.M.; 2 L, from imported *Quercus*, in coll. F.P.R.L.

**References.** Blackman & Stage, 1924 (Biol.); Craighead, 1923b (L fig., P, Biol.), 1950 (L fig., Biol., Contr.); Riley 1880 (Biol.); Vogt, 1949 (Biol.).

### \*Trachyderini

#### \**Trachyderes hilaris* Bates

[In recently imported timber from South America.]

**Mature larva** (fig. 149). Very similar to that of *Chion cinctus*: the distinguishing characters are given in the key, p. 72. See also p. 13.

Larvae of this tribe are apparently so far unknown. Examination of this larva has

shown it to possess all the major characters of the Hesperophanini, and its resemblance to *Chion* is very close. In the adult classification the Trachyderini have been placed (provisionally?) at the end of the CERAMBYCINAE, but in view of the larval morphology it is suggested that the position of this tribe in the adult classification be reviewed.

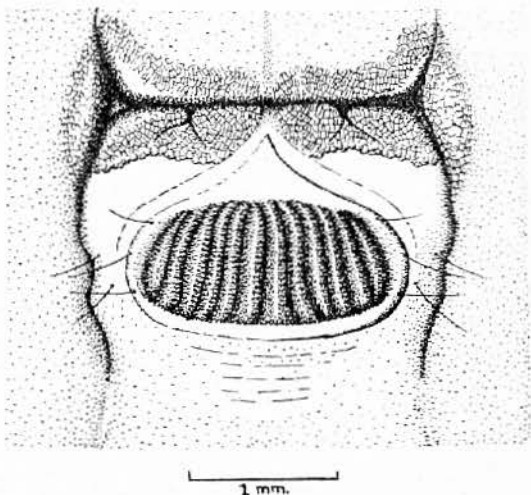


Fig. 149. *Trachyderes hilaris* Bates. Mature larva. Ampulla of sixth abdominal sternite.

Host plants: *Virola* sp. (from records of F.P.R.L.).

Material studied. 1 L, 20.xi.1947, from imported South American *Virola*, in coll. F.P.R.L.

References. None available.

#### \*Ehuriini

##### \**Eburia quadrigeminata* Say

A study of the larval characters has shown this tribe to have closer affinities to the Callichromini than to the Phoracanthini. See p. 198.

#### \*Phoracanthini

##### Larval Characters

*Head* rather depressed, with sides rather strongly diverging posteriorly. Genae shouldered; temples without postocular carina. Front margin of frons evenly rounded, upper boundary indistinct. Antennal foramen with upper boundary not raised or produced. Mouthframe entirely sclerotised beneath antennae. Antennae strongly salient. Labrum cordate. Ocelli absent, or one or two pairs present. Hypostoma with front margin transversely striate; sutures very short. Gular sutures well defined, raised. Process of palpifer indistinct. *Prothorax* depressed, moderately setose; lateral regions with scattered, glabrous spots; postnotal fold present; presternal plates absent. *Abdomen* with ampullae microscopically alutaceous, glabrous. Pleural discs indistinct.

Anal lobes sparsely setose. *Legs* short but clearly four-segmented; femur and tibiotarsus strongly sclerotised; unguiculus flagelliform, usually feebly sclerotised and imbricately tuberculate or spinose.

**\**Coleocoptus senio* Newman**

[Occasionally in imported timber from Australia and New Zealand.]

*Mature larva.* Length up to 25 mm.; maximum breadth (at prothorax) 6.5 mm. Form rather slender and depressed. *Head* slightly transverse (maximum head-width 5.1 mm.). Temples with the broad ferruginous area behind antenna rather protuberant and bisected by a well-marked, transverse impression. Front margin of head narrowly ferruginous. Antenna with third segment rather stout, cylindrical, about twice as long as its basal width and less than half the length of the second segment; supplementary process very small and conical. Labrum slightly transverse. Ocelli indiscernible. Hypostoma with front margin ferruginous; sutures ferruginous, very short. Maxilla with third segment of palp slightly shorter than second. *Prothorax* with lateral regions microscopically, velvety-pubescent, and with rather inconspicuous, scattered, glabrous spots; posterior part of pronotum very finely and longitudinally striate. *Abdomen* with ampullae microscopically alutaceous or reticulate and glabrous. *Legs* with unguiculus scarcely sclerotised, slender, flagelliform, imbricately tuberculate.

*Pupa* (fig. 150). Length 16–20 mm.; maximum breadth 3.75 mm. *Head* strongly elongate; vertex not visible from above, dome-shaped, smooth and glabrous; front feebly rugose and glabrous; clypeus with a transverse impression at base. Antennae with first four segments (at least) pectinate at apex of inner margin only; extending as far as third or fourth abdominal segment, where they are strongly recurved to terminate between the mid and fore coxae. Eyes feebly convex, glabrous. Labrum trapezoidal, front margin not angled and sometimes with a few minute setae. Maxillary palpi slightly broadened and rounded at apex. *Pronotum* very strongly elongate, with front margin strongly rounded, and sides bearing a pair of acutely pointed tubercles; disc transversely striate and two groups of minute setae near middle; basal half with a pair of paramedian, raised, oval areas bearing numerous slightly longer setae. *Mesonotum* almost smooth, with two groups of minute setae; scutellum moderately

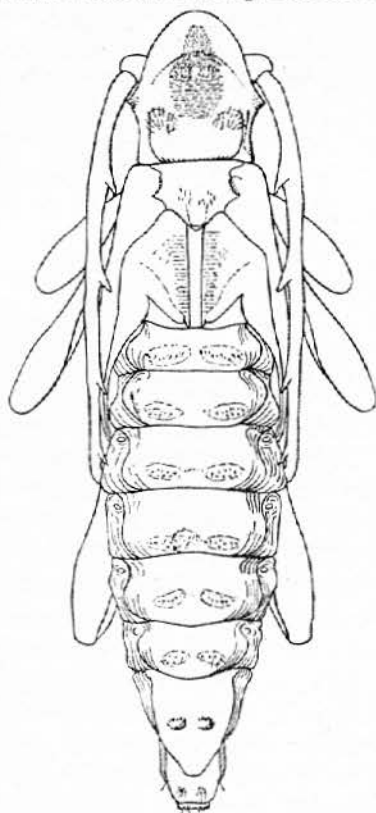


Fig. 150.  
*Coleocoptus senio* Newman.  
Female pupa. Dorsal aspect.

protuberant and glabrous. *Metanotum* transversely striate on each side of scutellar groove and bearing a few scattered minute setae; scutellar groove very distinct. Elytra and wings extending as far as fourth abdominal segment. *Abdomen* with tergites one to six each with paired, slightly raised, oval areas, bearing about six short, stout spines. Seventh tergite elongate, with a pair of tuberculate protuberances each bearing about four to six stouter spines which are inclined forward. Eighth tergite elongate, with two groups of about four more slender spines directed posteriorly. Ninth tergite extremely short and bearing a few short, stout spines. Sternites glabrous. Pleura rather strongly protuberant, rugose, glabrous. *Legs* with femora clavate; hind femora each with a tuberculate process near base; extending to between fifth and sixth abdominal segments. *Functional spiracles* present on first five abdominal segments, but vestigial pairs present on sixth to eighth; peritreme broadly oval, moderately thick and rather strongly raised above general level of cuticle.

Host plant: *Syncarpia*.

*Material studied.* 3 L, 3 P, 1 I, Fiji, Lautoka, 10.xii.1945, in *Syncarpia* from N.S. Wales, R. A. Lever leg., in coll. B.M.

*References.* None available.

#### \**Phoracantha semipunctata* Fabricius

[Occasionally in imported timber from Australia, New Zealand, South Africa, and South America.]<sup>1</sup>

*Mature larva.* Very similar to that of *Coleoptus senio*, from which it may be distinguished as follows. Length up to 32 mm.; maximum breadth (at prothorax) 10.5 mm. *Head* with maximum head-width 6.5 mm. Temple with one or two shallow, transverse impressions on each side of strong median impression. Front margin of head rather broadly pithy. Labrum slightly longer than broad. One pair of distinct ocelli present laterad and ventrad of antenna; ocellar lens large, oval; pigmented spot indistinct. Maxilla with third segment of palpi as long as or longer than second. Labial palpi with third segment as long as or longer than second. *Prothorax* with conspicuous, scattered, dark glabrous spots on lateral regions.

*Pupa.* Similar to that of *Coleoptus senio*, from which it differs as follows. Length 25 mm.; maximum breadth 6 mm. *Head* with vertex partly visible from above and less elongate. Maxillary palpi not broadened apically. *Pronotum* quadrate and with front margin feebly rounded; bearing scattered, short, curved, testaceous spines, especially near front angles; lateral tubercles acute and much more strongly produced. *Mesonotum* transversely striate and glabrous. Elytra with inner angles more strongly toothed. *Abdomen* with tergites one to six with spinose areas scarcely raised and with spines smaller. *Functional spiracles* with peritreme more narrowly oval and scarcely or not raised.

*Egg.* Length 2.6 mm. Form elongate, subcylindrical, spindle-shaped. Chorion pale yellow, soft and gelatinous (Tooke, 1935a).

<sup>1</sup> It should be noted that this species, and also other species of this genus, have been accidentally introduced into South Africa in timber from Australia: they have since spread to several South African states where they have attacked *Eucalyptus* trees planted for their shade and timber. It has also become established in South America.

Host plants: *Eucalyptus* spp., especially *E. globulus* and *E. viminalis*; it has also been recorded from *E. longifolia*, *E. robusta*, *E. saligna*, *E. acmenoides*, *E. diversicolor*, *E. leucoxyton*, *E. salubris*, *E. tereticornis*, *E. crebra* (Tooke, 1935a).

**Biology.** Oviposition takes place on dead or sickly trees and cut logs, especially felled timber with the bark on. The eggs are deposited beneath the thin strips of dry bark which are loosely attached to the smooth green bark of the boles and main branches. The incubation period is ten to fourteen days. The larvae feed for about three to six months subcortically, making regular galleries which are packed tightly with frass; these may either extend for several feet in a straight line or twist and turn in all directions. Pupation takes place in the wood, often several inches from the surface. The pupal period lasts about ten days. Emergence occurs from September to April (Tooke, 1935a).

**Predators.** Coleoptera: *Pelonium amoenum* Guér., and *Temnochilia steinheili* Reitter (De Santis, 1945).

**Economic importance.** This species sometimes does considerable damage to sickly trees and felled timber, but dry wood, even with the bark intact, is not attacked.

**Control.** Tooke (1935a) suggests the placing of trap trees (trees of little economic value) in clearings during the emergence period; these should subsequently be burned. Stripping the bark off trees as soon as they are felled and allowing the timber to dry out as soon as possible, discourages oviposition.

**Material studied.** 3 L, 1 P, 1 I, South Africa, Orange River Colony, from *Eucalyptus*, in coll. B.M.

**References.** Bruch, 1918 (Biol.); De Santis, 1945 (L fig., P fig., Biol. fig., Contr.); Lounsbury, 1918 (Biol. fig.); Schiödte, 1876 (L); Tooke, 1935a (L fig., Biol., Contr.).

#### \**Phoracantha recurva* Newman

[Occasionally in imported timber from Australia and New Zealand.]

**Mature larva.** No material available.

**Egg.** Froggatt (1923) gives the following description: ". . . pale yellow, elongate, spindle-shaped in form, but flattened on the upper and lower surface when deposited (as is usually the case) in a shallow depression between the dry scaly and green bark. They are composed of a soft, gelatinous matter without any definite structure or skin, and a very large percentage appear to be infertile or shrivelled up by the heat without any larvae emerging. The average length of each egg is about one-tenth of an inch. Before the emergence of the larvae the eggs swell out, and are almost cylindrical in form."

Host plants: Numerous species of *Eucalyptus*, including *E. novae-angliae* and *E. rostrata* (Froggatt, 1923).

**Biology.** The larval habitat is in the trunk and main branches. The young larvae feed for about six months under the bark, where they make irregular galleries, which are tightly packed with frass; a single gallery may be several feet in length. When nearly mature the larva tunnels into the sapwood, and then, usually, into the heartwood, where it pupates several inches from the surface (Froggatt, 1923).

*Parasites.* Hymenoptera: *Iphiaulax rubriceps* Frogg., *I. phoracanthae* Frogg., and *I. morleyi* Frogg. (Froggatt, 1923).

*Predators.* Coleoptera: *Trogodendron fasciculatum* Schreiber.

*References.* Froggatt, 1923 (E., Biol.); Schiödte, 1876 (L fig.).

**\*Phoracantha tricuspis** Newman

[Occasionally in imported timber from Australia and New Zealand.]

*Mature larva.* No material available.

*Host plants:* Various species of *Eucalyptus*, including *E. viminalis*.

*Biology.* Similar to that of *P. recurva*.

*References.* Froggatt, 1893 (Biol.), 1923 (Biol.).

**\*Phoracantha punctata** Donovan (= *quinaria* Newman)

[Occasionally in imported timber from Australia.]

*Mature larva.* No material available.

*Host plant:* *Acacia homalophylla*.

*References.* None available.

**\*Cordylomera suturalis** Chevrolat

[Regularly in imported timber from West Africa.]

*Mature larva* (figs. 151, 152). Rather similar to that of *Coleoptus senio*, from which it differs as follows. Length up to 32 mm.; maximum breadth (at prothorax) 7.75 mm. *Head* with genae narrowly ferruginous; region behind ocellus entirely testaceous, and with a transverse row of three small oval tubercles (in some larvae these are contiguous, forming one large tubercle), each about the size of an ocellus (fig. 151). Front margin of head rather broadly ferruginous to pitchy. *Antenna* with third segment cylindrical, very slender, about four times as long as basal width and about two-thirds the length of second segment. One pair of indistinct ocelli present; ocellar lens small, protuberant; pigmented spot indistinct. *Maxilla* with third segment of palp slightly shorter than second. *Prothorax* with lateral regions bearing numerous short, reddish setae microscopically reticulate (not pubescent) and with inconspicuous, glabrous spots; posterior part of pronotum longitudinally rugose. *Legs* with unguiculus (fig. 152) ferruginous, flagelliform and imbricately spinose.

*Pupa.* Similar to that of *Coleoptus senio*, from which it differs as follows. Length up to 22 mm.; maximum breadth 5 mm. *Pronotum* with lateral tubercles obtuse and less conspicuous. *Elytra* acutely produced apically. *Abdomen* with tergites one to six each with numerous spines, which are closely set and arranged in a single, almost straight row. Seventh tergite with a single tuberculate, spinose protuberance. Eighth tergite with spines very much smaller than those on seventh. *Legs* with hind femora simple at base. *Functional spiracles* present on first six abdominal segments and vestigial pairs present on segments seven and eight.

Host plants: *Khaya* (Fraser, 1949c) and various other West African mahoganies.

*Biology.* The larvae usually feed entirely subcortically, only entering the outer sapwood if the bark is damaged (Fraser, 1949c). The pupal cell is shown on Pl. VIII, fig. 39.



Fig. 151

Fig. 151. *Cordylomera* sp. Mature larva. Larval head showing position of ocellus and sclerotised areas. Lateral aspect.

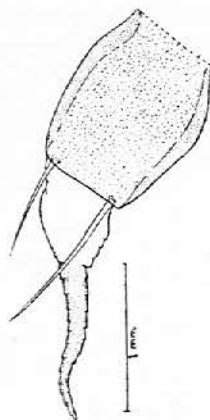


Fig. 152

Fig. 152. *Cordylomera* sp. Mature larva. Apical part of mesothoracic right leg. Lateral aspect.

*Material studied.* 8 L, 2 P, Lancashire, viii.1948, in logs of *Khaya* from West Africa, M.G.F. leg., in coll. D. [Adults reared.]

*References.* Fraser, 1948e (Biol.), 1949c (Biol.).

**\**Cordylomera spinicornis* Fabricius**

[Regularly in imported timber from Africa.]

*Mature larva.* In the single larva available, no characters are evident whereby this species can be separated from *C. suturalis*.

Host plants: Various African mahoganies, including *Khaya*.

*Material studied.* 1 L, from East African logs (*Khaya* sp.), 13.vi.1947, in coll. F.P.R.L.

*References.* Duffy (1952).

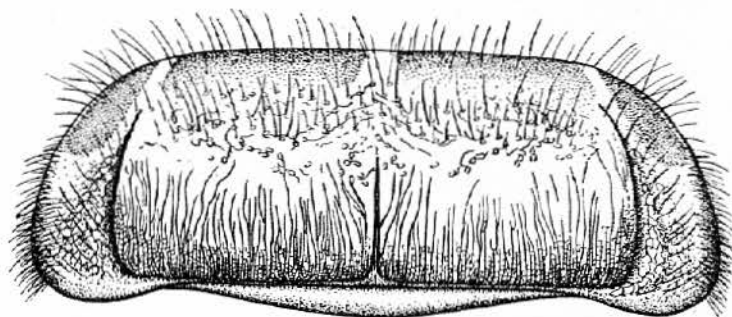
**\**Elaphidion nanum* Fabricius**

[Occasionally in imported timber from Jamaica and South America.]

*Mature larva* (fig. 153). Similar to that of *Coleocoptus senio*, from which it may be distinguished as follows. Length up to 17 mm.; maximum breadth (at prothorax) 4.75 mm. *Head* with third segment of antenna rather slender, cylindrical, about three times as long as its basal width and about two-thirds as long as second segment. Two pairs of ocelli present laterad and ventrad of antenna; lens small, round;

pigmented spot distinct. Hypostomal sutures indistinct. Maxilla with third segment of palpi as long as second. *Prothorax* (fig. 153) with lateral regions without velvety pubescence, and pronotum more finely longitudinally striate.

*Pupa* (fig. 154). As in the case of the larvae, pupae of this genus are remarkably diverse and that of *E. nanum* does not conform to the general characters of the Phoracanthini. It differs from other genera of the Phoracanthini so far examined as



1 mm.  
Fig. 153

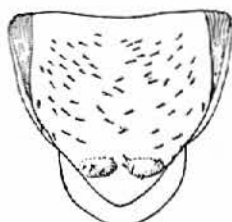


Fig. 154

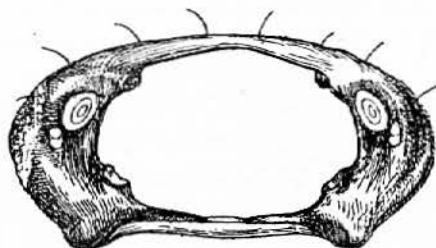


Fig. 155

Fig. 153. *Elaphidion nanum* Fabricius. Mature larva. Prothorax. Dorsal aspect.

Fig. 154. *Elaphidion nanum* Fabricius. Female pupa. Seventh and eighth abdominal tergites.

Fig. 155. *Elaphidion mucronatum* Fabricius. Mature larva. Mouthframe. (Craighead, 1923b)

follows. Length up to 13 mm. *Head* with antennae filiform. Eyes with three or four long fine setae near posterior margin. *Pronotum* glabrous, except for a few minute spinules and setae along front margin; lateral tubercles absent. *Abdomen* with seventh tergite (fig. 154) with numerous long, slender spines, which are mostly recumbent and pointing inward; posterior margin with a pair of very small tuberculate protuberances which bear a few sub-erect spines. Eighth tergite glabrous, with hind margin semi-circular.

Host plants: *Guaiacum officinale* (Fraser, 1948c); *Conocarpus* (Schwarz, 1886).

*Biology*. The larvae feed subcortically for their entire larval existence in branches and boles and make meandering galleries which are roughly two-thirds or more in the bark, and one-third or less in the sapwood [Pl. I, fig. 2]. The pupal habitat is in the

outer sapwood, or, occasionally, in the inner bark. The pupal cell consists of a short, shallow, oval excavation about 3 cm. long. It is usually formed close to where the larval gallery was first started. Pupation takes place in August and September, and emergence during September and October.

*Parasites.* Many larvae and pupae were observed by the writer to be infested with dipterous larvae belonging to the family Phoridae.

*Material studied.* 15 L, 4 P, 2 I, Lancashire, 13.ix.1948, in *Guaiacum* imported from Jamaica, M.G.F. leg., in coll. D. [Adults reared.]

*References.* Fraser, 1948c (Biol.); Schwarz, 1886 (Biol.).

**\*Elaphidion mucronatum** Fabricius

[Occasionally imported in timber from North America.]

*Mature larva* (fig. 155). Similar to that of *E. nanum*, from which it may be distinguished by the characters given in the key, p. 76.

Host plants: *Quercus*, *Chamaerops palmetto*, *Celtis*, *Vitis*, *Cercis canadensis*, *C. japonica*, *Fagus*, *Acer* (Chittenden, 1898); *Rhus*, *Morus*, *Castanea*, *Populus*, *Liriodendron*, *Asimina*, *Pyrus*, *Sassafras*, *Taxodium* (Craighead, 1923b); recently imported in *Tilia* (Duffy).

*Biology.* The larva feeds subcortically in dry twigs and dead branches, but does not girdle as do most species of this genus (Chittenden, 1898). Pupation occurs in the sapwood. The pupal cell enters at right angles to the grain of the wood and then abruptly turns parallel to it. It is opened through the bark by the larva (Craighead, 1923b).

*Economic importance.* This species is particularly destructive to rustic furniture.

*Material studied.* 7 L, U.S.A., Grenville, Carolina, 12.ii.1913, F. C. Craighead leg., in coll. U.S.N.M.

*References.* Chittenden, 1898 (Biol.); Craighead, 1923b (L fig. Biol.), 1950 (Biol., Contr.).

**\*Elaphidion spinicorne** Drury

[Occasionally in imported timber from Jamaica and South America.]

*Mature larva.* No material or references available.

**\*Romaleum rufulum** Haldeman.

[Occasionally in imported timber from North America.]

*Mature larva* (figs. 156, 157). Craighead (1923b) gives the following description: "Form robust, elongate, anteriorly depressed; integument tough, firm, shining, sparsely covered with short coarse castaneous hairs. *Head* roundly rectangular, slightly narrowed in front; mouthframe heavily corneous, piceous; labrum transversely oblong, hairs short, stiff; mandibles stout, piceous, basal piece about one-half length of distal, fovea on outer face; antennae slender, first and second joints subequal, third slender, shorter, supplementary a mere point; ocellus large, globular, clear, somewhat enveloped

by gena. Ventral mouthparts more corneous than usual; last joint of maxillary palpi more slender and shorter than either second or last labial; process of palpifer distinct; hypostomal edge finely longitudinally wrinkled, the outer striae becoming transverse (fig. 156); gula longer than wide. *Prothorax* (fig. 157) depressed, little more than twice as wide as long; hairs on lateral region short, subulate, ferruginous; pronotum nearly

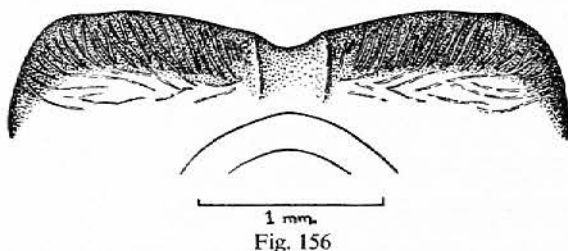
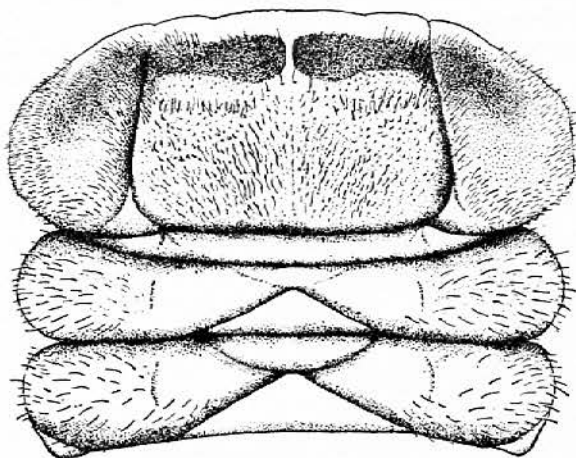
1 mm.  
Fig. 156

Fig. 157

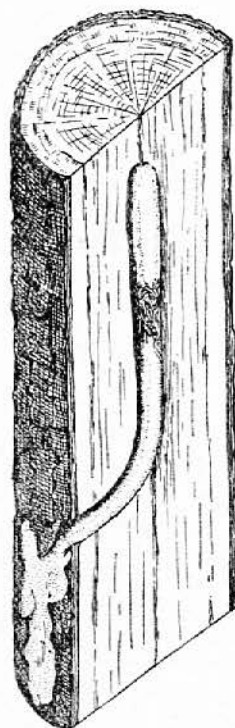


Fig. 158

Fig. 156. *Romaleum rufulum* Haldeman. Mature larva. Hypostoma.

Fig. 157. *Romaleum rufulum* Haldeman. Mature larva. Pro-, meso- and metanotum. (Craighead, 1923b)

Fig. 158. *Romaleum rufulum* Haldeman. Pupal cell in *Quercus*. (Craighead, 1923b)

twice as wide as long, with a border of short hairs on anterior margin, posterior area slightly embossed, protruding forward in centre, irregularly pinnately striate; median suture faintly impressed behind; sternum narrowly rectangular, very broad; ventrolateral sutures distinct; mesonotum and metanotum bearing X-shaped impression. *Legs* long, four-jointed. *Abdomen*: dorsal ampullae broadly oval, alutaceous, shining, marked by two lateral and two transverse impressions. Pleural disc wrinkled, indistinct. *Spiracles* broadly oval, peritreme corneous."

*Pupa*. Craighead (1923b) gives the following description: "Pronotum, mesonotum, and metanotum sparsely and rather regularly beset with minute erect asperities; abdominal terga armed with well-dispersed, erect, acute spines which become

larger and curved posteriorly, arranged in a somewhat oval figure, none on eighth segment."

Host plant: *Quercus* (Craighead, 1923b).

*Biology.* The larva feeds subcortically for about one year in boles and branches of living trees. It then excavates a long, vertical gallery deep into the heartwood (fig. 158); this is kept perfectly clear, large quantities of frass being ejected (Craighead, 1923b).

*Economic importance.* This species is considered to be of considerable economic importance and often become sufficiently numerous to kill completely fine, mature trees.

*Control.* Craighead (1950) recommends the injection of larval galleries with carbon disulphide or carbon tetrachloride, the holes afterwards being plugged with moist soil or putty. Spraying with orthodichlorobenzene is also recommended.

*Material studied.* 2 L, 2 P, U.S.A., Grenville, Carolina, 12.iii.1913, from *Quercus*, F. C. Craighead leg., in coll. U.S.N.M.; 1 L, England, Liverpool, x.1950, from bookcase of American *Quercus*, M.G.F. leg., in coll. D.

*References.* Craighead, 1923b (L fig., P fig., Biol. fig.), 1950 (Biol., Contr.); Fisher, Cann & Parkin, 1932 (Biol. fig.).

#### \*Sphaerionini

##### \**Stizocera plicicollis* Germar

[Very occasionally in imported timber from South America.]

*Mature larva.* No material available.

Host plant: ? *Dalbergia nigra*.

##### \**Ambonus electus* Gahan

[Very occasionally in imported timber from South America.]

*Mature larva.* No material available.

*References.* Bayford, 1950 (P, Biol.).

#### (\* Callidiopini

##### (\* *Trinophylum cribratum* Bates

[Recently in imported timber from India, and possibly now established in England.]

*Mature larva.* From the single larva at hand, which may possibly prove to be of this species, the characters are typical of those of the Callidini, and its resemblance to that of *Phymatodes testaceus* (with which it had been found), appears to be very close and differs as follows. *Head* subrectangular. Ocellus with distinct but feebly convex lens; pigmented spot less distinct. Mouthframe finely rugose, not interrupted beneath antenna. Antenna with second segment at least twice as long as broad. Maxilla with third segment of palp scarcely or not longer than second. *Abdomen* with ampullae much more coarsely reticulate. Pleural discs indistinct.

Host plants: *Quercus dilatata*, *Q. incana* (Beeson & Bhatia, 1939). This species has recently been discovered infesting English oak (*Quercus robur*) (Gilmour, 1948).

*Biology.* Probably very similar to that of *Phymatodes testaceus* (see p. 218), as adults of both species have been seen to emerge from the same wood. Emergence takes place in May and June. The account of this species by Stebbing (1914) is erroneous and actually applies to *Tetropium oreinum* Bates.

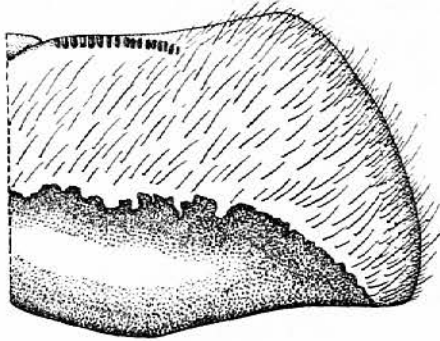
*Material studied.* 1 L ?, I.o.W., viii.1948, from *Quercus* heavily infested with *Phymatodes testaceus*, J. W. Saunt leg., in coll. D.

*References.* Beeson & Bhatia, 1939 (Biol.); Gilmour, 1948 (Biol.).

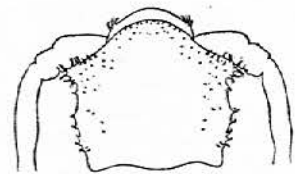
**\**Cylindera flava* Fabricius (= *pilicornis* Fabricius)**

[Occasionally in imported timber from North America.]

*Mature larva* (fig. 159). Length up to 16 mm.; maximum breadth (at prothorax) 4.2 mm. *Head* transverse, with sides diverging posteriorly. Genae with numerous long, pale, slightly curved setae. Front margin narrowly pitchy. Labrum transversely oval. Ocelli absent. Hypostoma with front margin narrowly ferruginous; sutures indistinct; some long, fine setae present on each side of gula, which is distinctly raised.



1 mm.  
Fig. 159



1 mm.  
Fig. 160

Fig. 159. *Cylindera flava* Fabricius. Mature larva. Left half of prothorax.

Fig. 160. *Cylindera flava* Fabricius. Pupa. Head and pronotum.

Maxillary and labial palps with third segment longer than second. *Prothorax* with posterior half of pronotum dull, milky white and finely granulate; front margin of prothorax (fig. 159) with a row (interrupted medially) of about thirty small, elongate, brownish tubercles; proeusternum dull, milky white and finely granulate. *Abdomen* with ampullae granulate and glabrous. *Legs* small, slightly longer than third segment of maxillary palp.

*Pupa* (fig. 160). Length 8–11 mm.; maximum breadth 3.1 mm. *Head* with vertex, which is visible from above, bearing a group of spines immediately above each antenna. Eyes strongly convex with a row of spines along ventral margin. *Pronotum* with a pair of prominent, spinose, lateral tubercles near front margin. *Abdomen* with

spines on tergites one to six mostly directed anteriorly. Seventh tergite with numerous scattered, short spines. Eighth tergite with about six short spines. *Legs* with femora strongly clavate; hind femora extending as far as fifth abdominal segment. *Functional spiracles* present on first five abdominal segments, but vestigial pairs present on sixth and seventh; peritreme broadly oval and moderately thick.

*Host plants:* *Pimenta officinalis* and *Acacia decurrens*.

*Biology.* Apparently unknown.

*Material studied.* 8 L, 1 P, Honolulu, v.1928, from *Acacia decurrens*, O. H. Swezey leg., in coll. U.S.N.M.

*References.* Schiödte, 1876 (L fig.).

### Molorchini

#### Larval Characters

Larvae of the genera *Molorchus*, *Obrium*, *Gracilia*, and *Leptideella* appear to form so natural and homogenous a group that they are dealt with here as one tribe instead of being segregated into the tribes Molorchini, Obriini, Graciliini, and Psebiini respectively.

Form small, slender, seldom as much as 17 mm. in length. *Head* depressed, strongly transverse, widest at or just behind middle. Gena not shouldered but gradually narrowed up to base of mandible and bearing numerous long, slightly curved setae. Mouthframe interrupted beneath antennae. Ocelli usually absent, but sometimes one pair present. Antenna with first and second segments very short; third segment elongate, cylindrical; supplementary process well developed, about half as long as third segment. Maxillary palp with third segment much longer than second; process of palpifer rather large. Labial palp with third segment much longer than second. *Prothorax* with pronotum striate posteriorly (except *Leptideella*); median suture inconspicuous (except *Obrium*). Postnotal fold present. Eusternum usually distinct. *Abdomen* with ampullae granulate, often bilobed. Pleural discs indistinct. *Legs* extremely small or absent. *Spiracles* very small, with peritreme below general level of cuticle.

#### *Molorchus umbellatarum* (von Schreber)

*Mature larva* (figs. 161-165). Length up to 9 mm.; maximum breadth (at prothorax) 2.1 mm. Form subcylindrical, moderately slender and tapering posteriorly. *Head* (fig. 161) strongly transverse (maximum head-width 1.54 mm.), widest just behind middle, testaceous, shining and moderately strongly sclerotised. Genae with numerous long, rather stout golden setae, which are curved backward. Mouthframe slightly rugose, heavily sclerotised, broadly ferruginous dorsally and bearing a few stout setae. Frons with a small pair of paramedian oval depressions near front margin, each bearing a short seta. Antenna (fig. 162) minute, conical, three-segmented; second segment transverse and bearing ventrally a lanceolate supplementary process; apical segment elongate and equipped with one very long and two shorter setae. Mandible robust, shining, basal part reddish-brown, apical part pitchy. Labrum transversely oval, broadly rounded in front and bearing numerous stout setae. Ocelli

absent. Hypostoma with anterior margin narrowly testaceous; sutures divergent, nearly straight. Gular sutures indistinct. Maxilla (fig. 163) and labial palpi (fig. 165) as figured. *Prothorax* depressed, almost three times as broad as long. Pronotum

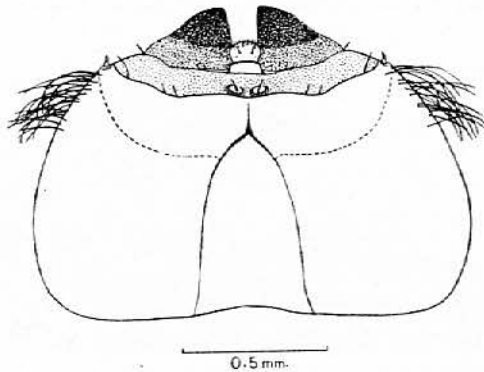


Fig. 161

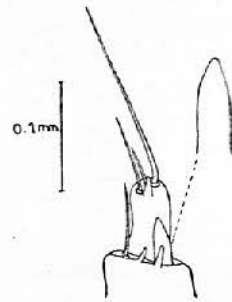


Fig. 162

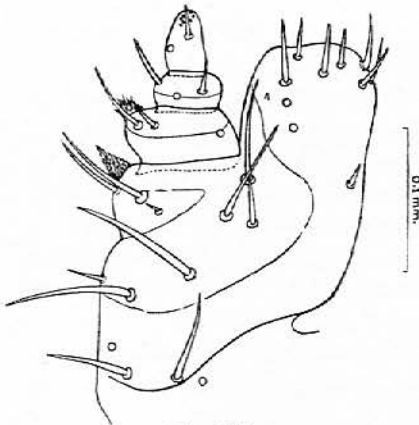


Fig. 163

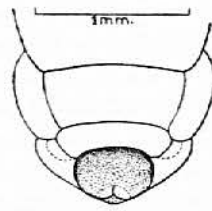


Fig. 164

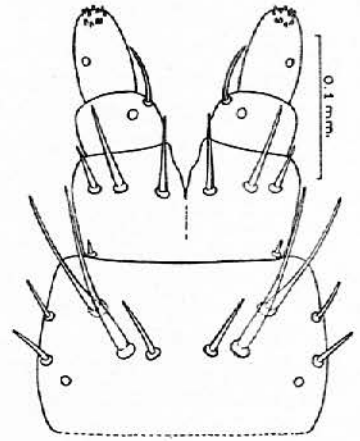


Fig. 165

Fig. 161. *Molorchus umbellatarum* (von Schreber). Mature larva. Head. Dorsal aspect.

Fig. 162. *Molorchus umbellatarum* (von Schreber). Mature larva. Apical part of antenna. Lateral aspect.

Fig. 163. *Molorchus umbellatarum* (von Schreber). Mature larva. Right maxilla. Ventral aspect.

Fig. 164. *Molorchus umbellatarum* (von Schreber). Mature larva. Last three abdominal sternites.

Fig. 165. *Molorchus umbellatarum* (von Schreber). Mature larva. Labial palpi. Ventral aspect.

rectangular, about twice as wide as long and with median cleavage line indistinct; anterior half smooth, testaceous and bearing a row of fine setae along front margin; posterior half milky white, glabrous, shining and confusedly rugose except at base, where the rugosity becomes longitudinal. Sternum very broad and narrow, rather coarsely granulate. *Mesonotum* and *metanotum* finely granulate, less shining than pronotum. *Abdomen* with dorsal ampullae very slightly bilobed, shining, finely rugose,

granulate and with a posterior transverse and somewhat curved impression. Intersegmental skin finely and transversely rugose. Epipleura (fig. 164) forming a protuberant ridge on last three segments. Hind margin of ninth abdominal tergite with numerous short brownish setae. Anal lobes compact, transversely oval and dome-shaped (fig. 164). *Legs* absent. *Spiracles* of abdomen with peritreme broadly oval, testaceous, feebly sclerotised and below general level of cuticle.

*Pupa* (figs. 166–168). Length 6.5–9.4 mm.; maximum breadth 1.5 mm. *Head* triangular, with vertex, which is visible from above, smooth and glabrous; front smooth and with two groups of four setae. Antennae extending as far as fifth or

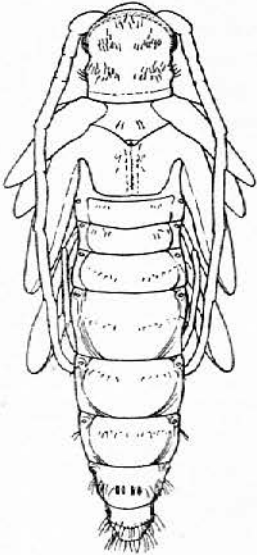


Fig. 166



Fig. 168

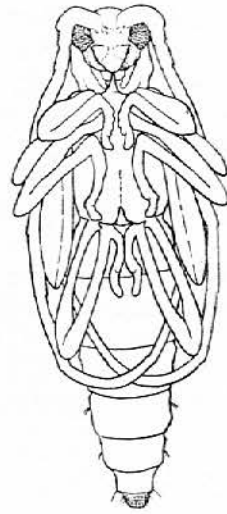


Fig. 167

Fig. 166. *Molorchus umbellatarum* (von Schreber). Male pupa. Dorsal aspect.

Fig. 167. *Molorchus umbellatarum* (von Schreber). Male pupa. Ventral aspect.

Fig. 168. *Molorchus umbellatarum* (von Schreber). Pupa. Spines of seventh tergite (enlarged).

sixth abdominal segment where they either terminate (in female), or are strongly recurved and crossed to terminate near lateral margins of third abdominal segment (in male). Eyes very strongly convex and with a single seta near mesal margin. Labrum triangular, glabrous. *Pronotum* with front margin strongly rounded, raised and about equal in width to hind margin, near which is a transverse impression; smooth, bearing five to seven groups of long, ferruginous setae, which are inclined forward. *Mesonotum* short, with two pairs of setae on disc; scutellum moderately protuberant, with a median depression. *Metanotum* elongate, with a few small scattered setae on disc; scutellar groove moderately distinct. Elytra very short, about half the length of wings; wings extending to fourth abdominal segment. *Abdomen* with tergites one and two, each with two groups of short setae; tergites three to six, each with a transverse row of very short spines (each with a fine basal seta). Seventh tergite tapering posteriorly and with four large blade-like spines, which are directed anteriorly. Eighth and ninth

tergites with posterior margins fringed with long, fine, pale, setae. Sternites glabrous (except in female, where the paired tubercles on the tenth sternite each have a single seta). Pleura moderately protuberant, each with paired, fine setae. Legs with femora strongly clavate; hind femora extending as far as fifth abdominal segment and lying almost parallel to longitudinal axis of body. Functional spiracles present on first six abdominal segments, but a vestigial pair present on seventh; peritreme broadly oval, thin and raised above general level of cuticle.

Host plants: *Rubus*, *Pyrus malus*, *Rosa canina* (Duffy, 1946c, Perris, 1877). Reineck (1919) records *Picea* and *Pinus*.

**Biology.** The larval habitat is in slender, slightly decaying twigs and stems. The larvae feed subcortically until about two-thirds grown, making broad, shallow galleries (fig. 169). They then bore into the wood to pupate. The pupal cell (fig. 169) is slightly curved and plugged with two wads of tightly packed frass, one at the entrance to the cell, and the other about half-way along, immediately in front of the pupa. Pupation occurs during April and May, and adults emerge from May to July.

**Parasites.** Hymenoptera: *Perithous septemcinctorius* Thunb., *P. divinator* Rossi, *Ephialtes messor* Grav. (Rudow, 1912).

**Material studied.** 12 L, Surrey, Bookham, iii.1946, in decaying stem of *Rosa canina*, D. leg., in coll. D.; 4 L, 1 P, 2 I, Surrey, Ashtead, iv.1946, in twig of *Pyrus malus*, D. leg., in coll. D. [Adults reared.]

**References.** Della Beffa, 1931 (Biol.); Duffy, 1946c (Biol.), Henriksen, 1914 (L fig.); Kaltbach, 1874 (Biol.); Perris, 1877 (L fig., P, Biol.); Reineck, 1919 (Biol.); Rudow, 1912 (Biol.); Verhoeff, 1891 (Biol. fig.); Xambeu, 1902 (L, P, Biol.).

### **Molorchus minor** (Linnaeus)

**Mature larva** (figs. 170, 171). This larva closely resembles that of *M. umbellatarum*. A detailed comparison is unnecessary as all the important differences are given in the key, p. 76.

The larva has previously been described by Schiödte (1876), who wrote of the legs: "Pedes palpis maxillaribus dimidio minores; tibiae cylindricae, longitudinis femorum; unguulae tibiis dimidio longiores, parte terminali valde extenuata, profunde bisinuata." It is difficult to see how this error arose: in the present larval material not even vestigial legs are evident, and according to Craighead (1923b), Emden (1939-1940), and Paulian & Villiers (1941), all known larvae of this genus are apodous.

**First-instar larva.** Length up to 1.5 mm.; maximum breadth 0.30 mm. Head with one pair of very distinct ocelli. Egg-bursting spines as in *Rhagium bifasciatum* (fig. 63), but much smaller. Spiracles biforous.

**Pupa.** Very similar to that of *M. umbellatarum*, from which it differs as follows. Length up to 11 mm. Head with front usually with two groups of two fine setae. Abdomen with seventh tergite with six anteriorly directed spines; each spine proportionately smaller and thorn-like. Eighth tergite with two or more spines (as well as setae), which are much smaller than those on seventh tergite.

**Egg.** Length 1.1 mm.; breadth 0.3 mm. Form somewhat variable but usually

elongate, subcylindrical, with rounded poles, one being considerably broader than the other. Some eggs examined have been pear-shaped. Chorion thin, soft, white, feebly shining and finely reticulated. The eggs are usually deposited in batches of about half a dozen.

Host plants: *Pinus*, *Picea*, *Larix* and *Betula* (Duffy, 1946c).

*Biology.* The larval habitat is in recently cut or damaged branches and, occasionally, in exposed roots and boles. The habits of the larva are similar to those of *M. umbellatarum*. The galleries (fig. 172), when numerous, form a characteristic

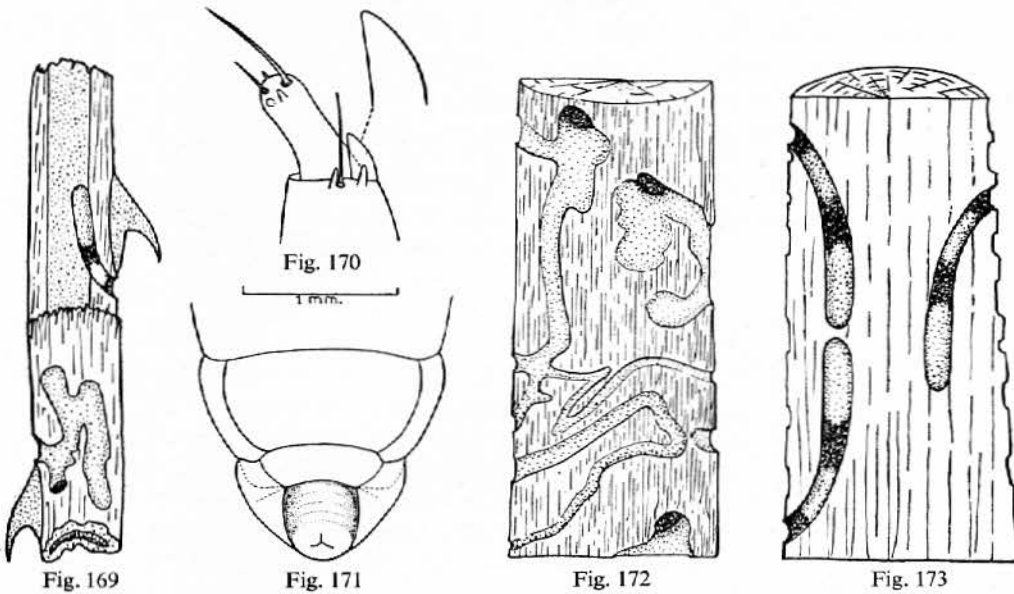


Fig. 169. *Molorchus umbellatarum* (von Schreber). Larval gallery and pupal cell in stem of *Rosa*.

Fig. 170. *Molorchus minor* (Linnaeus). Mature larva. Apical part of antenna.

Fig. 171. *Molorchus minor* (Linnaeus). Mature larva. Last three abdominal sternites.

Fig. 172. *Molorchus minor* (Linnaeus). Subcortical larval galleries in section of *Larix*.

Fig. 173. *Molorchus minor* (Linnaeus). Pupal cells in section of *Larix*.

pattern which is quite distinct from those of other larvae. The writer has recently seen trees covered with these conspicuous and unusual galleries, which extended even up to the uppermost twigs (Pl. VI, fig. 25) and down to the exposed portions of the roots.

The pupal cell (fig. 173) is essentially similar to that of *M. umbellatarum* and characteristic of those of the genus as a whole. According to Zwölfer (1936), pupation takes place in the bark, but this would seem to be exceptional. Pupation occurs in July and August, the adults ecdoding in August or September. They remain in their pupal cells until the following May or June. The life-cycle is completed in two years.

*Parasites.* Hymenoptera: *Cleonymus depressus* F.,<sup>1</sup> and *Helcostizus albator* Thunb. (reared by the writer).

<sup>1</sup> Identified by J. F. Perkins (British Museum, Natural History).

*Material studied.* 26 L, Surrey, Ashtead, 16.i.1946, in exposed roots and dead branches of *Picea*, D. leg., in coll. D.; 28 L, Surrey, Effingham, vi.1948, in cut branches of *Picea*, D. leg., in coll. D. [Adults reared.]

*References.* Altum, 1874 (Biol.); Barbey, 1913 (Biol.); Busse, 1929 (Biol.); Della Beffa, 1931 (L, Biol.); Duffy, 1946c (Biol.); Escherich, 1923 (Biol. fig.); Hacker, 1900 (Biol.); Henriksen, 1914 (L fig.); Judeich & Nitsche, 1889 (Biol.); Kaltenbach, 1874 (Biol.); Nüsslin, 1905 (Biol.); Ratzeburg, 1839 (Biol.); Reineck, 1919 (Biol.); Röthenburg, 1907 (Biol.); Rudow, 1897 (Biol.); Saalas, 1923 (P fig.); Schiödte, 1876 (L fig.); Trägårdh, 1939 (Biol. fig.); Trappen, 1908 (Biol.); Xambeu, 1898-1902 (L, P, Biol.); Zwölfer, 1936 (Biol. fig.).

[Graciliini]

*Gracilia minuta* (Fabricius)

*Mature larva.* Very similar to those of *Molorchus* species, from which it differs as follows. Form much more slender. *Head* with a distinct ocellar lens laterad and slightly ventrad of antenna; pigmented spot black, very distinct. *Prothorax* with pronotum more closely and evenly longitudinally striate. *Abdomen* with ampullae more strongly protuberant. Epipleura of eighth and ninth segments much less strongly protuberant. *Legs* present but very minute.

*Pupa* (fig. 174). Length 3.5-7 mm.; maximum breadth 1.3 mm. *Head* with vertex visible from above, smooth and with about six papillae (each with a long, fine, subapical seta) on each side of disc; front with two or three minute setae near base of each antenna; clypeus with a transverse impression at base. Antennae extending as far as fourth abdominal segment, where they are strongly recurved to terminate near fore coxae. Eyes moderately convex, with a stout seta near mesal margin. Labrum triangular, glabrous. *Pronotum* bearing numerous long pale papillae (each with a long, fine basal seta) along front and lateral margins and two groups of fine setae near base. *Mesonotum* smooth and usually glabrous; scutellum moderately protuberant. *Metanotum* smooth, but sometimes with two or three minute setae. Elytra and wings extending to third abdominal segment. *Abdomen* with tergites one to six, each with a transverse row of from four to six short papillae (each with a fine seta). Ninth segments retracted into eighth and not visible from above. Sternites glabrous or almost so.

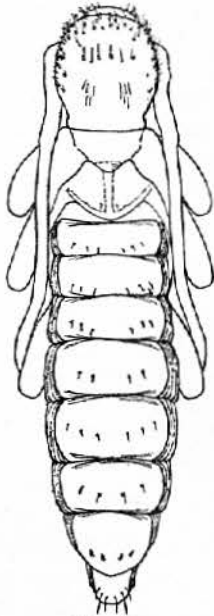


Fig. 174.  
*Gracilia minuta* (Fabricius). Female pupa.  
Dorsal aspect.

Pleura slightly protuberant, each with fine, paired setae. *Legs* with hind femora extending as far as fourth abdominal segment, and lying almost parallel to longitudinal axis of body. *Functional spiracles* present on first seven abdominal segments; peritreme round, very thin, and inconspicuous, but slightly raised above general level of cuticle.

Host plants: *Rubus*, *Rosa canina*, *Corylus* (Duffy, 1946c); *Salix*, *Aesculus*, *Betula*, *Quercus* (Reineck, 1919); *Crataegus* (Judeich & Nitsche, 1889); *Rhamnus alternus*, *Ceratonia siliqua* (Peyerimhoff, 1919).

*Biology.* The larval habitat is in dead, dry stems, branches and twigs (Pl. IV, fig. 18). Nests of the ant *Formica rufa* have been known to be composed of twigs infested with larvae of this species (Bouillon, 1859). According to Kaufmann (1948) this species has been known to breed in old shoe-leather.

The larvae make irregular longitudinal galleries under the bark. During March or April they pupate either head upward or head downward in the sapwood or pith channel. The pupal cell is similar to those of *Molorchus* species. Sometimes pupation takes place in the bark, if it is thick. Adults emerge from May to July.

*Economic importance.* This species has on occasions caused extensive damage to wickerwork (Hincks, 1930), rustic work, wooden hoops or casks, etc. Infestation often continues until the wood is almost completely reduced to powder. According to Fowler & Donisthorpe (1913) this species has been known to infest osiers grown at Lulworth Cove by fishermen for making lobster-pots.

*Material studied.* 12 L, 3 P, Surrey, Ashtead, 21.iv.1946, in dead stem of *Rubus*, D. leg., in coll. D.; 2 L, 2 P, Surrey, Effingham, 21.iv.1946, in dead *Rubus*, D. leg., in coll. D. [Adults reared.]

*References.* Beutenmuller, 1896 (Biol.); Bouillon, 1859 (Biol.); Della Beffa, 1931 (L, P, Biol. fig.); Duffy, 1946c (Biol.); Emden, 1939-1940 (L); Fowler & Donisthorpe, 1913 (Biol.); Henriksen, 1914 (L); Hincks, 1930 (Biol.); Judeich & Nitsche, 1889 (Biol.); Nördlinger, 1880 (Biol.); Perris, 1877 (L, P, Biol.); Peyerimhoff, 1919 (Biol.); Reineck, 1919 (Biol.); Sandahl, 1892 (Biol.); Schiödte, 1876 (L fig.); Schmitt, 1843 (L); Verhoeff, 1892 (Biol.); Xambeu, 1898-1902 (L, P, Biol.).

#### \**Penichroa fasciata* Stephens

[Occasionally in imported timber from southern Europe.]

*Mature larva.* No material available.

Host plants: *Glycyrrhiza glabra* (roots); also in *Ceratonia siliqua*, *Pistacia*, *Lentiscus*, *Eucalyptus globulus* and *Pinus halepensis* (Peyerimhoff, 1919).

*Biology.* Larvae infest recently dead or decaying twigs in particular. Adults emerge from June to August (Peyerimhoff, 1919).

*References.* Peyerimhoff, 1919 (Biol.).

#### [Obrini]

#### *Obrium cantharinum* (Linnaeus)

*Mature larva* (fig. 175). Very similar to those of *Molorchus* species, from which it differs as follows. Form more slender and elongate. Length up to 17 mm. Head with lens of ocellus rather large and feebly convex; pigmented spot distinct. Antenna with second segment twice as long as broad; third segment slender, cylindrical, about four times as long as broad. Gula distinct, triangular. *Prothorax* with posterior part

of pronotum rather coarsely striate; median cleavage line feebly impressed. *Abdomen* with ampullae on segments three to seven (fig. 175) deeply bilobed and strongly protuberant. *Epipleura* scarcely protuberant on last three segments. *Legs* very minute, much shorter than third segment of maxillary palp.

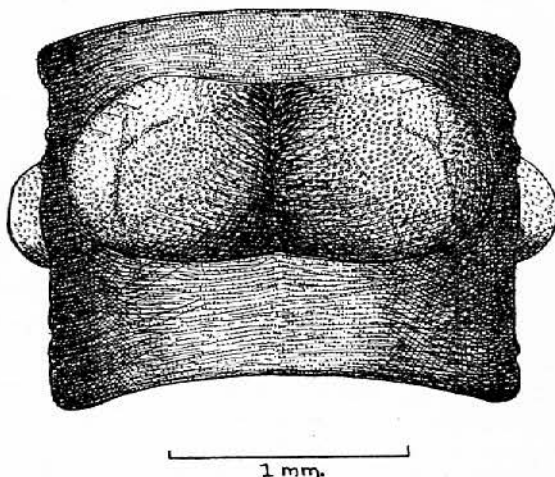


Fig. 175. *Obrium cantharinum* (Linnaeus). Mature larva. Third abdominal segment. Dorsal aspect.

*Pupa.* The pupa has been briefly described and figured by Palm (1942), but there are not sufficient details provided to enable the present writer to effect a comparison with those of allied genera.

*Host plants:* *Populus tremula*, *Quercus* (Reineck, 1919); *Pyrus malus* (Fowler, 1889-1890).

*Biology.* The larval habitat is in branches and boles of hard, sound trees, usually of a diameter of 15-30 cm., and with the bark 4-15 mm. thick (Palm, 1942). The larvae feed subcortically and enter the sapwood only to pupate. The gallery and pupal cell are similar to those of *Molorchus* species. Pupation takes place in May and June, and emergence in June and July. Adults are often to be found on flowers of Umbelliferae. The life-cycle is completed in one year.

*Parasites.* Hymenoptera: *Ephialtes mesocentrus* Gr., *Xorides praecatorius* Gr., *Deuteroxorides albitarsus* Gr., *Spathius curvicaudis* Ratz. (Palm, 1942).

*Material studied.* 1 L, Sweden, Aelokarleby sorkan, Upland, 21.viii.1938, from *Populus tremula*, Palm leg., in coll. E.

*References.* Bedel, 1889 (Biol.); Davis, 1833 (Biol.); Emden, 1939-1940 (L); Fowler, 1889-1890 (Biol.); Kaltenbach, 1874 (Biol.); Palm, 1942 (L fig., P fig., Biol. fig.); Reineck, 1919 (Biol.); Xambeu, 1898-1902 (Biol.); 1899 (L, P).

(\*) ***Obrium brunneum*** (Fabricius)

*Mature larva.* No material available.

*Host plants:* *Abies excelsa* (Estiot, 1905); *Pinus*, *Picea* (Bedel, 1889).

*Biology.* The larval habitat is under the dead bark of branches and boles. Pupation occurs from April to May, and emergence from May to July.

*References.* Bedel, 1889 (Biol.); Estiot, 1905 (Biol.); Galibert, 1917 (Biol.); Harwood, 1946 (Biol.).

[Psebiini]

***Leptideella brevipennis* (Mulsant)**

[Occasionally imported from the Continent in wickerwork, etc.]

*Mature larva* (fig. 176). The characters by which this larva may be distinguished from those of *Molorchus* species are given in the key, p. 73.



Fig. 176. *Leptideella brevipennis* (Mulsant). Mature larva. Lateral aspect.

*Egg.* According to Nicolas (1884) the eggs are covered with a glutinous coating, mixed with particles of earth or dust which have accumulated on the pubescent abdomen of the adult (see also pp. 32 and 47).

*Host plants:* *Salix* (Reineck, 1919); *Rosa canina* (Duffy, 1946c). According to Kaufmann (1946) this species is less discriminating on the Continent, and has been recorded feeding in *Castanea*, *Quercus*, *Corylus*, *Cupressus* and *Robinia*. Middlekauff & Underhill (1949) record it from *Ficus* and *Juglans*, and Peyerimhoff (1919) from *Ceratonia* and *Pinus*.

*Biology.* The larvae feed in dead stems and twigs and in wickerwork. Pupation takes place in April and May, and emergence during June and July.

*Economic importance.* Considerable damage has been done in the past by this species to wickerwork (Hincks, 1930). As in the case of *Gracilia minuta*, infestation continues for several years until the wickerwork has been almost reduced to powder. According to Fowler & Donisthorpe (1913) this species has been known to infest osiers grown at Lulworth Cove by fishermen for making lobster-pots. A cotton-mill in Germany recently became infested with this species through the importation of osier baskets (Prell, 1927a). N. E. Hickin recently sent the writer a section of a hurdle made of hazel and some osier wickerwork which were heavily infested. They were both definitely of English origin, which confirms the writer's contention that this species is now established in this country.

*Control.* Manon (1911) suggests the impregnation of infested wickerwork with petrol or copper sulphate solution.

*Material studied.* 4 L, North America, New York, 5.v.1948, in barrel-hoops (*Castanea*) imported from France, in coll. E. [This species has recently been reared by the writer from larvae taken from *Rosa* at Ashtead, Surrey.]

*References.* Barnes, 1904 (Biol.); Delarue, 1875 (Biol.); Della Beffa, 1931 (L, P, Biol.); Duffy, 1946c (Biol.); Emden, 1939-1940 (L); Fowler & Donisthorpe, 1913

(Biol.); Hincks, 1930 (Biol.); Kaufmann, 1946 (Biol.); Manon, 1911 (Biol.); Middlekauff & Underhill, 1949 (Biol.); Nicolas, 1884 (Biol.); Perris, 1877 (L, P, Biol.); Peyerimhoff, 1919 (Biol.); Prell, 1927 (Biol.); Reineck, 1919 (Biol.); Xambeu, 1898-1902 (L, P, Biol.).

**\*Tessarommatini**

**\*Tessaromma undatum** Newman

[Occasionally in imported timber from Australia.]

*Mature larva.* No material or references available.

Host plants: *Eucalyptus* species.

**\*Eburiini**

**\*Eburia quadrigeminata** Say

[Frequently in imported timber from North America.]

*Mature larva* (fig. 177). Length up to 25 mm.; maximum breadth (at prothorax) 7 mm. Form rather robust, compressed posteriorly. *Head* quadrate, with sides almost straight and parallel-sided (maximum head-width 4.2 mm.). *Gena* moderately shouldered, smooth, narrowly testaceous and bearing a few long, fine setae. *Front*

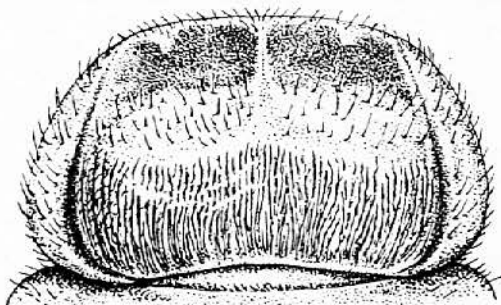


Fig. 177. *Eburia quadrigeminata* Say. Mature larva. Pronotum. (Craighead, 1923b)

margin of head rather indistinctly ferruginous. Front margin of frons evenly rounded. Antennal foramen with upper boundary not raised or produced. Mouthframe entirely sclerotised beneath antennae. Antenna slender, with second and third segments at least twice as long as broad; third segment cylindrical, about half length of second; supplementary process minute. Clypeus very short. Labrum suborbicular, thick, fleshy, with front margin densely setose. Mandible short, stout; basal part ferruginous, two-thirds length of pitchy, apical part. Ocellus subcontiguous with base of antenna; lens large, round, white; pigmented spot very indistinct and partly surrounded by shouldered gena. Hypostoma with front margin longitudinally rugose, testaceous. Gular sutures protuberant, parallel. Maxilla with third segment of palp shorter than second; process of palpifer minute. *Prothorax* (fig. 177) quadrangular, with four pale yellow, sclerotised plates; pronotum slightly transverse; anterior part bearing scattered fine setae; posterior part alutaceously striate and with scattered lenticular pits; median

cleavage line deeply impressed. Sternum wrinkled, with scattered setae, except for two glabrous, smooth patches on eusternum. *Abdomen* compressed laterally; dorsal ampullae alutaceous, shining, with two lateral and two transverse grooves. Anal lobes rugose. Pleural discs wrinkled, indistinct. *Legs* four-segmented, moderately long; unguiculus flagelliform, feebly sclerotised and imbricately spinose. Spiracles with peritreme thin and pale.

*Pupa.* See key, p. 92.

Host plants: *Quercus*, *Hicoria*, *Robinia*, *Fraxinus*, *Castanea*, *Ulmus*, *Fagus* (Craighead, 1923b); *Acer*, *Cupressus* (Craighead, 1950).

*Biology.* The larvae bore into the heartwood of dry solid timber, excavating large, contorted galleries, which are very tightly packed with frass. The life-cycle is extremely variable. There are records of this species emerging from furniture that has been in use for as long as twenty years (Blair, 1948; Craighead, 1923b; Webster, 1888). See also p. 10.

*Economic importance.* This species is of decided economic importance, particularly in so far as furniture is concerned. There are numerous instances on record of furniture being damaged through the emergence of adults often several years after its construction (see p. 10).

Mature oaks bearing scars through which larvae can gain access to the heartwood are often severely damaged (Craighead, 1923b).

*Control.* Craighead (1950) recommends fumigation or the removal of infested woodwork.

*Material studied.* 1 L, London, from cabinet of American oak, 22.viii.1935, in coll. B.M.; 1 L, 1 P, U.S.A., Veitch, Virginia, 19.x.1912, from logs of *Quercus*, A. D. Hopkins leg., in coll. U.S.N.M.

*References.* Blackman & Stage, 1924 (Biol.); Blair, 1948 (Biol.); Cann, 1937 (Biol.); Craighead, 1923b (L fig., Biol.), 1950 (Biol., Contr.); Duffy, 1949b (Biol.); Emden, 1939-1940 (L); Webster, 1888 (Biol.).

#### \**Typhoecis macleayi* Pascoe

[Occasionally in imported timber from Australia.]

*Mature larva.* No material or references available.

Host plant: ?*Pleiogynium solandri*.

#### Callichromini

##### *Aromia moschata* (Linnaeus)

*Mature larva* (figs. 178-183). Length up to 35 mm.; maximum breadth (at prothorax) 8.5 mm. *Head* slightly rugose, with rounded divergent sides (figs. 178, 179); frontal sutures indistinct, median adfrontal suture well defined. Front margin of frons narrowly ferruginous. Labrum semicircular. Mandible short, robust; basal part pale, separated from apical pithy part by a deep transverse impression.<sup>1</sup> Antenna (fig. 180)

<sup>1</sup> In the present material examined the proportions of these two parts were found to vary considerably: in several specimens the apical part was scarcely one-third the length of the mandible, while in others it was almost two-thirds.

small, salient; third segment cylindrical, at least twice as long as basal width. One pair of ocelli present just behind and ventrad to antenna; lens small, oblong, convex (often indistinct in mature larvae); pigmented spot grey, rather indistinct. Maxilla (fig. 181) with third segment of palp shorter than second; maxillary lobe glabrous on entire inner margin; dorso-external process of palpifer extremely small. Labial palpi as figured (fig. 182). Hypostoma with front margin very narrowly ferruginous; sutures broadly curved. Gula very broad; sutures indistinct. *Prothorax* (fig. 183) with lateral

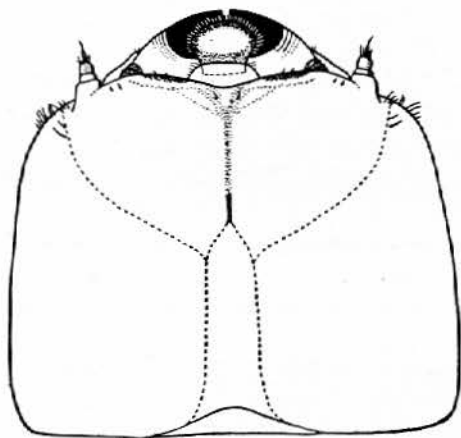


Fig. 178

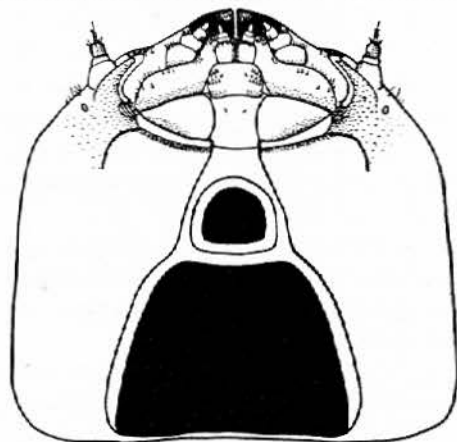


Fig. 179

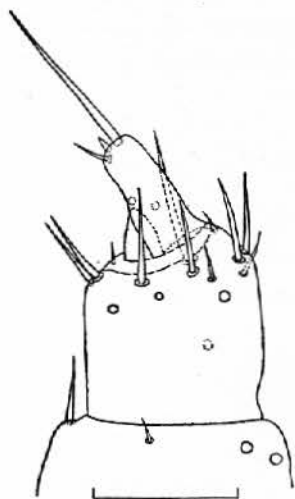
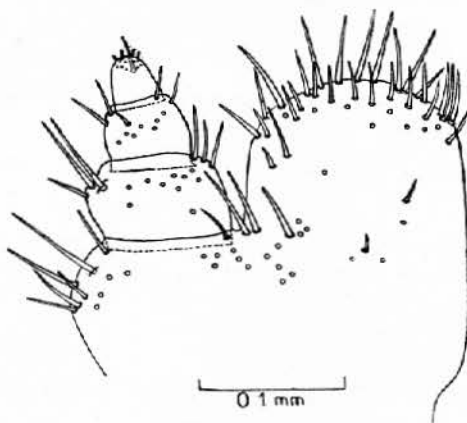
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Fig. 181

Fig. 178. *Aromia moschata* (Linnaeus). Larva form "b". Head. Dorsal aspect. (Duffy, 1949)

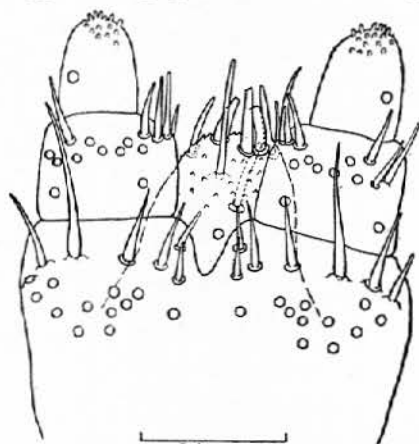
Fig. 179. *Aromia moschata* (Linnaeus). Larva form "b". Head. Ventral aspect. (Duffy, 1949)

Fig. 180. *Aromia moschata* (Linnaeus). Mature larva. Apical part of antenna. Lateral aspect. (Duffy, 1949)

Fig. 181. *Aromia moschata* (Linnaeus). Mature larva. Apical part of maxilla. Ventral aspect. (Duffy, 1949)

regions bearing numerous short, fine setae. Pronotum rectangular, glabrous, milky white and shining; posterior half rather coarsely and longitudinally rugose. Abdomen with dorsal ampullae marked by a shallow median longitudinal furrow, one anterior transverse, straight furrow and a posterior transverse, bilobed furrow; their extremities being connected with a pair of deep, lateral furrows. Anal lobes rugose, with scattered short setae. Pleural discs indistinct. Legs four-segmented, longer than maxillary palp; unguiculus strongly sclerotised, ferruginous and imbricately spinose. Spiracles with peritreme thin, testaceous.

*First-instar larva* (figs. 184, 185). Length up to 2.5 mm. Cuticle milky white, waxy. Egg-bursting spines are situated in pairs dorso-laterally on the third, fourth, fifth and



0.1 mm.  
Fig. 182

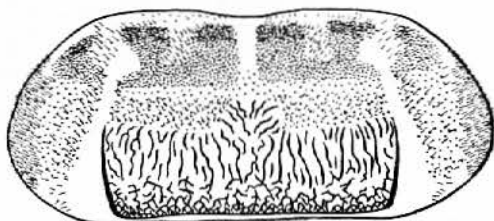
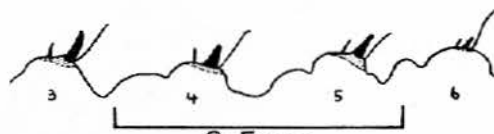


Fig. 183



0.5 mm.  
Fig. 184

Fig. 182. *Aromia moschata* (Linnaeus). Labial palpi. Ventral aspect. (Duffy, 1949)

Fig. 183. *Aromia moschata* (Linnaeus). Mature larva. Prothorax. Dorsal aspect. (Duffy, 1949)

Fig. 184. *Aromia moschata* (Linnaeus). First-instar larva. Egg-bursting spines of abdominal segments three to six. (Duffy, 1949)

usually the sixth abdominal segments (fig. 184), though in some specimens examined the last pair were rudimentary. Each spine (fig. 185) is stout, thorn-like and reddish-brown; at the base it merges into a circular, sclerotised plate similarly pigmented (see also p. 60). Spiracles biforous.

*Later-instar larvae* (fig. 186). The examination of a large number of larvae has revealed the existence of two quite diverse larval forms which have previously been designated by the writer (1949a) as forms "a" and "b". Form "b" corresponds to the description already given of the mature larva, which is yellowish-white, and almost cylindrical. In form "a" (fig. 186), the mandibles are more strongly produced and their basal part is much darker than the head capsule, being usually ferruginous, though sometimes as dark as the apical part. The head is more strongly depressed, smoother and darker. The second antennal segment is proportionately longer. The ocellus has a strongly protuberant lens. The gula is narrower. There are no sclerotised weals on the sides of the meso- and metathorax and the legs are smaller. All the

setose and pigmented areas of the prothorax are denser and more clearly defined, sclerotised parts such as the mandibles being smooth and shining. This form of the larva is greyish-white in colour and comparatively longer and more slender, segments one to six tapering appreciably.

It has not been possible to ascertain at which ecdysis form "a" changes to form "b", except that the transformation definitely takes place during the latter half of the

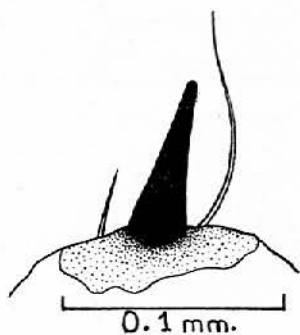


Fig. 185

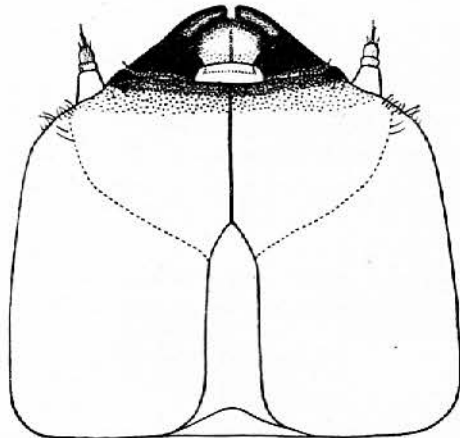


Fig. 186

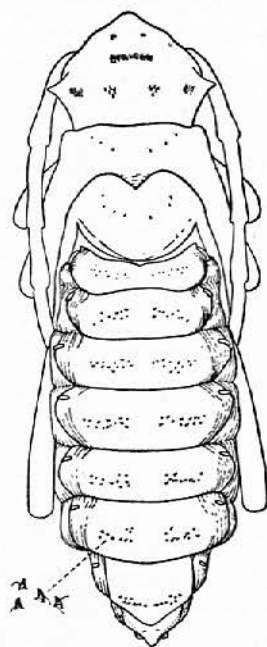


Fig. 187

Fig. 185. *Aromia moschata* (Linnaeus). First-instar larva. Egg-bursting spine (greatly enlarged). (Duffy, 1949)

Fig. 186. *Aromia moschata* (Linnaeus). Larva form "a". Head. Dorsal aspect. (Duffy, 1949)

Fig. 187. *Aromia moschata* (Linnaeus). Female pupa. Dorsal aspect.

larval period, and that form "b" is assumed throughout at least the penultimate and final instars.

*Pupa* (fig. 187). Length 20–33 mm.; maximum breadth 6 mm. *Head* totally concealed from above; elongate, triangular; vertex dome-shaped, smooth and usually glabrous; front smooth and glabrous; clypeus with a deep transverse impression at base, glabrous. *Antennae* extending as far as third or fourth abdominal segment, where they are recurved ventrally. *Eyes* feebly convex, glabrous. *Labrum* cordate, glabrous. *Pronotum* with sides bearing a pair of lateral tubercles; front margin strongly

produced medially, V-shaped, and bearing several groups of short fine setae as figured (their distribution varies somewhat intraspecifically). *Mesonotum* with a few very fine short setae; scutellum pointed, transversely striate, glabrous. *Metanotum* smooth, bearing a few fine short setae; scutellar groove rather broad and shallow. Elytra and wings extending to fourth abdominal segment. *Abdomen* with tergites one to six with paired, transversely oval groups of short spines, which are inclined forward (not backward, as in the majority of species). Seventh tergite much less transverse, with hind margin produced and "V"-shaped; bearing a transverse group of similar spines near hind margin. Eighth tergite with hind margin "V"-shaped; usually bearing a pair of setae. Ninth segment partly retracted into eighth and very short. Sternites smooth and glabrous. *Legs* with hind femora extending almost to, or as far as, sixth abdominal segment and lying parallel to longitudinal axis of body. *Functional spiracles* present on first seven abdominal segments, but a rudimentary pair present on eighth segment; peritreme narrowly oval, thick and slightly raised above general level of cuticle.

*Egg* (Pl. II, fig. 7). Length 2.9 mm.; breadth 1.2 mm. Form elongate-ovoid, slightly depressed, one pole usually more attenuated than the other. The shape seems to vary considerably, especially the degree of attenuation of one or both poles and the degree of depression; some are straight, and enlarged in the middle, whereas others are slightly curved and almost parallel-sided. The newly laid eggs are milky white in colour and the chorion, which at this stage is transparent, is covered with a thin, sticky coating which serves to secure the eggs to the bark. There are no appreciable signs of pigmentation or sculpturing of the chorion until, usually, about twelve hours after the eggs have been deposited; they are then yellowish-green, becoming pale green later. The chorion is thick and is marked out into microscopic polygonal areas which correspond with the overlying follicular cells; this reticulation is best seen when the embryo is fully developed. Periods of incubation between fourteen and twenty days have been observed (Duffy, 1949a).

Host plants: *Salix* species, especially *S. atrocinerea*, *S. caprea* and *S. viminalis* (Duffy, 1949a). Paulian & Villiers (1941) record also *Acer pseudoplatanus*.

*Biology*. Either the main stem or the bases of the stoutest branches are selected for oviposition, as these invariably bear numerous crevices and fissures suitable for egg sites. Entrance burrows and emergence holes of other wood-boring insects are often utilised. An average of forty-eight eggs has been obtained from the dissected ovaries of several females (Duffy, 1949a).

Although it seems to be a generally accepted fact that larvae of this species infest only old, rugged, though not necessarily rotten, willows, it has been the writer's experience in Surrey, Essex, Sussex, Hants and Wiltshire that this species shows a decided preference for young, slender willow bushes. In most cases it was the main stems (which varied approximately between 2 and 6 in. in diameter) which showed the most extensive signs of attack (Pl. VII, fig. 33). Practically all the most seriously infested bushes were growing in ground subject to flooding during the winter months.

Upon leaving the egg-shell, the first-instar larva commences to bore its way through the bark, an operation which usually takes from two to four days, according

to the thickness it has to penetrate. As it tunnels, the gnawed wood is excreted in the form of fine powdery frass. When it has passed through the bark, it feeds subcortically, where, under laboratory conditions, it has been observed to remain until its third stadium. It then proceeds in a horizontal direction, boring deeper and deeper into the sapwood, pushing behind it all the frass and particles of gnawed wood which accumulate. When the heartwood is reached, the larva tunnels upward in a vertical direction, often for a distance of a foot or more. By the third winter the larva is almost full-grown. During the coldest months it remains more or less inactive, but early in the spring it bores to just beneath the bark, whereupon it gnaws its way upward for another 4 or 5 in. by which time it is mature and ready to pupate. Before doing so, it enlarges the portion of the tunnel which it occupies and "pads" the cell by rasping the walls with its mandibles (Pl. VIII, fig. 38); this produces minute shavings of wood which give additional protection to the pupa. Having plugged the entrance to the chamber with coarse wooden shavings, it reverses its position, and lies motionless for a period varying from two to ten weeks until its final ecdysis, which takes place during April, May or June. Adults emerge from about the end of June to the beginning of September (Pl. VI, fig. 28).

It is probable, under exceptionally cold and dry weather conditions, that the larval period would be prolonged by an additional year. That a high constant temperature does have an accelerating effect on larval development was proved in the laboratory: final-instar larvae were brought in from their natural habitat on December 29 and were subjected to an average temperature of 65° F. By the end of January they had pupated; this was at least two months earlier than they would have done in their natural environment.

When molested the larva extrudes from between its parted mandibles a yellowish-grey, viscous globule; a litmus test proved this to be acid. Apparently this is its only defence against intruders.

Owing to its prolonged lignicolous existence, it has not been possible to ascertain the exact number of times the larva undergoes ecdysis. Ova were hatched under laboratory conditions, and larvae from these attained their third stadium; unfortunately they later became desiccated owing to overheated conditions. Later, additional material was obtained which chiefly comprised larvae about two-thirds grown; four of these were observed to undergo ecdysis three times, the third revealing the pupa. From this observation it would appear that there are at least five instars. The type of habitat so often harbouring *Aromia* larvae rather suggests that they may be to a certain extent resistant to drowning, since the lower portions of stems known to be infested with them have in several instances been seen to be submerged for weeks at a time (see also p. 14) (Duffy, 1949a).

*Parasites.* Hymenoptera: *Deuteroxorides albitarsus* Grav. (Duffy, 1949a); *Ischnoceros rusticus* Grav. (Brischke, 1880); *Perithous mediator* Grav., ?*Pimpla lignicola* Ratz. (Xambeu, 1898-1902); *Xorides praecatorius* F. (Reineck, 1919).

*Natural enemies.* The Green Woodpecker (*Gecinus viridis*).

*Economic importance.* *Aromia moschata* has never been regarded as a serious timber pest in this country as few of the trees which it attacks are of commercial value. Only four of our native willows are grown for their timber, the Bat Willow

(*Salix caerulea*) being the only one that is grown systematically. Osiers are grown extensively in riverside beds for the production of shoots for basket-weaving: *Salix viminalis*, *S. purpurea* and *S. aurita*, with numerous varieties, are cultivated for this purpose. *Aromia* used to be regarded as a serious pest by osier growers, but since 1925 large quantities of continental osiers have been imported with the consequence that many osier beds have been neglected as local production proved uneconomical (except for a limited market for certain varieties). It seems probable that this may have resulted in an increase in the numbers and colonies of this insect. As most other species of *Salix* are grown chiefly for ornamental and shade purposes, *Aromia* is really more of a plantation than a timber pest. In the south of England, *S. atrocineria* appears to be the favourite host plant (Duffy, 1949a).

*Material studied.* 28 L, Surrey, Ash, 7.vii.1944, in young branches of *Salix*, D. leg., in coll. D.; 17 L, 4 P, Surrey, Croydon district, v.1947, in branches of *Salix*, D. leg., in coll. D. [Adults reared.]

*References.* Barbey, 1913 (Biol. fig.); Bedel, 1889 (Biol.); Della Beffa, 1931 (Biol. fig.); Donisthorpe, 1945 (Biol.); Duffy, 1945a (Biol.), 1945b (Biol.), 1949a (E fig., L fig., P fig., Biol. fig.); Emden, 1939–1940 (L); Escherich, 1923 (Biol. fig.); Gillanders, 1912 (Biol.); Haines, 1944 (Biol.); Henriksen, 1914 (L fig.); Houlbert & Monnot, 1908 (L fig.); Jarvis, 1944 (Biol.); Kaltenbach, 1874 (Biol.); Lefroy, 1873 (Biol.); Lunardoni, 1889 (Biol.); Masee, 1945 (Biol.); Perris, 1877 (L fig., P, Biol.); Piffard, 1902 (Biol.); Planet, 1890 (L fig., P fig., Biol.), 1924 (Biol.); Röthenburg, 1907 (Biol.); Schiödt, 1876 (L); Stephens, 1945 (Biol.); Trägårdh, 1922 (Biol. fig.), 1939 (Biol. fig.); Westwood, 1839 (L fig., Biol.); Xambeu, 1898–1902 (L, P, Biol.).

**\**Philematium natalense* Bates**

[Recently in imported timber from West Africa.]

*Mature larva* (fig. 188). Extremely similar to that of *Aromia moschata*, from which it may be distinguished as follows. *Head* (fig. 188) with genae rather densely covered

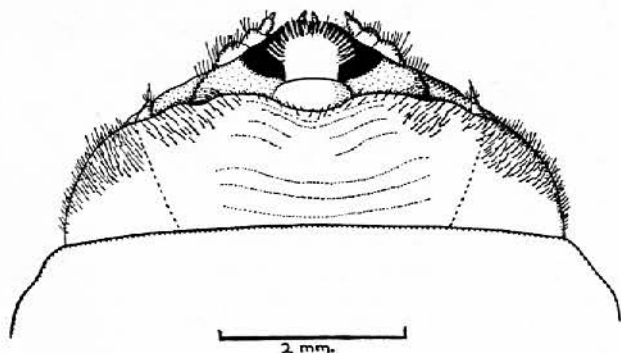


Fig. 188. *Philematium natalense* Bates. Mature larva. Head. Dorsal aspect.

with short reddish setae. Antenna with third segment at least four times as long as basal width. Abdomen bearing distinctly reddish setae.

Host plant: *Mimusops africana* (Fraser).

*Biology.* According to some unpublished notes by Fraser, larvae feed in both the heartwood and the sapwood, and cause severe damage. The pupal cells are unusual in that they are formed at random as far as longitudinal direction is concerned, being as commonly across the grain as parallel to it. One gallery was found to extend fully 9 in. into the tree, 6 in. of which was in the heartwood. The pupal cell is closed with a calcareous operculum.

*Material studied.* 2 L, 1 I, Lancashire, Lydiate, x.1949, in imported *Mimusops africana*, M.G.F. leg., in coll. D.

*References.* None available.

**\*Callichroma vittatum** Fabricius

[Occasionally in imported timber from South America.]

*Mature larva.* No material or references available.

Host plant: *Ponteria ovata*.

**\*Compsocerini**

**\*Rosalia alpina** Linnaeus

[Occasionally in imported timber from the Continent.]

*Mature larva.* No material available. The description given by Mayet (1890) is too vague to afford reliable specific or generic characters.

Host plants: *Fagus*. Reineck (1919) gives *Picea*, *Pinus* and *Pyrus*. Germain (1905) gives *Salix* and *Populus*. *Crataegus* is listed by Kaltenbach (1874) and *Juglans* by Mendizabal (1943).

*Biology.* Although known to feed in sound wood, the larvae seem to prefer decaying boles. The pupal cell is elongate and usually about 1 cm. deep in the sapwood. Pupation occurs in June and adults emerge in July.

*Economic importance.* This species is apparently of some economic importance, since several instances of adults emerging from structural timbers and furniture have recently been brought to the notice of the writer. This indicates that the larvae are more partial to sound wood than was originally supposed.

*References.* Altum, 1878 (Biol. fig.); Germain, 1905 (Biol.); Holeczek, 1887 (Biol.); Kaltenbach, 1874 (Biol.); Lunardon, 1889 (Biol.); Mayet, 1890 (L, P, Biol.); Mendizabal, 1943 (Biol.); Reineck, 1919 (Biol.); Xambeu, 1898-1902 (L, P, Biol.).

**\*Compsocerus equestris** Guérin-Ménéville

[Occasionally in imported timber from South America.]

*Mature larva.* No material or references available.

**\*Paromoeocerus barbicornis** Castelnau

[Occasionally in imported timber from South America.]

*Mature larva.* No material or references available.

## Callidini

## Larval Characters

Form robust and of a contracted appearance. *Head* subtrapezoidal, widest well behind middle; with three pairs, one pair or no ocelli. Mandible with a deep longitudinal impression on outer face (shallow in *Semanotus*). Maxilla with lobe glabrous on entire inner margin; process of palpifer nearly as long as or longer than third segment of maxillary palpi (if smaller, then three ocelli present.) Antenna with first and second segments quadrate to strongly elongate. Gula distinct, raised. *Prothorax* densely setose laterally, the setae being more or less equal in length; pronotum not more than twice as wide as long; median cleavage line incomplete (except *Hylotrupes bajulus*), though often deep; posterior half lightly reticulate (except *H. bajulus*) and with some rather coarse longitudinal striae. Postnotal fold present. Sternum with two paramedian or one median oval, glabrous area, the eusternum not clearly defined (except *H. bajulus*). *Abdomen* with ampullae broad, often finely reticulate, with a distinct but shallow longitudinal median impression; posterior transverse impression incomplete (except *H. bajulus*). Pleural discs distinct on segments three to six (except *H. bajulus*); each disc a deep pore surrounded by a reticulate area. *Legs* two- or three-segmented; at least as long as maxillary palp (except *Poecilium alni*); segments more or less globular; unguiculus imbricately spinose.

*Hylotrupes bajulus* (Linnaeus)

*Mature larva* (figs. 189, 190). Length up to 24 mm.; maximum breadth (at prothorax) 7.5 mm. Form rather robust, slightly depressed. *Head* subtrapezoidal, widest well behind middle (maximum head-width 4.25 mm.). Gena somewhat shouldered, pale, smooth and with a few short, pale setae. Front margin of head pale, ferruginous, rugose. Front margin of frons rather swollen. Mouthframe completely, though rather weakly, sclerotised beneath antennae. Antenna (fig. 190) testaceous, with second segment three times as long as third; third cylindrical, twice as long as broad; supplementary process rather attenuated, at least two-thirds as long as third segment. Mandible broad, with basal part ferruginous; apical part pitchy, shining and with a deep longitudinal, median impression. Labrum fleshy, transversely oval and with numerous long, fine setae. Epipharynx setose only on sides. Three distinct ocelli present close together in a straight row laterad and ventrad of antenna<sup>1</sup>; ocellar lens strongly protuberant; pigmented spot distinct. Hypostoma rugose, with front margin not or scarcely darker than remainder; sutures curved. Gula rather broad, slightly raised, with concave sutures. Maxilla with lobe entirely glabrous on inner margin; maxillary palp with third segment shorter than second and shorter than third segment of labial palpi; dorso-external process of palpifer slightly shorter than last segment of maxillary palpi. Labial palpi with second and third segments equal in length. *Prothorax* rectangular, depressed, with numerous long, fine setae; posterior half smooth, shining, with a few irregular coarse striae; median cleavage line deeply impressed. Eusternum distinct, triangular, shining, rugose and almost glabrous. *Abdomen* with dorsal ampullae shining, coarsely rugose (even slightly

<sup>1</sup> Behind these, two widely-separated, vestigial ocelli are usually visible.

tuberculate), with posterior transverse impression distinct; median furrow rather shallow. Anal lobes sparsely setose. Pleural discs indistinct or absent. *Legs* with femur wider than long; femur and tibiotarsus testaceous; unguiculus ferruginous for at least apical two-thirds and strongly imbricately spinose. *Spiracles* with peritreme broadly oval, very thin and pale.

Although there seems no doubt that this species has been correctly placed in the

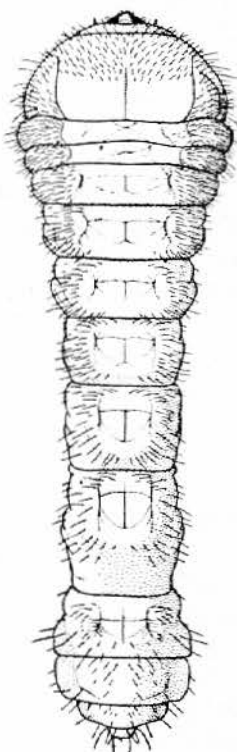


Fig. 189

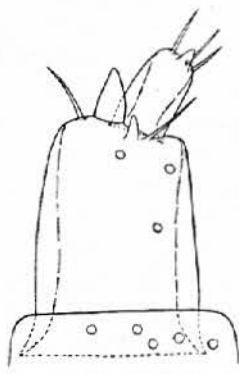


Fig. 190

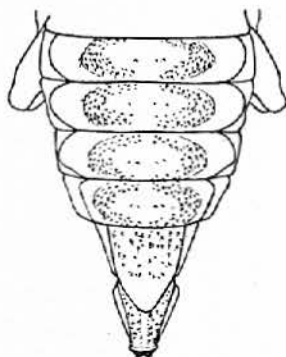


Fig. 191

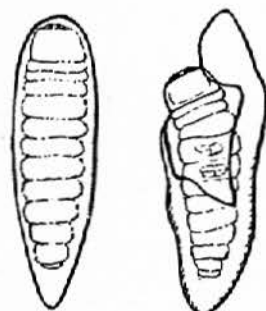


Fig. 192

Fig. 189. *Hylotrupes bajulus* (Linnaeus). Mature larva. Dorsal aspect.

Fig. 190. *Hylotrupes bajulus* (Linnaeus). Mature larva. Apical part of antenna. Lateral aspect.

Fig. 191. *Hylotrupes bajulus* (Linnaeus). Female pupa. Posterior part of abdomen. Dorsal aspect.

Fig. 192. *Hylotrupes bajulus* (Linnaeus). Eggs, showing emerging larvae.

Callidini according to adult and pupal characters, the larva does not conform at all satisfactorily to what would appear to be the true larval characteristics of this tribe. On the other hand, larvae of certain other species of *Hylotrupes* approximate much more closely to the tribal characters. Craighead (1923b) suggests that the exceptional characters of *H. bajulus* may have developed due to its unusual habitat.

*Pupa*<sup>1</sup> (fig. 191). Length 14–25 mm.; maximum breadth 7 mm. *Head* quadrate, glabrous. *Mesonotum* with several long, fine pale setae directed backward on each

<sup>1</sup> In the only pupa available, the head and pronotum are severely mutilated; hence the description is incomplete, although sufficient for reliable identification.

side of scutellum, which is depressed. *Metanotum* with numerous similar setae on each side of scutellar groove which is slightly depressed. Elytra and wings extending to fourth abdominal segment. *Abdomen* with tergites one to six, each with short ferruginous spines (each bearing a fine basal seta) arranged in a transverse row along anterior and posterior margins and in a broad, semi-oval group near each lateral margin. Seventh tergite very elongate and strongly tapering posteriorly; anterior two-thirds with numerous scattered, slightly stouter spines directed posteriorly; posterior third glabrous. Eighth tergite elongate, subparallel-sided and bearing numerous spines on each side of a longitudinal median groove. Ninth tergite extremely short, rugose, slightly bilobed, each lobe bearing a fine seta. Sternites smooth and glabrous. Pleura protuberant, rugose and glabrous. *Legs* with hind femora extending as far as fourth segment. *Functional spiracles* present on first five abdominal segments; peritremely broadly oval, moderately thick and slightly raised above general level of cuticle.

*Egg* (fig. 192). Length 1.2–2 mm.; breadth 0.5 mm. Form elongate, spindle-shaped, very variable in outline, but one pole usually more attenuated than the other. Chorion white, dull, smooth. According to Weidner (1936b), eggs laid at the beginning of the oviposition period are much more slender than those laid later on.

Host plants: *Pinus*, *Picea*, *Abies*. Feytaud (1939) states that this species is not entirely confined to conifers, since *Populus*, *Alnus*, *Corylus* and even *Quercus* have been infested by it. Chobaut (1904) records it from *Genista scorpius*, and Riley (1880) from *Conium maculatum*. Conifers, however, are undoubtedly its favourite hosts and in this country, at any rate, it has never been found in any others.

*Biology*. The eggs are deposited in batches in cracks and crevices about 0.2–9.6 mm. wide; rough surfaces are preferred. Estimates of the maximum number of eggs laid by a single female are extremely variable: Eckstein (1936a) records 200, Kaufmann (1936) 300 and Becker (1942a) 400, although estimates of most other authors lie between 30 and 100. The incubation period is usually from one to three weeks. Steiner (1937) found that the shortest period was 5.9 days at 31.5°C. (89°F.) and 90–95 per cent humidity, and that the longest period was 48 days at 16.6°C. (62°F.) and 18 per cent humidity. Increased humidity accelerated development, but with 100 per cent humidity many eggs were killed by moulds. The most favourable humidity was 90–95 per cent. High temperatures (31.5°C. [89°F.] and 26.3°C. [79°F.]) reduced mortality by accelerating development and retarding the growth of moulds. Becker (1942a) found that oviposition could be induced experimentally by treating wooden blocks with the terpenes  $\alpha$ -pinene and  $\beta$ -pinene or an oil (turpentine) containing them.

The larval habitat is generally in the sapwood and, to a lesser extent, the heartwood of dry, seasoned, coniferous timber such as telegraph posts, fencing and structural timbers in buildings, especially those of roofs and attics. Infestation usually starts in the attic (particularly around a chimney) and gradually spreads downward. In an infestation recently seen by the writer, however, the entire first floor of a twenty-five-year-old council house had become infested and yet the attic above was perfectly sound. Although in recent years this insect has become adapted to a truly domestic environment there is no doubt that the original habitat was, and probably still is in many areas, confined to woodland and forest. In South Africa, according to Tooke & Scott (1944), this species breeds in old logs and stumps and even in dead branches

high up on living trees. It has also been found breeding in a dead standing tree near Paris, and also recently in an old pine stump in this country.

After emerging from the egg, the first-instar larva usually crawls about for a short period before starting to enter the wood. The larval galleries, which extend parallel to the grain of the wood (Pl. III, figs. 12, 13), are tightly packed with fine powdery particles of wood and frass; the frass is characteristic, being in the form of short cylinders, which, according to Eckstein (1936a), later break up into approximately two spherical portions (probably due to desiccation?). In heavy infestations the wood is almost entirely reduced to tightly packed powder, only a thin "veneer" of sound wood and sometimes a central core of heartwood being left untouched. Often the skin-like "veneer" splits or bursts under the pressure of the frass, and it is only under these circumstances or through the emergence of adults that frass is ejected. It is due to the absence of the tell-tale "boring-dust" that infestations are usually so difficult to detect, although blister-like swellings on the surface of wood indicate that it is or has been infested. The larvae feed mainly in the sapwood, and infestation decreases as soon as the heartwood is reached. There are several instances recorded in literature of both larvae and adults of this species boring through metal sheeting covering wooden structures and even lead cables (Horn, 1933, 1934; Laing, 1919, 1920; Westwood, 1839). After tunnelling for several years and doing considerable damage, the larva usually bores to just beneath the surface of the wood and then turns back to excavate a pupal cell often at some depth and usually parallel to the grain of the wood.

Although intracellular micro-organisms are known to occur in the gut of many species of Cerambycid larvae, they are apparently absent in that of *Hylotrupes* (see also p. 11). According to Mansour (1934), *Hylotrupes* larvae are able only to digest seasoned wood through their ability to secrete cellulase, a cellulose-splitting enzyme. Falck (1930) has found through a comparative analysis of the frass and sound timber that larvae remove about 21 per cent of the total cellulose and hemicellulose content of seasoned coniferous wood. Parkin (1940) suggests that although *Hylotrupes* appears to be confined to coniferous woods (see p. 11), the enzymes present in the larval gut would apparently enable it to digest deciduous wood with equal facility. Kaltwasser (1941a) discovered that larvae were able to develop satisfactorily in deciduous wood, and in coniferous heartwood, providing such substances as resin, which are harmful to them, were first removed. This was corroborated by Becker (1944), who found that larvae could survive in deciduous wood providing the latter were first soaked for 24 to 48 hours in 1 or 5 per cent sodium hydroxide, and then for 17 days in distilled water. The larvae increased somewhat in weight—probably due to the removal of pentosans.

Numerous experiments have been made in an attempt to accelerate larval growth. Schuch (1937) has shown that some constituent of the cell contents of the wood is necessary for rapid growth, since larvae increase in weight more rapidly when feeding in the outer sapwood than in the inner zone or in the heartwood. Becker (1938a) observed considerable acceleration of growth in larvae which had been inserted in wood impregnated with peptone solution. Gösswald (1939) accelerated larval development through increasing the nutritive value of pine by impregnating blocks under pressure with a 5 per cent suspension of diastase; this was more satisfactory than with

peptone or other ferments. Later, Kaltwasser (1941), by adopting a similar technique, succeeded in reducing the total larval period to fourteen months.

The time of pupation is extremely variable in this species as its environment is subject to considerable changes in atmospheric conditions. Usually it takes place in the spring about May, though sometimes it occurs in the autumn or even in the winter. The pupal period is of two to three weeks' duration. Adults usually eclose in June or July. Eckstein (1928) states that adults remain in their pupal cells from five to seven months after eclosion before attempting to emerge, whereas certain other authors contend that adults do not always attempt to emerge, and have been known to copulate and oviposit in excavated portions, often deep in the wood.

The duration of the life-cycle varies considerably, but would seem usually to be three or four years. Records of from six to eleven years are not uncommon, and there are several accounts of prolonged larval life, notably that by Bayford (1938), who discusses a larva estimated to be at least seventeen years old.

*Parasites.* Hymenoptera: *Cryptus minator* Grav., *C. seticornis* Ratz., *Ephialtes manifestator* L. (Reineck, 1919); *Doryctes leucogaster* Nees (Xambeu, 1898-1902); *Ephialtes tuberculatus* Fourc. (Rudow, 1912); *Rhoptrocentrus* sp. (Thompson, 1943).

*Predators.* Coleoptera: *Opilo domesticus* L. (Steiner, 1938).

*Economic importance.* Although originally a forest insect, this beetle has now become one of the few truly domestic species and the material damage it does in many countries to structural timbers, especially roofs and rafters, is enormous. During the past twenty years damage has increased considerably, and many costly measures have been adopted in combating this species on the Continent. In 1935 over a million marks were spent on control measures in Hamburg alone. In Sweden hundreds of houses have been severely infested, while in Denmark buildings have been insured against attack. In certain German districts before the war assurance companies levied an increase in premium to cover the risk of infestation (Fisher, 1938). It has been calculated that an infested house would collapse within twenty-five to thirty years providing the insect could spread undisturbed. In this country the possibility of this species spreading and causing extensive and serious damage cannot be lightly disregarded. Already breeding has increased in a number of buildings, and infestations have recently been recorded from Surrey, Essex, and Sussex (Duffy, 1949b). Hickin (1947a) gives an account of a forty-year-old house in Camberley, and points out that if infested timber had been used in its construction the insect must have maintained itself for at least four, or more probably eight, generations.

This recent increase is apparently due to forms of construction which promote exceptionally warm conditions in roof spaces during the summer months. This not only accelerates larval development but causes the wood to crack, thus providing additional oviposition sites. But by far the greatest cause is the widespread use of fast-grown, imperfectly seasoned softwoods as roof timbers. Although the rafters become air-dried, they still contain an appreciable quantity of water, and where the humidity is highest, the damage, owing to the accelerated growth of the larvae, is greatest. Another contributing factor to the recent increase of this insect is the selection of timbers more closely related to the strain involved than was previously the case, with the result that they break more readily (Larsson, 1945).

According to Schuch (1939) recently built houses are most liable to attack, there being comparatively little damage to timber over fifty years old. Topp & Jensen-Storch (1927) have estimated that structural timbers are not usually severely damaged until they are about twenty or thirty years old. The considerable amount of damage that can be caused by only a few larvae is explained by the long larval period. When this insect is well established, it appears that infestation is more likely to spread through adults flying to fresh sites than by the importation of infested timber. Adults have recently been observed by A. W. McKenny Hughes and the writer to be extremely active in hot sunny weather and to engage frequently in short, rapid, wheeling flights around infested houses in Surrey. In certain districts on the Continent telegraph posts have been heavily attacked (Blair, 1947), and Donisthorpe (1947) records the emergence of this beetle from telegraph posts and fences in Surrey. Imported packing-cases, too, have recently been found to be infested and the danger of *Hylotrupes* spreading by this means should not be overlooked.

*Control.* In cases where structural timbers have become very heavily infested they should be removed and burned, as even if it were possible to kill off the larvae they would be a source of danger, having become weakened through the larval damage. As a treatment for floors which are only moderately heavily infested Feytaud (1939) suggests the removal of the most heavily attacked boards and either the introduction of a volatile fluid into holes drilled at intervals in the remaining boards or the application of a solution of paradichlorobenzene in carbon tetrachloride<sup>1</sup> by means of a stiff brush.

For major infestations Jensen-Storch & Henriksen (1932) found that the application of carbon bisulphide<sup>2</sup> at the rate of 25 fluid ounces per 1,000 cubic feet completely killed off the larvae and that hydrocyanic acid gas<sup>2</sup> produced by Zyklon B at the rate of 30 ounces per 1,000 cubic feet proved quite effective in summer though less so in winter owing to the reduction in larval respiration. Hahmann (1932) experimented with the application of dry heat produced by a generator of the type commonly used for drying out newly built houses. After one hour an air-temperature of 80–87°C. (176–188.6°F.) was attained, which later rose from 88–100°C. (190.4–212°F.) at which it was maintained for seven hours. All larvae and adults were killed inside the beams in which temperatures of 63–74°C. (145.4–165.2°F.) were recorded.

According to Eckstein (1936b) a proprietary liquid insecticide known as "Imprägnier Lasolineum H" killed larvae in telegraph posts to a depth of 4 in.; it acts as both a contact and a respiratory poison. Kaltwasser (1941b), however, maintains that larvae are not harmed by boring short distances through heavily impregnated wood.

Sieke (1936) describes an electrical sound detector designed to amplify the rhythmic sound produced by larvae scraping off thin wooden shavings with their mandibles. This apparatus has proved useful in the examination of treated timber to ascertain the efficiency of insecticides. It is sometimes necessary to warm the timber to induce feeding.

Trägårdh (1937) maintains that infestation is commonest through adults flying

<sup>1</sup> It is now thought inadvisable to use carbon tetrachloride as the health hazard is too great.

<sup>2</sup> Both these methods are now considered too dangerous to adopt.

from place to place on sunny days and recommends the placing of gauze over open windows in attics.

As a result of experiments with certain essential oils, Becker (1942a) suggests that they could be used to induce oviposition in a given place to prevent extensive oviposition on other timber.

There appears to have been no serious attempt at biological control measures, although Deckert (1929b) states that the large-scale breeding of the predaceous Clerid *Opilo domesticus* L. has been considered. Despite earlier assumption, blue-stained timber (i.e. timber attacked by the fungus *Ceratostomella*) is not protected against attack by *Hylotrupes* (Steiner, 1939).

The owner of any property which is suspected of being infested with this species should communicate with the Director, Forest Products Research Laboratory, Princes Risborough, Aylesbury, Bucks. This laboratory maintains records of the occurrence and distribution of this insect throughout the country and will advise on treatment in specific instances of attack.

*Material studied.* 7 L, Germany, nr. Berlin, K. Eckstein leg., in coll. B.M.; 4 L, 1 P, Essex, nr. Grays, vii.1949, in infested floorboards D. leg., in coll. D. [Adults reared.]

*References.* Altum, 1881 (Biol.), 1886 (Biol.), 1923 (Biol.); Barbey, 1913 (Biol. fig.); Bayford, 1938 (Biol.); Becker, 1938a (Biol.), 1938b (Contr.), 1942a (Biol.), 1944 (Biol.), 1950 (Contr.); Blair, 1947 (Biol.); Blanc, 1907 (Biol.); Boas, 1923 (Biol. fig.); Bouthery, 1879 (Biol.); Brammanis, 1944 (Biol., Contr.); Butovitsch, 1939 (Biol.); Craighead, 1923b (L, Biol.), 1950 (Biol. fig., Contr.); Deckert, 1928a (Biol.), 1928b (Biol.), 1929a (Biol.), 1929b (Biol.), 1930 (Biol.), 1933 (Biol.); Della Beffa, 1931 (Biol. fig.); Department of Scientific and Industrial Research, 1938 (L fig., Biol. fig., Contr.); Donisthorpe, 1947 (Biol.); Duffy, 1949b (Biol. fig.); Eckstein, 1920a (Biol.), 1920b (Biol.), 1921 (Biol.), 1926 (Biol.), 1928 (Biol.), 1929 (Biol.), 1932a (Biol.), 1932b (Biol.), 1934 (Biol.), 1935 (Biol.), 1936a (L, Biol. fig.), 1936b (Contr.), 1936c (Biol.); Eckstein & Butovitsch, 1931 (Biol.); Emden, 1939-1940 (L fig.); Escherich, 1923 (Biol. fig.); Falck, 1930 (Biol.), 1933 (Biol.); Feytaud, 1939 (Biol., Contr.); Fisher, 1938 (Insurance), 1945 (Biol.), 1949 (L fig., Biol. fig., Contr.); Fisher & Harris, 1949 (Biol.); Gemignani & Rodriguez, 1940 (Biol.); Girard, 1881 (Biol.); Gösswald, 1939 (Biol.); Guse, 1893 (Biol.); Hahmann, 1932 (Contr.); Heeger, 1857 (E fig., L fig., P fig., Biol.); Heidenreich, 1939 (Biol. fig., Contr.); Heitz, 1927 (Biol.); Henriksen, 1914 (L fig.); Henry, 1907 (Biol., Contr.), 1909 (Biol.); Hespeler, 1934 (Biol.), 1939 (Contr.); Hickin, 1947 (Biol.); Horn, 1933 (Biol.), 1934 (Biol.); Houlbert & Monnot, 1908 (L fig., Biol.); Jarvis, 1947 (Biol.); Jensen, 1931 (Biol.), 1933 (Biol.); Jensen-Haarup & Henriksen, 1914 (L fig.); Jensen-Storch, 1932 (Biol. fig.); Jensen-Storch & Henriksen, 1932 (Contr.); Judeich & Nitsche, 1889 (Biol.); Kaltwasser, 1941a (Biol.), 1941b (Biol., Contr.); Kaufmann, 1936 (Biol.), 1938 (Contr.); Kunike, 1936 (L fig., Biol. fig.); Laing, 1919 (Biol.), 1920 (Biol.); Lakowitz, 1937 (Biol. fig.); Larsson, 1945 (Biol. fig.); Määr, 1933a (Biol.), 1933b (Biol.), 1933c (Biol.), 1935 (Biol.); Mansour, 1934 (Biol.); Mansour & Mansour-Bek, 1934a (Biol.), 1937 (Biol.); Moll, 1926 (Biol.); Nördlinger, 1848 (Biol.); Nüsslin, 1905 (Biol.); Parkin, 1934 (Biol.), 1940 (Biol.); Pavel, 1886 (Biol.); Perris, 1856 (L fig.), 1877 (L); Peyerimhoff, 1919 (Biol.); Reineck,

1919 (Biol.); Riley, 1880 (Biol.); Rudow, 1912 (Biol.); Ruiz Castro, 1943 (Biol.); Saalas, 1923 (Biol.); Schedl, 1935 (Biol.); Scheel, 1930 (Biol.); Schiödtte, 1876 (L fig.); Schlottke & Becker, 1942 (Physiology); Schmitz, 1926 (Biol.); Schomann, 1936 (Biol.); Schuch, 1937 (Biol., Contr.), 1939 (Biol.); Schwarz, 1935 (Biol.); Schwerdtfeger, 1932 (Biol.); Sieke, 1936 (Contr. fig.); Snyder, 1927 (Biol. fig.); Steiner, 1937 (Biol. fig.), 1938 (Biol.), 1939 (Contr.); Steyer, 1928a (Biol.), 1928b (Biol.); Thompson, 1943 (Paras.); Tooke, 1949 (Biol., Contr.); Tooke & Scott, 1944 (Biol.); Topp & Jensen-Storch, 1927 (Biol.); Trägårdh, 1927 (Biol.), 1937 (Contr.), 1939 (Biol. fig.), 1940 (Biol.); Weidner, 1936a (Biol. fig.), 1936b (E fig., L fig., P fig., Biol.); Westwood, 1839 (Biol.); Wichmænd, 1931 (Biol. fig.); Xamheu, 1898-1902 (L, P, Biol.); Zillig, 1925a (Biol.), 1925b (Biol.); Zumpt 1947 (Biol., Contr.). (See also Becker (1949) and Dürr (1951).)

**\**Semanotus undatus* Linnaeus**

[Recently in imported timber from Europe.]

*Mature larva.* Rather similar to that of *Hylotrupes bajulus*, from which it may be distinguished as follows. Form rather slender, less depressed. *Head* with front margin broadly piceous. Mouthframe strongly sclerotised beneath antennae. Antenna with second segment less than twice as long as third. Mandible without a deep longitudinal impression. Ocelli indiscernible. Hypostoma with front margin ferruginous. Maxillary palp with third segment about equal in length to second; dorso-external process of palpifer as long as third segment of maxillary palp. *Prothorax* with posterior half of pronotum very finely striate; median cleavage line lightly impressed. Pleural discs distinct.

Host plants: *Pinus* and *Picea* (Saalas, 1923).

*Biology.* Larvae of this species feed subcortically in usually very slender standing boles of conifers. Pupation takes place in July and August and adults emerge from May to September (Saalas, 1923).

*Material studied.* 1 L, Suomi, Ilomantsi, 18.vi.1913, U. Saalas leg., in coll. U.S.N.M.

*References.* Saalas, 1923 (L fig., P fig., Biol.).

***Callidium violaceum* (Linnaeus)**

*Mature larva.* Rather similar to that of *Hylotrupes bajulus*, from which it differs as follows. *Head* with gena rather broadly ferruginous, enclosing ocellus. One pair of ocelli<sup>1</sup> present; lens large, oval, convex; pigmented spot rather indistinct. Mouthframe finely rugose and completely and strongly sclerotised beneath antenna. Ventral front margin of head with a distinct sclerotised tubercle on acetabulum in which the *condylus mandibulae* rotates (analogous to the subfossal process of Prionine larvae?). Front margin of hypostoma broadly ferruginous. Antenna ferruginous, with second segment less than twice as long as third; third segment two and one-half times as long as broad; supplementary process conical, less than half as long as third segment. Maxilla with third segment of palpi as long as second and as long as third segment of

<sup>1</sup> Not two, as stated by Shoebottom (1909).

labial palp. *Prothorax* with anterior half of pronotum with coarse lenticulate depressions and reddish setae; posterior half finely longitudinally striate; median cleavage line lightly impressed. Eusternum not clearly defined. *Abdomen* with ampullae very finely reticulate, dull; posterior transverse impression indistinct. Pleural discs distinct on segments three to six. *Legs* with femur longer than wide; femur and tibiotarsus dark brown.

*Pupa* (fig. 193). Length 9–17 mm.; maximum breadth 6 mm. *Head* with vertex visible from above; slightly elongate, with sides rounded, smooth and glabrous.

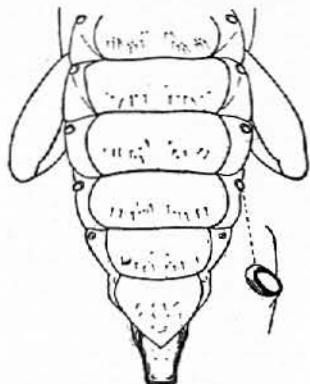


Fig. 193

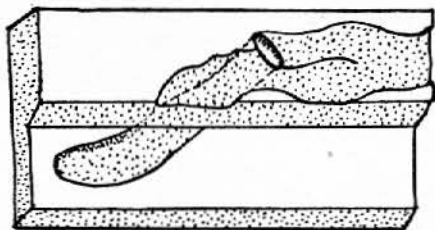


Fig. 194

Fig. 193. *Callidium violaceum* (Linnaeus). Female pupa. Posterior part of abdomen. Dorsal aspect.

Fig. 194. *Callidium violaceum* (Linnaeus). Pupal cell.

Antennae with basal segment transversely rugose; extending as far as second abdominal segment where they are curved downward alongside mid femora to terminate near fore or mid coxae. Eyes scarcely protuberant, glabrous. Labrum triangular, with front margin rounded; transversely rugose, glabrous. Maxillary palpi enlarged apically. *Pronotum* rugose and glabrous, except for a few conical papillae above middle of posterior margin. *Mesonotum* smooth, except for a faintly striated, longitudinal, median line and a few short testaceous spines; scutellum with two to four stouter spines. *Metanotum* smooth, and with a few scattered, short, testaceous spines, each with an apical seta. Elytra and wings extending to fourth abdominal segment, the former appreciably shorter than the latter. *Abdomen* with tergites one to six each with a transverse group of short testaceous spines across posterior half; anterior half glabrous. Seventh tergite elongate, with hind margin produced medially into a right angle; posterior half bearing a few scattered spines. Eighth tergite elongate, about half as long as seventh, with sides subparallel and hind angles rounded; bearing about four short spines in middle. Ninth tergite extremely short, with hind margin almost straight and strongly rugose. Sternites smooth and glabrous. Pleura strongly protuberant, rugose, and glabrous. *Legs* with hind femora extending to between fourth and fifth abdominal segments. *Functional spiracles* present on first five abdominal segments, but vestigial ones on segments six and seven; peritreme broadly oval, thin, and raised well above general level of cuticle.

*Egg.* Length 1.6 mm.; breadth 0.45 mm. Form elongate-oval, slightly broader at one end than the other. Chorion white (Shoebottom, 1909).

*Host plants:* *Larix*, *Picea*, *Pinus*. Reineck (1919) also gives *Alnus* and *Salix*; the latter seem questionable. Although conifers are undoubtedly its preferred hosts, the present writer has recently seen palings of *Picea* supported by posts of *Quercus* which were both extensively damaged by this species.

*Biology.* The larvae feed under the bark of dry, seasoned woods, especially posts, palings and rustic work. When the bark is unusually thick, larvae sometimes feed therein and pupate without entering the wood. The first-instar larva bores through the bark and excavates a narrow gallery between the bark and the sapwood, which gradually widens as the larva matures. Although the larva feeds mainly on the outer sapwood, the inner surface of the bark is superficially grazed, the depredations, which are of a characteristic design (Pl. I, fig. 4), being plainly visible on both. As the larva matures, the gallery becomes considerably wider as the larva continuously turns first to one side and then to the other, excavating large, more or less oval areas which often extend right to the very edge of the wooden section. In the autumn the mature larva tunnels for a short distance straight into the wood, and then gradually curves round until it is parallel to the grain; it then turns round and pupates facing the entrance. The length of the pupal cell (fig. 194) is about 5 cm. Adults emerge in May and June. The life-cycle is extremely variable, the minimum period apparently being two years. Kessler (1927) refers to a larva which he estimates to be fifteen years old. Prolongation of larval life is no doubt due to the excessive dryness of the wood.

*Parasites.* Hymenoptera: *Helcon carinator* Nees (Xambeu, 1898-1902); *Helcon aequator* Nees (Schimitschek, 1929); *Ephialtes manifestator* L. (Donisthorpe, 1898). Diptera: ?*Stevnia umbratica* Flin. (Emden, 1950).

*Economic importance.* This species has often caused considerable and extensive damage to posts, palings and rustic work, such as summer-houses. Although the initial damage is only superficial, decay soon sets in through the accumulation of rainwater and fungoid spores. Moreover, they soon loosen the bark, thus depriving the wood of its ornamental value. No instances of this species attacking standing trees are known to the writer.

*Control.* The most efficient preventive and remedial measure is to strip off all the bark, thus preventing reinfestation and killing off the existing larvae, providing they have not already gone into the sapwood to pupate. When rustic work is being used essentially for ornamental purposes, a thorough treatment with creosote is advised.

*Material studied.* 7 L, 2 P, Glos., nr. Cirencester, viii.1947, in palings of *Larix*, H. K. Airy Shaw and D. leg., in coll. D.

*References.* Boas, 1923 (Biol. fig.); Collinge, 1912 (E fig., L fig., P fig., Biol. fig.); Donisthorpe, 1898 (Paras.); Emden, 1939-1940 (L), 1950 (Paras.); Kaltenbach, 1874 (Biol.); Kessler, 1927 (Biol.); Kirby, 1800 (L fig., P fig.); Macdougall, 1929 (Biol. fig.); Reineck, 1919 (Biol.); Reitter, 1916 (Biol.); Saalas, 1923 (Biol.); Schimitschek, 1929 (Paras.); Shoebottom, 1909 (E fig., L fig., P fig., Biol. fig.); Trägårdh, 1939 (Biol. fig.); Westwood, 1839 (Biol.); Xambeu, 1898-1902 (L, P, Biol.).

**Phymatodes testaceus** (Linnaeus)

*Mature larva* (fig. 195). Similar to that of *Callidium violaceum*, from which it may be distinguished as follows. *Head* with ferruginous area of gena not enclosing ocellus. Ocellus with lens indistinct or absent; pigmented spot large, distinct beneath cuticle. Mouthframe smooth and interrupted by a pale narrow gap at inner side of ocellus, just beneath antenna. Acetabulum without a tubercle. Maxilla with third segment of palpi one and one-half times as long as second. *Prothorax* with pronotum more coarsely striate, the interstices reticulate only near base; median cleavage line deeply impressed.

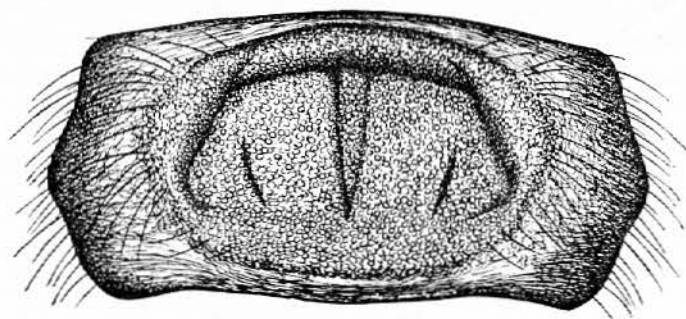
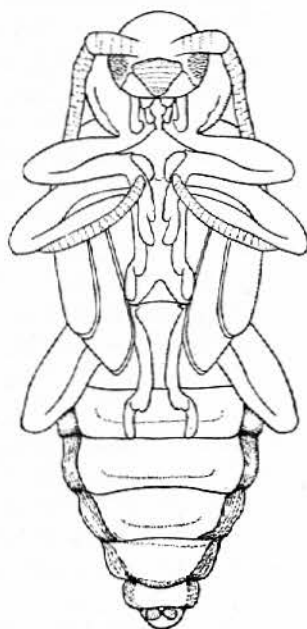
1 mm.  
Fig. 195

Fig. 196

Fig. 195. *Phymatodes testaceus* (Linnaeus). Mature larva. Third abdominal segment. Dorsal aspect.

Fig. 196. *Phymatodes testaceus* (Linnaeus). Female pupa. Ventral aspect.

*Abdomen* with ampullae more coarsely reticulate (fig. 195), slightly shining. *Legs* with femur wider than long; femur and tibiotarsus testaceous.

*First-instar larva*. Length up to 1.2 mm.; maximum breadth (at prothorax) 0.45 mm. Egg-bursting spines similar to those of *Rhagium mordax*, but more pointed; longest on segment eight. *Legs* with unguiculus attenuated as in *Asemum*. *Spiracles* biforous.

*Pupa* (fig. 196). Length 7–16.5 mm.; maximum breadth 3.5 mm. *Head* finely rugose, transversely striate in part, glabrous, with vertex visible from above. *Antennae* transversely striate, especially near base; extending as far as first abdominal segment, where they are curved downward alongside mid femora to terminate near mid coxae. *Eyes* scarcely protuberant, glabrous. *Labrum* triangular, with front margin rounded, glabrous. *Maxillary palpi* enlarged apically. *Pronotum* very slightly transverse, with

sides moderately rounded, and front margin slightly wider than hind margin; a conspicuous conical tuberculate process present just behind middle of front margin; disc transversely striate, glabrous. *Mesonotum* usually transversely striate medially, glabrous. *Metanotum* for the most part transversely striate, glabrous. Elytra and wings extending to between third and fourth abdominal segments, the former appreciably shorter than the latter. *Abdomen* with tergites one to six each with a transverse group of small, pale spines across posterior half, and with an incomplete row of slightly smaller spines across anterior half (which are often curved laterally to form an ellipse). Seventh tergite slightly transverse, parallel-sided for anterior half, with sides converging posteriorly, but hind margin not angled medially; bearing scattered, stouter spines, which are stoutest near posterior margin. Eighth tergite transverse and explanate laterally, glabrous. Ninth tergite extremely short, with hind margin almost straight, glabrous. Sternites smooth and glabrous; tenth sternite protruding beyond ninth, thus partly visible from above. Pleura strongly protuberant, longitudinally rugose and glabrous. *Legs* with femora markedly clavate, glabrous; hind femora extending to fifth abdominal segment. *Functional spiracles* present on first seven abdominal segments; peritreme broadly oval, thin and raised above general level of cuticle.

*Egg.* Length 1 mm.; breadth 0.5 mm. Form elongate, cylindrical. Chorion milky white (sometimes with a greenish tint), shining, smooth.

*Host plants:* *Fagus*, *Salix*, *Prunus avium*, *Quercus* (Reineck, 1919); *Castanea* (Xambeu, 1898-1902); *Hicoria* (Beutenmuller, 1896); *Picea*, *Tsuga*, *Conium maculatum* (Craighead, 1923b, 1950); *Fraxinus* (Duffy, 1945c). *Quercus* is the preferred host.

*Biology.* The eggs are laid under bark of recently dead boles and branches and in recently cut timber from which the bark has not been removed. The larval galleries are similar to those of *Pyrrhidium sanguineum*. Pupation takes place from March to May. If the bark is thin, the larva excavates a short curved cell in the sapwood (Pl. VI, fig. 27), but if the bark is thick, pupation usually occurs either in or beneath the bark in a shallow oval cell. The pupal period is about three weeks. Adults emerge from May to July. The life-cycle is usually completed in two years.

*Parasites.* Hymenoptera: *Spathius ferrugatus* Goureau, *Helcon carinator* Nees (Xambeu, 1898-1902); *Xorides praecatorius* F., *Ephialtes tuberculatus* Fourc., *Helcon tardator* Nees (Reineck, 1919); *Pteromalus bimaculatus* Rtz., *Xorides filiformis* Grav., *Doryctes gallicus* Reinh. (Thompson, 1943).

*Economic importance.* This species is often of economic importance in tan bark industries where bark of oak and hemlock are stored. Craighead (1950) refers to the destruction of over \$50,000 worth of bark at one tannery. Imported timber is frequently extensively attacked by larvae of this species. Samples of timber from the Black Forest region recently seen by the writer have been so heavily infested that the outer sapwood was completely destroyed. The damage, however, is comparatively superficial and does not very seriously detract from the utility of the timber.

*Control.* Craighead (1950) recommends the utilisation of bark before it is three years old when used for tanning purposes. Prompt decortication will discourage oviposition.

*Material studied.* 8 L, 2 P, Surrey, Cutmill, 8.iv.1945, under bark of *Quercus*, D. leg., in coll. D.; 19 L, Surrey, Mytchett, 12.xii.1943, in logs of *Fraxinus*, D. leg., in coll. D. [Adults reared.]

*References.* Barbey, 1913 (Biol. fig.); Beutenmuller, 1896 (Biol.); Boas, 1923 (Biol.); Craighead, 1923b (L fig., Biol.), 1950 (Biol., Contr.); Della Beffa, 1931 (Biol. fig.); Duffy, 1945c (Biol.); Emden, 1939–1940 (L); Escherich, 1923 (Biol. fig.); Fraser, 1948b (Biol.); Henriksen, 1914 (L fig.); Judeich & Nitsche, 1895 (Biol. fig.); Lataste, 1930 (L, P, Biol.); Lunardoni, 1889 (Biol.); Munro, 1928 (Biol. fig.); Nördlinger, 1880 (Biol.); Perris, 1877 (L fig., P fig., Biol.); Planet, 1893 (Biol.); Reineck, 1919 (Biol.); Savard, 1884 (Biol.); Schiödte, 1876 (L fig., P); Seillière, 1905 (Biol.); Trägårdh, 1939 (Biol. fig.); Xamheu, 1898–1902 (L, P, Biol.).

### (\* *Phymatodes lividus* (Rossi)

[Occasionally in imported timber from the Continent.]

*Mature larva.* No material available. According to the description by Perris (1877) it closely resembles that of *P. testaceus*, but the description is not sufficiently detailed to provide reliable distinguishing characters.

*Host plants:* *Quercus*, *Castanea* (Xamheu, 1898–1902); Reineck (1919) also gives *Aesculus* and *Salix*.

*Biology.* Larvae feed under the bark of recently cut wood or recently dead trees. The larval habits are similar to those of *Pyrrhidium sanguineum*.

*Economic importance.* This species used to be of some economic importance in the brewing industry, as the chestnut hoops used in the construction of barrels and casks often became infested with a result that casks often collapsed and much wine was wasted. Nowadays, owing to the widespread use of metal hoops, the damage caused by this insect has become insignificant.

*References.* Judeich & Nitsche, 1889 (Biol.); Perris, 1877 (L fig., P, Biol.); Reineck, 1919 (Biol.); Xamheu, 1898–1902 (L, P, Biol.).

### *Pocillum alni* (Linnaeus)

*Mature larva* (figs. 197, 198). Very similar to that of *Phymatodes testaceus*, from which it may be distinguished as follows. Length up to 7 mm.; maximum breadth (at prothorax) 3 mm. *Head* with gena testaceous, this area not enclosing ocellus. Ocellus with lens rather large, oval, scarcely convex; pigmented spot deep beneath cuticle, usually very indistinct. Mouthframe smooth, pale, testaceous. Antenna with second segment not or scarcely longer than broad (fig. 197). Maxilla (fig. 198) with third segment of palp twice as long as second. Front margin of hypostoma pale testaceous; sutures indistinct. *Legs* extremely minute (not visible with a  $\times 15$  lens) and apparently absent in some specimens.

*Pupa* (fig. 199). This species differs from that of *Phymatodes testaceus* as follows. Length 4–7 mm.; maximum breadth 2.25 mm. *Head* with antennae not curved downward alongside mid femora, but continuing posteriorly as far as mid femora where they are slightly curved to terminate near apices of elytra. Maxillary palpi entirely

cylindrical, not enlarged at apex. *Pronotum* without a conspicuous cone-shaped tubercle, but with front margin very slightly raised medially. *Abdomen* with tergites one to six, each with paired groups of two to three small spines near posterior margin; anterior half of tergites glabrous. Seventh tergite with a single row of spines near posterior margin. *Functional spiracles* with peritreme rather narrowly oval.

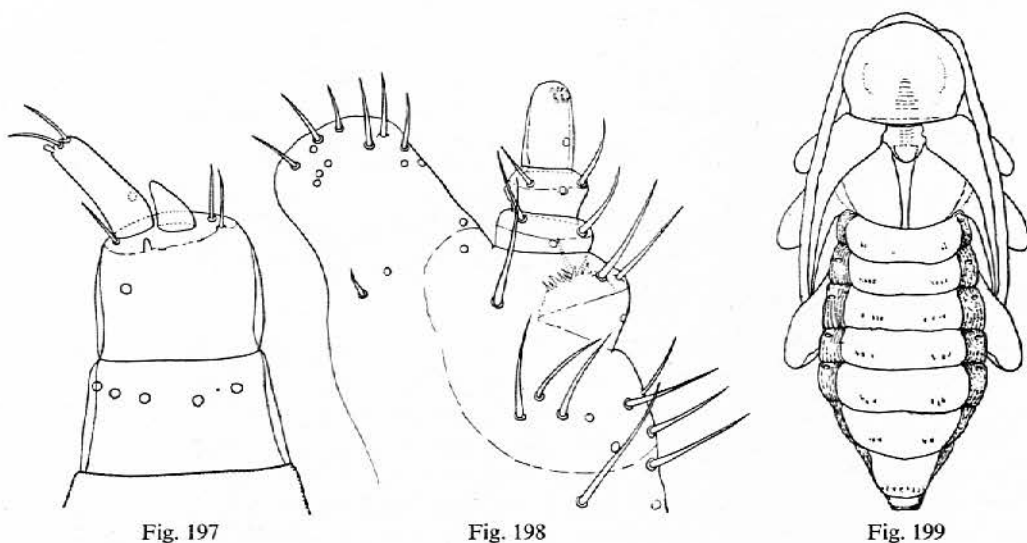


Fig. 197. *Poecilium alni* (Linnaeus). Mature larva. Apical part of antenna. Lateral aspect.  
 Fig. 198. *Poecilium alni* (Linnaeus). Mature larva. Apical part of left maxilla. Ventral aspect.  
 Fig. 199. *Poecilium alni* (Linnaeus). Female pupa. Dorsal aspect.

Host plants: *Quercus*, *Alnus*, *Ulmus*, *Rosa*, *Castanea* (Xambeu, 1898–1902). Reineck (1919) also gives *Fraxinus*. *Quercus* and *Alnus* are undoubtedly the preferred hosts.

*Biology*. The larvae feed under the bark of decaying or recently dead, slender twigs; also in recently erected posts and lopped branches (Duffy, 1946b). They tunnel subcortically, parallel to the grain of the wood, making a more or less straight gallery. In the autumn the mature larva bores into the sapwood (or the pith channel) in which it excavates a shallow oval cell. Pupation occurs in March and April and adults emerge in April and May. The life-cycle is usually completed in one year.

*Parasites*. Hymenoptera: *Spathius rubidus* Rossi (Thompson, 1943).

*Material studied*. 8 L, 3 P, Surrey, Cutmill, 26.iv.1945, under bark of *Quercus*, D. leg., in coll. D.; 11 L, 4 P, Surrey, Effingham, 22.iv.1946, under bark of *Quercus*, D. leg., in coll. D. [Adults reared.]

*References*. Duffy, 1946b (Biol.); Henriksen, 1914 (L); Kaltenbach, 1874 (Biol.); Perris, 1877 (L fig., P, Biol.); Reineck, 1919 (Biol.); Thompson, 1943 (Paras.); Xambeu, 1898–1902 (E, L, P, Biol.).

(\*) *Pyrrhidium sanguineum* (Linnaeus)

[Occasionally in imported timber from the Continent.]

*Mature larva.* Very similar to that of *Phymatodes testaceus*, from which it may be separated as follows.<sup>1</sup> *Head* with front margin of hypostoma broadly ferruginous and distinctly longitudinally or slightly obliquely striate. *Prothorax* with anterior third orange-yellow, and distinctly darker than posterior part which is pale testaceous.

*Pupa* (fig. 200). Very similar to that of *Callidium violaceum* and apparently only distinguishable from that species by the presence of a conspicuous, papillate protuberance on the pronotum (fig. 200).

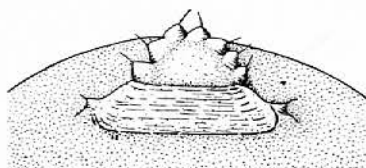


Fig. 200. *Pyrrhidium sanguineum* (Linnaeus). Pupa. Pronotal process.

*Host plants:* *Aesculus*, *Carpinus*, *Quercus* (Reineck, 1919); *Castanea* (Peyerimhoff, 1919); *Fagus* (Marcu, 1928). *Pinus* is recorded, apparently for the first time, by Fraser (1948h). Its preferred host appears to be *Quercus*.

*Biology.* The eggs are laid in the crevices of dry bark of recently cut branches, or of recently dead or decaying standing trees. The subcortical larval galleries frequently loosen the bark from the sapwood; they are tightly packed with fine powdery frass. In the autumn the mature larva tunnels into the sapwood, and excavates an elongate-oval cell about 2 cm. long and 1 cm. wide, in which it pupates in March or April. Adults emerge in May or June (Lataste, 1930).

*Parasites.* Hymenoptera: *Doryctes gallicus* Reinh., *Xorides praecatorius* F. (Xamheu, 1898-1902); *Bracon truncorum* Gour. (Reineck, 1919); *Neoxorides nitens* Grav., *Pyracmon xoridiformis* Hlgr., *Spathius rubidus* Rossi (Seyrig, 1924); *Cheiro-pachys colon* L. (Mendizabal, 1943); *Dibrachys cavus* Wlk., *Xorides filiformis* Grav. (Thompson, 1943).

Diptera: *Billaea triangulifera* Zett. (Lepesme & Paulian, 1943); ? *Phryxe vulgaris* Fln. (Emden, 1950).

*Economic importance.* Imported timber is occasionally infested with this species but the damage it does is in no way comparable to that caused by *Phymatodes testaceus*. Adults of this species have been known to bore through metal sheeting (Houlbert, 1912). There are indications that this species may have become established or re-established in this country (see Lloyd, 1950).

*Control.* As infestation is most likely to occur after the timber has been cut and stacked, the removal of the bark should adequately prevent oviposition.

*Material studied.* 1 P, no data, in coll. U.Z.M.C.; 2 L, from imported European

<sup>1</sup> The distinguishing character of the antenna as given by Emden (1939-1940) will not serve to separate this species from *Phymatodes testaceus*. The supposed larva of *P. sanguineum* examined by this author was no doubt an aberrant specimen of *P. testaceus*.

*Quercus*, in coll. F.P.R.L.; 9 L, 1 P, Hereford, St. Weonards, v.1950, from *Quercus*, R. W. Lloyd leg., in coll. D.

*References.* Emden, 1939-1940 (L); Fraser, 1948h (Biol.); Goedart, 1662 (L fig., Biol.); Goureau, 1843 (L fig., P fig., Biol. fig.), 1844 (L); Henriksen, 1914 (L fig.); Houlbert, 1912 (Biol.); Houlbert & Monnot, 1908 (L fig.); Judeich & Nitsche, 1889 (Biol.); Kaltenbach, 1874 (Biol.); Lataste, 1930 (Biol.); Lloyd, 1950 (Biol.); Macdougall, 1929 (Biol. fig.); Marcu, 1928 (Biol.); Mendizabal, 1943 (Paras.); Perris, 1877 (L, P); Peyerimhoff, 1919 (Biol.); Reineck, 1919 (Biol.); Seyrig, 1924 (Paras.); Thompson, 1943 (Paras.); Xamheu, 1898-1902 (L, P, Biol.). (See also the recent account by Allen, A. A., and Lloyd, R. W., 1951, *Ent. mon. Mag.* 87: 157-158.)

### \*Saphanini

#### \**Zamium incultum* Pascoe

[Occasionally in imported timber from South Africa.]

*Mature larva* (fig. 201).<sup>1</sup> Similar to those of the Callidini, from which it may be separated as follows. *Head* with antenna as figured (fig. 201). *Prothorax* rather sparsely setose laterally. Pronotum with a broad pale brown band near front margin, which is distinctly darker than posterior area. *Abdomen* with pleural discs indiscernible.

Host plant: "Rhodesian teak" (from records of F.P.R.L.).

*Material studied.* 6 L, vi.1945, from imported "Rhodesian teak", in coll. F.P.R.L.

*References.* None available.

### Clytini

#### Larval Characters

Form robust, contracted, rather strongly tapering, but last two or three segments conspicuously enlarged. *Head* trapezoidal, slightly widened posteriorly. Gena hardly ever shouldered: genal setae present (except certain North American species?). One, two, or three pairs of ocelli present. Labrum quadrate to transverse, fleshy. Mandible without a deep longitudinal impression on outer face. Hypostoma either rugose or longitudinally striate (at least in the following species). Subfossal spine absent (minute in certain North American species). Dorso-external process of palpifer much shorter than third segment of palp (absent in certain North American species). *Prothorax* with distinct proalar plates and short lateral setae; pronotum slightly inclined anteriorly; glabrous or velvety pubescent, seldom striate, although often longitudinally rugose; median cleavage line absent or impressed. Eusternum indistinct, marked by two round, glabrous, shining areas. *Abdomen* with ampullae broad, oval, flat and with two lateral and one transverse impressions (often indistinct). Pleural discs indistinct, sometimes reticulate. *Legs* absent or very small (except *Anaglyptus mysticus* and certain North American species); femur wider than long.

<sup>1</sup> Although the adult was originally placed in the tribe Saphanini near the beginning of the CERAMBYCINAE, Lepesme (1948) has suggested that it should be transferred to the ASEMINAE. The present writer, however, has found that the larva clearly belongs to the CERAMBYCINAE, and that no characteristics of the ASEMINAE such as the wedge-shaped mandibles and internal tentorial cross-arm are evident. Moreover, the larva appears to possess several characters in common with the Callidini.

Several tribal characters listed by Craighead (1923b) are not applicable to British and European species. For example, the genae are strongly shouldered in *Anaglyptus*; genal setae are always present; the pronotum is longitudinally striate, and the pleural discs are distinctly reticulate in *Clytus*.

### *Clytus arietis* (Linnaeus)

*Mature larva* (fig. 202). Length up to 20 mm.; maximum breadth (at prothorax) 5.5 mm. *Head* with maximum head-width 3.1 mm. Gena gradually narrowed up to mouthframe; smooth, and with a few long pale setae; temples rather narrowly ferruginous behind ocellus, and not as darkly pigmented as front margin of frons. Sclerotisation of mouthframe not interrupted beneath antennae, ferruginous. Antenna with

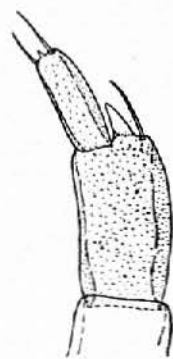


Fig. 201

Fig. 201. *Zamium incultum* Pascoe. Mature larva. Apical part of antenna. Lateral aspect.



Fig. 202

Fig. 202. *Clytus arietis* (Linnaeus). Mature larva. Front margin of hypostoma.

second segment twice as long as broad; third segment three times as long as broad, and just over half as long as second; supplementary process conical, tapering, nearly half as long as third segment. Mandible broad, with basal part ferruginous; apical part pitchy; longitudinal impression absent. Labrum transversely oval, fleshy, with rather long pale setae. One pair of ocelli present; lens large, convex; pigmented spot rather indistinct. Hypostoma with front margin broadly ferruginous and distinctly longitudinally striate (fig. 202); sutures ferruginous, curved. Gula distinctly raised; sutures concave, distinct and strongly divergent. Maxilla with lobe entirely glabrous on inner margin; maxillary palpi with third segment short, equal to second; dorso-external process of palpifer much shorter than third segment of palp. Labial palpi with second segment much broader than and as long as third. *Prothorax* with pronotum glabrous, longitudinally rugose (almost striate); median cleavage line distinctly impressed. *Abdomen* with ampullae very finely rugose, reticulate; median longitudinal furrow rather broad and deep. Pleural disc wrinkled, reticulate and rather indistinct. *Legs* absent.

*Pupa* (fig. 203). Length 7-15 mm.; maximum breadth 4 mm. *Head* with vertex visible from above, smooth; front transversely striate medially, glabrous. Antennae

extending as far as first (in female) or second (in male) abdominal segment where they terminate above elytra and wings. Eyes strongly convex, glabrous. Labrum triangular, glabrous. Pronotum slightly elongate, with sides moderately rounded and smooth: posterior half glabrous, or almost so; anterior half with numerous scattered, short, fine setae and a few (less than ten) conspicuous spines on each lateral region. *Mesonotum* smooth and glabrous or almost so. *Metanotum* similar; scutellar groove

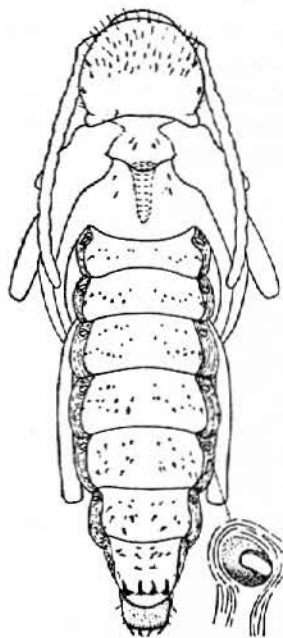


Fig. 203. *Clytus arietis* (Linnaeus). Female pupa. Dorsal aspect.

distinct. Elytra and wings extending to third abdominal segment. *Abdomen* with tergites one to six each with a broad, transverse band of short spines which are stoutest near posterior margin. Seventh tergite transverse, with sides converging posteriorly, and hind margin strongly rounded; bearing similar spines, but also a transverse row of from four to five very large spines (which are curved forward) near posterior margin. Eighth tergite slightly transverse, and posterior margin with from four to five slightly smaller spines which may be either directed posteriorly or recurved. Ninth segment retracted into eighth. Sternites sometimes glabrous, but usually with a few fine minute setae, especially near lateral regions. Pleura moderately protuberant, longitudinally rugose and glabrous. *Legs* with hind femora extending as far as sixth abdominal segment and lying parallel to longitudinal axis of body. *Functional spiracles* present on first five abdominal segments, but vestigial ones present on segments six to eight; peritreme rather broadly oval, with anterior half much thicker than posterior half and raised well above general level of cuticle; surrounded by a bulbous, cuticular protuberance.

Host plants: *Quercus*, *Castanea*, *Rubus*, *Acer pseudo-platanus*, *Pyrus malus*, *Ficus*, *Prunus cerasus*, *Crataegus* (Fabre, 1891); *Rosa* (Reineck, 1919); *Corylus*, *Fagus*, *Betula*, *Salix*, *Laurus nobilis* (Duffy, 1945a, 1946c); *Wistaria* (Wilson, 1925).

*Biology.* The larvae feed usually under the bark and in the sapwood of dead trees, fallen dry branches, posts, etc., where they live beneath the bark until about half-grown. They then tunnel into the sapwood (Pl. V, fig. 23), in which the pupal cell is constructed; the latter is short and curved round parallel to the grain of the wood. Pupation may occur either in August or September or in March or April. Adult emergence takes place in May and June. The life-cycle is usually completed in two years. Denny (1934) records an instance of adults emerging from oak branches used in a museum exhibit three years after the latter had been installed; as the branches had been well dried over a stove beforehand, it seems remarkable that the larvae should have survived.

*Parasites.* Hymenoptera: *Aspidogonus diversicornis* Wesm., *Pyracmon austriacus* Tschek. (Thompson, 1943).

*Predators.* Coleoptera: *Lygistopterus sanguineus* F. (Reineck, 1919).

*Natural enemies.* Turpin (1949) witnessed a Field Mouse (*Apodemus s. sylvaticus* L.) gnawing through wood and extracting a pupa of this species. Adults of this species are accepted by the Arachnids *Segestria florentina* Ross., *Aranea sexpunctata* L., and *Ciniflo similis* Bl. (Bristowe, 1941).

*Material studied.* 14 L, 3 P, Surrey, Mytchett, 6.v.1944, in dead branch of *Betula*, E. W. Classey leg., in coll. D.; 8 L, Surrey, Cutmill, 8.iv.1945, from *Quercus*, D. leg., in coll. D. [Adults reared.]

*References.* Bristowe, 1941 (Paras.); Chapuis & Candèze, 1853 (L fig.); Denny, 1934 (Biol.); Doebner, 1850 (Biol.); Duffy, 1945a (Biol.), 1946c (Biol.); Emden, 1939–1940 (L); Fabre, 1891 (Biol.); Henriksen, 1914 (L fig.); Kaltenbach, 1874 (Biol.); Nördlinger, 1880 (Biol.); Perris, 1847 (L fig., P, Biol.), 1877 (L, P); Reineck, 1919 (Biol.); Rye, 1868 (Biol.); Thompson, 1943 (Paras.); Turpin, 1949 (Biol.); Verhoeff, 1891 (Biol. fig.); Wilson, 1925 (Biol.); Xambeu, 1892 (L, P, Biol.), 1898–1902 (Biol.).

(\* *Plagionotus arcuatus* (Linnaeus)

[Frequently in imported timber from the Continent.]

*Mature larva.* Rather similar to that of *Clytus arietis*, from which it may be distinguished as follows. Form more robust; length up to 26 mm.; maximum breadth (at prothorax) 6 mm. *Head* with temples behind ocelli broadly ferruginous, as darkly pigmented as front margin of frons. Three pairs of ocelli present; lens small, convex; pigmented spot black, distinct. Front margin of hypostoma with fine transverse rugae. Antenna with third segment at most two and one-half times as long as broad and slightly less than half as long as second. Dorso-external process of palpifer nearly as long as apical segment of maxillary palpi. *Prothorax* with median cleavage line of pronotum incomplete, lightly impressed. *Legs* distinctly two-segmented, but much shorter than maxillary palp.

*Pupa.* This pupa is similar to that of *Clytus arietis*, from which it may be distinguished as follows. Length up to 25 mm.; maximum breadth 6 mm. *Pronotum* quadrate, with sides much more strongly rounded; each lateral region with at least twenty stout spines. *Mesonotum* and *metanotum* usually with a few scattered spines. *Abdomen* with seventh tergite bearing a transverse row of from four to eight very large, anteriorly curved spines. *Legs* with hind femora not extending beyond fifth abdominal segment. *Functional spiracles* with peritreme raised, but not surrounded by a bulbous protuberance.

Host plants: *Prunus* (Fowler & Donisthorpe, 1913); *Quercus* and *Salix* (Reineck, 1919). The latter seems rather questionable.

*Biology.* The eggs are laid in crevices in the bark of felled or recently dead trees. Fraser (1948b) gives the following account of the larval habits: "The gallery is sub-cortical for the entire larval existence, moderately straight and mainly parallel to the grain of the wood in which it cuts to a depth of about  $\frac{1}{8}$  in. The frass is powdery and tightly packed, and the gallery is frequently as wide as  $\frac{3}{4}$  in. . . . When about to pupate the larva burrows out to within  $\frac{1}{32}$  in. of the surface of the bark, not infrequently puncturing the surface, before turning to burrow into the sapwood. Immediately upon entering the sapwood the burrow turns through 90 degrees to form a pupal

cell some  $1\frac{1}{2}$  in. in length, parallel to the grain of the wood, and, normally, running in the direction of the root-end of the wood. The entrance to the pupal cell is packed with fibrous shavings, the full length of the cell being clear of frass. As observed the larvae invariably pupated upon their backs, with the head towards the entrance to the cell; from which it may be deduced that, in a standing tree, the pupa would probably be found head upward; an assumption which is strengthened by the arrangement of the terminal segment of the pupa. In two instances, pupae were found in cells which had no outer wall of sapwood, the full length of the cell being exposed by the removal of the bark (Pl. V, fig. 22); in three cases pupae were found in cells in the bark itself.<sup>1</sup> In these cases no exit had been prepared by the larva before pupating. . . . The larvae are slow to pupate, the process not being completed until four or five weeks after the larva has finished feeding." Adults emerge in June and July.

*Parasites.* Hymenoptera: *Helcon tardator* Nees (Fraser, 1848b); *Oncophanes lanceolator* Nees (Reineck, 1919); *Ephialtes abbreviatus* Thoms., *Xorides nitens* Grav. (Thompson, 1943).

*Economic importance.* This species is of economic importance chiefly owing to the abundance of larvae, and the extent of the ravages. The damage, however, is superficial and only detracts to a small extent from the utility of the timber. Timber recently imported from the Black Forest region has proved to be very heavily infested, and it seems by no means improbable that this species may eventually become established (or re-established?) in this country.

*Control.* Escherich (1916a) suggests the placing of felled logs in the shade, and the application of luminous paints to prevent oviposition.

*Material studied.* 14 L, 6 P, Lancs., Liverpool, iv.1948, in imported *Quercus*, M.G.F. and D. leg., in coll. D. [Adults reared.]

*References.* Barbey, 1913 (Biol. fig.); Bond, 1833a (L), 1836 (Biol.); Chapius & Candèze, 1853 (L fig.); Emden, 1939-1940 (L); Escherich, 1916a (Biol. fig., Contr.), 1916b (Biol.), 1917 (Biol., Contr.); 1923 (L, P fig., Biol. fig.); Fowler & Donisthorpe, 1913 (Biol.); Fraser, 1948b (Biol.); Goureau, 1842 (P); Henriksen, 1914 (L); Kaltenbach, 1874 (Biol.); Perris, 1847 (Biol.); Reineck, 1919 (Biol.); Schiödte, 1876 (L); Stark, 1926 (L fig., P fig., Biol. fig.); Teodoro, 1918 (L); Thompson, 1943 (Paras.); Trägårdh, 1922 (L fig., P fig., Biol. fig.), 1929 (Biol. fig.), 1939 (Biol. fig.); Xambeu, 1898-1902 (L, P).

#### \**Plagionotus detritus* Linnaeus

[Frequently in imported timber from the Continent.]

*Mature larva.* In the material at hand, no distinctive differences seem apparent between this larva and that of *P. arcuatus*. Trägårdh (1922) separates these two species by the formation of the ampullae on segments four and six, but this character appears to vary, depending as it does on whether the larvae were approaching ecdysis or not, and their condition when preserved. Additional larval material is required.

*Pupa.* No constant differences are apparent between the pupa of this species and that of *P. arcuatus* in the present material. According to Trägårdh's description and

<sup>1</sup> According to Trägårdh (1929) pupation takes place in the bark only when it exceeds 10-15 mm. in thickness.

figure (1922), this pupa may be distinguished from that of *P. arcuatus* by the number and arrangement of the spines on tergites seven and eight: the examination of several pupae of both species, however, has shown that these spines are extremely variable, and may be less or more numerous than those shown in Trägårdh's figure. A long series of pupae of both species may perhaps reveal some distinctive character.

Host plants: *Quercus* and *Castanea*, especially the former (Perris, 1877).

Biology. Very similar to that of *P. arcuatus* (see Fraser, 1948b).

Parasites. Hymenoptera: *Helcon tardator* Nees (Fraser, 1948b).

Economic importance. Similar to that of *P. arcuatus*. Both species are frequently found together and appear to cause similar and an equal amount of damage.

Material studied. 2 L, 4 P, Lancs., Liverpool, iv.1949, from *Quercus*, M.G.F. leg., in coll. D. [Adults reared.]

References. Fraser, 1948b (Biol.); Henriksen, 1914 (L fig.); Kaltentbach, 1874 (Biol.); Perris, 1877 (L fig., P, Biol.); Reineck, 1919 (Biol.); Trägårdh, 1922 (L fig., P fig., Biol. fig.); Xamheu, 1898-1902 (L, P, Biol.).

#### \**Sarosethes fulminans* Fabricius

[Rarely in imported timber from North America.]

Mature larva. No material available.

Host plants: *Castanea vesca* (Packard, 1881); *Conium maculatum* (Felt, 1906).

References. Felt, 1906 (Biol.); Packard, 1881 (Biol.).

#### \**Cyllene acuta* Germar

[Occasionally in imported timber from South America.]

Mature larva (fig. 204). Very similar to that of *Plagionotus* species, from which it differs as follows. Head with front margin of hypostoma with very strong transverse rugae. Ocelli with pigmented spot grey, indistinct. Antenna with third segment almost as long as second. Abdomen with ampullae with extremely fine reticulation; dull, milky white.

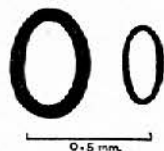


Fig. 204. *Cyllene robiniae* Forster (left) and *Cyllene acuta* Germar (right). Mature larvae. Peritreme of seventh abdominal spiracles.

Pupa. Very similar to those of *Plagionotus* species, from which it may be distinguished by the characters given in the key, p. 96.

Host plant: *Balfourodendron riedielanum*.

Biology. The characteristic larval galleries and pupal cells are shown on Pl. V, fig. 19.

*Material studied.* 6 L, 1 P, Lancs., Halsall, 20.ix.1948, from *Balfourodendron* from Brazil, M.G.F. leg., in coll. D. [Adults reared.]

*References.* None available.

\**Cyllene robiniae* Forster

[Occasionally imported from North America.]

*Mature larva* (fig. 204). Very similar to that of *C. acuta*, from which it may be distinguished by the characters given in the key, p. 76.

*Pupa.* Very similar to that of *C. acuta*, from which it may be distinguished by the characters given in the key, p. 96.

Host plants: *Robinia pseudacacia*, and sometimes in *Carya*, *Gleditschia* and *Juglans* (Packard, 1890); *Solidago* (Garman, 1921). According to Hopkins (1916) *Gleditschia* is not attacked.

*Biology.* The white eggs are usually deposited singly in the living bark of boles and branches of healthy trees from August to October. The incubation period lasts about seven days. It has been noticed (Hall, 1942) that temperature is apparently the principal limiting factor in oviposition: when the daily maximum air temperatures exceed 75° F. the females exhibit a decided preference for shaded parts of the tree, but when air temperatures are below 70° F. they oviposit in the sun or shade indiscriminately. The young larvae burrow into the inner bark in which they overwinter. In the spring they start to tunnel into the sapwood (usually in an upward direction) and, later, the heartwood, where they make winding, irregular galleries. According to Packard (1890) these galleries soon become filled with coarse frass, and the larvae are forced to open up fresh holes in the bark through which to eject it. The presence of larvae is indicated by oozing sap and accumulations of frass at the base of the tree. The bark around the places attacked soon becomes disfigured and weakened. Pupation takes place in July or August and lasts for two or three weeks. Adults emerge during the period August to October. The life-cycle is completed in one year.

*Predators.* Coleoptera: *Hemirhipis fascicularis* F. (Hopkins, 1907a). Hemiptera: *Prionidus cristatus* feeds on adults (Sanborn & Painter, 1917).

*Natural enemies.* Woodpeckers (*Gecinus* spp.) (Hall, 1942).

*Economic importance.* This species is of considerable economic importance and does extensive and serious damage to living trees, especially *Robinia pseudacacia*. Injury consists of wounds in the bark and sapwood which, if repeated year after year, result either in stunted, worthless growth or in killing both young and mature trees. The larval depredations render the wood worthless. Apart from its commercial value, *Robinia* is planted systematically to reduce soil erosion; thus control of this pest is doubly important. It has been noticed (Hall, 1942) that slow-growing, overtopped trees are less able to withstand attack, and often succumb or become so infested that they are worthless commercially. Craighead (1919) maintains that trees in shady positions are less liable to attack by this insect.

*Control.* Factors reducing the vigour of the trees (i.e. drought, fire, abrasion by cattle) tend greatly to increase their susceptibility to injury by this pest. Silvicultural methods such as clearing, thinning and mixed planting serve to improve growing

conditions. The spraying of trees with orthodichlorobenzene (Hall, 1942) has proved very successful but it is too costly for general purposes. Packard (1890) suggests the collecting by schoolchildren of adults which swarm on golden rod in September, and the thorough soaping or greasing of trunks in August to cause asphyxiation of adults through spiracular congestion. Sanborn & Painter (1917) recommend the coating of trunks with whitewash. For small plantations or individual trees Craighead (1950) recommends, besides various silvicultural practices, the application of a fumigant spray (orthodichlorobenzene emulsion), which should be applied early in the spring before the young larvae enter the sapwood. The trunk should be completely coated with the spray to a height of six feet.

*Material studied.* 3 L, U.S.A., Arlington Farm, Va., 20.viii.1907, from *Robinia*, A. D. Hopkins leg., in coll. U.S.N.M.

*References.* Bethune, 1877 (Biol.); Bruner, 1893 (Biol.); Cotton, 1906 (Biol.); Craighead, 1919 (Biol. fig., Contr.), 1923b (L, P, Biol.), 1950 (Biol. fig., Contr.); Dearborn, 1821 (Biol.); Felt, 1906 (L fig., P); Garman, 1915 (Biol.), 1921 (Biol. fig.); Hall, 1942 (L fig., P fig., Biol. fig.); Harris, 1841 (Biol.); Hopkins, 1898 (Biol.), 1906 (E fig., L fig., P fig., Biol. fig.), 1907a (Biol.), 1907b (Biol.); Laurent, 1893 (Biol.); Osten-Sacken, 1862 (L fig., P, Biol.); Packard, 1890 (L, P, Biol.); Pickering, 1821 (Biol.); Sanborn & Painter, 1917 (Biol. fig., Contr.); Walsh, 1865 (L); White, 1906 (Biol.); Woods, 1898 (Biol.).

#### \**Cyllene caryae* Gahan

[Occasionally in imported timber from North America.]

*Mature larva.* No material available.

*Host plants:* *Carya alba*; also *Juglans nigra* and *J. cinerea* (Lintner, 1893); *Pecan* (Riley, 1880); *Hicoria* (Beutenmuller, 1896); *Machura aurantiaca* (Dusham, 1921); *Gleditschia triacanthos*, *Toxylon pomiferum*, *Celtis occidentalis* (Zacher, 1937); *Prosopis* (Vogt, 1949).

*Biology.* The larvae feed in freshly cut wood, and eject large quantities of frass. According to Dusham (1921) the most serious damage is caused by the excavation of the pupal cells which extend 1-2 in. into the sapwood. The sapwood is often riddled with larval galleries. Pupation may occur either in late autumn or in the spring. Adults emerge in May and June. Sometimes a small Eumenid wasp constructs its nest outside the pupal cell, thus preventing parasites from gaining access to the pupa.

*Parasites.* Hymenoptera: *Bracon erythrogaster* Brullé and *Doryctes radiatus* Cr. (Dusham, 1921).

*Predators.* Coleoptera: Larvae of *Hemirhipus fascicularis* F. (Dusham, 1921).

*Economic importance.* This species attacks only dead or felled timber. Damage caused through the emergence of adults from worked wood such as hickory tool-handles is not infrequent. According to Craighead (1950), adults often emerge from wood stored for fuel in warm cellars and cause annoyance.

*References.* Beutenmuller, 1896 (Biol.); Craighead, 1950 (Biol.); Dusham, 1921 (Biol. fig.); Felt, 1907 (L, P fig., Biol. fig.); Lintner, 1893 (L fig., P fig.); Packard, 1890 (L fig., P fig., Biol.); Riley, 1880 (Biol.); Vogt, 1949 (Biol.); Zacher, 1937 (Biol. fig.).

**\*Cyllene spinifera** Newman

[Occasionally in imported timber from South America.]

*Mature larva.* No material available.Host plant: *Prosopis nigra-gris*.*References.* Scott, 1927 (Biol.).**\*Cyllene falsa** Chevrolat

[Occasionally in imported timber from South America.]

*Mature larva.* No material or references available.**\*Neoclytus acuminatus** Fabricius (= **erythrocephalus** Fabricius)

[Occasionally in imported timber from North America.]

*Mature larva.* Rather similar to that of *Clytus arietis* from which it may be distinguished as follows. Length up to 26 mm.; maximum breadth (at prothorax) 6 mm. *Head* with mouthframe beneath antennae very strongly sclerotised, pitchy. Hypostoma with front margin straight, and with feeble transverse rugae. Antenna with second segment nearly two and one-half times as long as broad; third segment three and one-half to four times as long as broad; supplementary process less than one-third as long as third segment. Maxillary palp with third segment as long as second. *Prothorax* with pronotum smooth, dull and extremely finely reticulate posteriorly; median cleavage line indiscernible. *Abdomen* with ampullae dull, very finely reticulate. *Legs* minute, much shorter than third segment of maxillary palp.

*Pupa.* This pupa is very similar to that of *Clytus arietis*, from which it may be separated as follows. Length up to 21 mm. *Head* with gena bearing a small but distinct teat-shaped tubercle near base of mandible. *Pronotum* with posterior half with a few scattered spinules. *Prothorax* with an acute tubercular process between mesothoracic spiracle and front coxa. Process of prosternum as thick as maxillary palp, fleshy and protuberant. *Abdomen* with seventh tergite with a transverse row of six stout, anteriorly curved spines. Sternites glabrous. *Functional spiracles* present on first seven abdominal segments.

Host plants: *Fraxinus*, *Hicoria*, *Quercus*, *Juglans*, *Betula*, *Fagus*, *Ostrya*, *Acer*, *Celtis*, *Vitis*, *Cornus*, *Cercocarpus*, *Ilex*, *Prosopis*, *Cercis*, *Diospyros*, *Syringa*, *Gleditschia*, *Lonicera*, *Prunus*, *Sassafras*, *Robinia*, *Liriodendron*, *Castanea* (Craighead, 1923b); *Ulmus*, *Pyrus communis*, *P. malus* (Felt, 1905); *Salix* (Chittenden, 1894); *Pithecolobium pallens* (Vogt, 1949). There are also records from *Pinus* and *Taxodium*, but these have not been confirmed (Craighead, 1923b). *Fraxinus* appears to be the favourite host (Blair, 1948).

*Biology.* The larvae tunnel in both dead and decaying wood and completely honeycomb the sapwood and outer heartwood. This species is often found in association with *Saperda tridentata* Olivier and probably follows it (Craighead, 1923b). Pupation takes place at a depth of about 1 in. in the sapwood where an "indirect" cell is prepared. Adults emerge from April to August. The life-cycle is usually completed within three months.

*Parasites.* Hymenoptera: *Bracon agrilli* Ashm. (Felt, 1905); *Bracon eurygaster* Br. (Chittenden, 1894); *Helconidea ligator* Say (Thompson, 1943).

*Economic importance.* According to Saunt (1931) larvae of this species are very destructive to timber and are responsible for much wasted labour because the damage is not often apparent until the timber has been prepared and utilised.

*Material studied.* 1 L, 1 P. In imported timber from North America, 27.i.1927, J. W. Saunt leg., in coll. B.M.

*References.* Blackman & Stage, 1924 (Biol.); Blair, 1948 (Biol.); Chittenden, 1894 (Biol.); Craighead, 1923b (L, P, Biol.), 1950 (Biol., Contr.); Emden, 1939-1940 (L); Felt, 1905 (Biol.); Fisher, Cann & Parkin, 1932 (Biol. fig.); Riley, 1880 (Biol.); Saunt, 1931 (Biol.); Thompson, 1943 (Paras.); Vogt, 1949 (Biol.); Webster, 1894 (Biol.).

**\**Neoclytus mucronatus* Fabricius (= *luscus* Fabricius)**

[Recently in imported timber from North America.]

*Mature larva.* No material available.

*Host plant:* *Hicoria* (Craighead, 1923b).

*Biology.* According to Craighead (1923b) this species attacks only dead or dying trees, mining about as much beneath the bark as in the wood. It is often associated with trees which have been killed by Scolytid beetles.

*References.* Craighead, 1923b (L, Biol.).

**\**Neoclytus caprea* Say**

[Sometimes in imported timber from North America.]

*Mature larva* (figs. 205, 206). Extremely similar to that of *N. acuminatus*, from which it may be distinguished by the protuberant hypostoma (fig. 205).

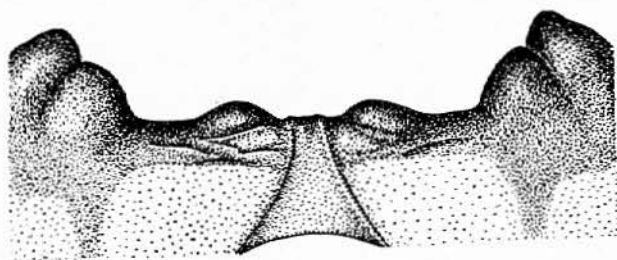


Fig. 205

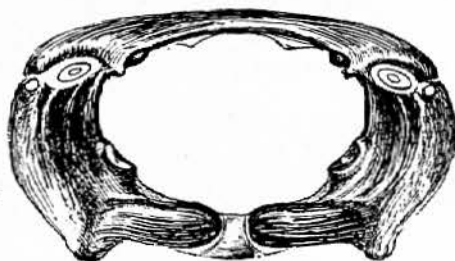


Fig. 206

Fig. 205. *Neoclytus caprea* Say. Mature larva. Front margin of hypostoma.

Fig. 206. *Neoclytus caprea* Say. Mature larva. Mouthframe. (Craighead, 1923b)

*Host plants:* *Fraxinus*, *Quercus*, *Prosopis* (Craighead, 1923b). Felt (1906) records this species from *Ulmus* and *Hicoria*.

*Biology.* Early in the spring the adults oviposit on logs cut during the winter months, depositing their eggs in crevices in the bark. Larvae feed subcortically for

only a short period, and soon start to tunnel into the sapwood and outer heartwood, which they often completely honeycomb. The galleries are packed with granular frass. The life-cycle is completed in one year (Craighead, 1923b, 1950).

*Parasites.* Hymenoptera: *Diospilus neoclyti* Rohw., *Xorides neoclyti* Rohw. (Thompson, 1943).

*Predators.* Coleoptera: *Chariessa* sp. (Craighead, 1923b).

*Economic importance.* This species is of economic importance and readily attacks dying trees and sawn logs. If the infested logs are stored, the wood becomes dry, with the result that adults emerge at irregular intervals for several years. Blair (1948) suggests that this species may eventually become established in this country.

*Control.* Craighead (1950) recommends the rapid disposal of logs or, if it is necessary to store them, they should be decorticated or floated in streams and exposed to sunlight, or sprayed with benzene hexachloride which is poisonous, and should be used with care.

*Material studied.* 2 L, from imported American *Fraxinus*, 9.i.1943, in coll. F.P.R.L.; 1 L, U.S.A., St. Louis, Missouri, 29.x.1912, from *Fraxinus*, in coll. U.S.N.M.

*References.* Blair, 1948 (Biol.); Craighead, 1923b (L fig., P, Biol.), 1950 (Biol. fig., Contr.); Felt, 1906 (Biol.); Macdougall, 1929 (Biol. fig.); Riley, 1880 (Biol.); Saunt, 1931 (Biol.).

#### \**Neoclytus scutellaris* Olivier

[Occasionally in imported timber from North America.]

*Mature larva.* Very similar to that of *N. acuminatus*, from which it may be distinguished by the characters given in the key, p. 77.

Host plants: *Quercus alba*, and always associated with a dry fungus rot (Craighead, 1923b).

*Biology.* The habits of this species are very similar to those of *N. caprea*, although the larval galleries are less extensive (Craighead, 1923b).

*Material studied.* 3 L, U.S.A., Falls Church, Virginia, 24.iii.1914, from *Quercus*, H. B. Kirk leg., in coll. U.S.N.M.

*References.* Craighead, 1923b (L, Biol.).

#### \**Neoclytus rufus* Olivier

[Occasionally in imported timber from the West Indies.]

*Mature larva.* No material or references available.

Host plant: *Mora excelsa*.

#### \**Xylotrechus colonus* Fabricius

[Occasionally imported in timber from North America.]

*Mature larva* (fig. 207). Rather similar to that of *Clytus arietis*, from which it may be distinguished as follows. *Head* with front margin of hypostoma transversely rugose. *Prothorax* (fig. 207) with front part of pronotum dull and velvety pubescent.

*Pupa.* Similar to that of *Clytus arietis*, from which it may be distinguished by the characters given in the key, p. 96.

*Host plants:* *Quercus* (Riley, 1880); *Acer*, *Hicoria*, *Castanea* (Chittenden, 1894); *Fagus*, *Juglans*, *Fraxinus*, *Ulmus* (Blackman & Stage, 1924).

*Biology.* Oviposition may occur either on living or dead trees, especially *Hicoria*. Blackman & Stage (1924) give the following account: "The larval burrow is at first rather straight, and may be either longitudinal, transverse or diagonal. Later it becomes very tortuous, bending backward and forward parallel with the grain of the wood except at the turns. The entire burrow is filled with meal-like frass derived

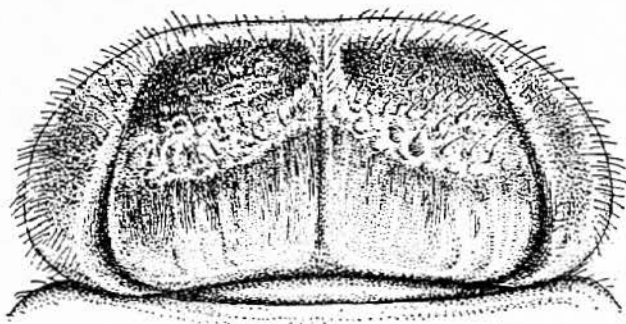


Fig. 207. *Xylotrechus colonus* Fabricius. Mature larva. Pro- and mesothorax. Dorsal aspect. (Craighead, 1923b)

equally from the bark and wood, closely packed and glued together." Pupation may take place either in the sapwood or in the bark. The life-cycle is sometimes completed within a year.

*Parasites.* Hymenoptera: *Xylonomus rileyi* Ashmead. (Chittenden, 1894); *Melanobracon simplex* Cress, and *Arotes decorus* Say (Felt, 1907).

*Material studied.* 4 L, from logs of *Hicoria* imported from North America, in coll. F.P.R.L.; 5 P, U.S.A., Springfield, Mass., 23.v.1901, from *Quercus alba*, in coll. U.S.N.M.

*References.* Blackman & Stage, 1924 (Biol. fig.); Chittenden, 1894 (Biol.); Craighead, 1923b (L fig., Biol.); Felt, 1907 (Biol. fig.); Packard, 1881 (Biol.), 1883 (Biol. fig.).

**\**Xylotrechus smei* Castelnau & Gory**

[Occasionally in imported timber from the Orient.]

*Mature larva* (figs. 208, 209). Very similar to that of *X. colonus*, from which it may at once be separated by the glabrous shining pronotum.

*Host plants:* *Adina cordifolia*, *Aegle marmelos*, *Anogeissus latifolia*, *Bauhinia retusa*, *Bombax malabaricum*, *Bridelia retusa*, *Buchanania latifolia*, *Butea frondosa*, *Calycopteris floribunda*, *Careya arborea*, *Cassia fistula*, *Cedrela toona*, *Dalbergia latifolia*, *D. paniculata*, *D. sissoo*, *Ehretia acuminata*, *Eugenia jambolana*, *Ficus gibbosa*, *F. religiosa*, *Garuga pinnata*, *Gmelina arborea*, *Grewia tiliaefolia*, *G. vestita*, *Holoptelea integrifolia*, *Hymenodictyon excelsum*, *Kydia calycina*, *Litsaea sebifera*, *Machilus odoratissima*, *Mallotus philippinensis*, *Mangifera indica*, *Morus alba*, *M. indica*,

*Pterocarpus marsupium*, *Schrebera swientenioides*, *Shorea robusta*, *Strychnos nuxvomica*, *Tectona grandis*, *Terminalia tomentosa*, *Vangueria spinosa*, *Vitis latifolia*, *Xylia dolabriformis* (Beeson & Bhatia, 1939).

*Biology.* Beeson & Bhatia (1939) give the following account: "The maximum number of eggs laid by one female is 190 and the maximum laid in 24 hours is 60; the longest recorded oviposition period is six days in April. Eggs are laid in crevices

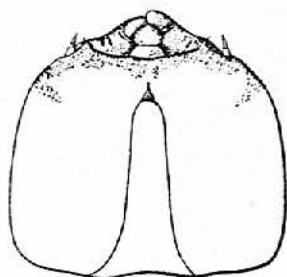


Fig. 208

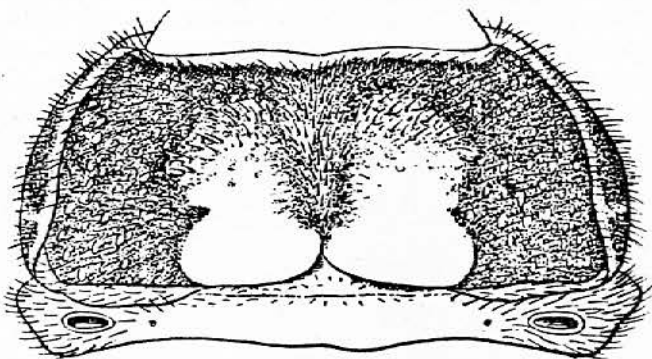


Fig. 209

Fig. 208. *Xylotrechus smei* Castelnau & Gory. Mature larva. Head. Dorsal aspect. (Gardner, 1927)

Fig. 209. *Xylotrechus smei* Castelnau & Gory. Mature larva. Prothorax. Ventral aspect. (Gardner, 1927)

and covered depressions on the surface of bark in large clusters. The egg hatches in four or five days in April. The rate of larval development is very variable. By inoculating newly hatched larvae in freshly cut logs (of *Shorea robusta*) between the 5th and 14th April the emergence of beetles was obtained as early as the 14th June. The shortest larval period under these conditions was fifty-two days in April-May, and the pupal period eighteen or nineteen days. . . . *X. smei* attacks newly felled trees within a month of felling and also several months after felling; girdled trees and the crowns of dying or stag headed trees are attacked. Logs stored in the sun are more liable to be attacked than logs stored in the shade but the preference is not very strongly marked. The larval tunnels which are excavated on the surfaces of the sapwood and inner bark, are flattened, oval in section, and tightly packed with bark and wood dust; in a crowded infestation the tunnels closely interlace. The pupal chamber is a cell about three-quarters of an inch long formed at a short depth in the sapwood. In timbers which have a strongly differentiated heartwood the borings are confined to the sapwood, but in homogeneous wood the tunnels may run right into the centre of the log and trend irregularly, or are more or less concentric with, the zones of growth. The emergence of *X. smei* (in Dehra Dun) begins at the end of March from overwintered broods and is at its peak in May, and may continue to the end of November. Eggs laid in April and May give rise to short-cycle and long-cycle generations, the former taking two and a half to seven months and emerging between the beginning of July and the end of November, and the latter hibernating to emerge in the second year. Eggs laid at the beginning of July and later in the year do not produce

a complete generation in the same year, as the immature beetle or larva passes the cold weather in a resting stage and the adult emerges in the second year between April and November. The shortest life-cycle of overwintering broods is about six months, and the longest might be sixteen months. The following diagram (fig. 210) shows that trees felled in January to May produce complete generations with emergence in August–November of the same year; trees felled June to December produce

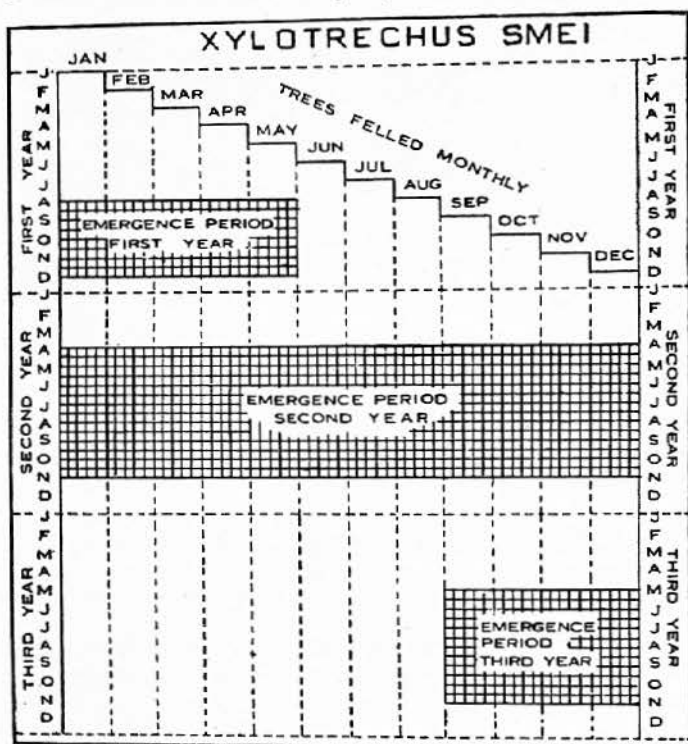


Fig. 210. Chart showing emergence periods of *Xylotrechus smei* Castelnau & Gory. (Beeson & Bhatia, 1939)

complete generations with emergence in April–November of the following year. Emergences also occur from long-cycle broods in the second year of felling.

*Material studied.* 3 L, from "Touas" wood imported from India, in coll. F.P.R.L.

*References.* Beeson & Bhatia, 1939 (Biol.); Gardner, 1927 (L fig., Biol.).

#### \**Xylotrechus contortus* Gahan

[Rarely in imported timber from India.]

*Mature larva.* No material available.

*Host plants:* *Juglans regia* and *Rhododendron aboreum* (Beeson & Bhatia, 1939).

*Biology.* Adults of this species emerge throughout the period April to September (Beeson & Bhatia, 1939).

*References.* Beeson & Bhatia, 1939 (Biol.).

*Anaglyptus mysticus* (Linnaeus)

*Mature larva* (figs. 211, 212). Rather similar to that of *Clytus arietis*, from which it may be distinguished as follows. *Head* with genae strongly shouldered. Sclerotisation of mouthframe interrupted beneath antennae. Front margin of hypostoma narrowly ferruginous, and transversely rugose. Antenna (fig. 211) as in *C. arietis*. *Prothorax* with pronotum finely striate on posterior half; median cleavage line indiscernible. *Abdomen* with ampullae with longitudinal median furrow rather deep. *Legs* almost as long as maxillary palp (fig. 212); femur, tibiotarsus and apex of unguiculus ferruginous; tibiotarsus transverse; unguiculus imbricately spinose.

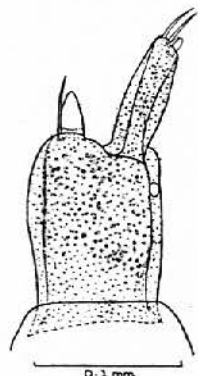


Fig. 211

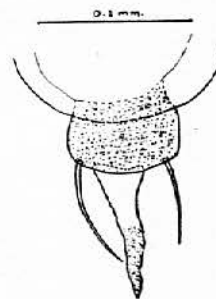


Fig. 212

Fig. 211. *Anaglyptus mysticus* (Linnaeus). Mature larva. Apical part of antenna. Lateral aspect.

Fig. 212. *Anaglyptus mysticus* (Linnaeus). Mature larva. Apical part of mesothoracic right leg.

Host plants: *Quercus*, *Prunus*, *Cornus*, *Pyrus*, *Diospyros*, *Betula*, *Benzoin* and *Acer* (Reineck, 1919); *Diospyros lotus* (Frauenfeld, 1872); *Fagus* (Hickin, 1947b). The present writer has found *Crataegus* to be the preferred host.

*Biology*. Larvae feed under the bark and in the wood of very dry, dead boles and branches. Trees that have been scorched by fire seem particularly prone to attack; this is probably due to the excessive dryness of the wood caused by desiccation. The larval galleries are very similar to those of *Clytus arietis*, but tend more frequently to enter the heartwood. The frass is extremely fine and tightly packed. Trees appear to be reinfested year after year until almost completely honeycombed by the larval ravages. Pupation occurs in the autumn, usually in the sapwood. The pupal cell is elongate, and parallel to the grain of the wood. Emergence takes place in May and June. The life-cycle is usually completed in two years. Hickin (1947b) records the discovery of a larva in the wood of a dressing-table in which it had survived for at least thirteen years.

*Material studied*. 9 L, Surrey, Ashtead, ii.1947, in dead bole of *Crataegus*, D leg., in coll. D. [Adults reared.]

*References*. Emden, 1939-1940 (L); Frauenfeld, 1872 (Biol.); Henriksen, 1914 (L fig.); Hickin, 1947b (Biol.); Reineck, 1919 (Biol.); Schiödte, 1876 (L fig., P); Xambeu, 1898-1902 (L, P, Biol.).

**\*Anaglyptus verrucosus** Olivier

[Occasionally in imported timber from North America.]

*Mature larva.* Similar to that of *A. mysticus*, from which it differs by the characters given in the key, p. 77.

*Pupa.* Similar to that of *Neoclytus acuminatus*, from which it may be distinguished by the characters given in the key, p. 96.

Host plants: *Quercus*, *Prunus*, *Cornus*, *Pyrus*, *Diospyros*, *Betula*, *Benzoin*, and *Acer* (Craighead, 1923b); *Cydonia vulgaris* (Riley, 1880); *Castanea*, *Fagus*, *Tilia* (Chittenden, 1894); *Hicoria*, *Juglans*, *Robinia*, *Vitis vinifera* (Blackman & Stage, 1924).

*Biology.* According to Craighead (1923b) larvae feed in solid, dead wood, especially *Quercus*, where they are often associated with larvae of *Neoclytus longipes* Kirby. Pupation takes place either in the spring or autumn. The life-cycle is completed in one year.

*Material studied.* 5 L, 2 P, U.S.A., Rockville, Pennsylvania, 11.xi.1913, from *Quercus*, H. B. Kirk leg., in coll. U.S.N.M.

*References.* Beutenmuller, 1896 (Biol.); Blackman & Stage, 1924 (Biol.); Chittenden, 1894 (Biol.); Craighead, 1923b (L fig., P, Biol.); Riley, 1880 (Biol.).

**\*Isotomus speciosus** Schneider

[Occasionally in imported timber from the Continent.]

*Mature larva.* Similar to that of *Anaglyptus mysticus*. All the major differences are listed in the key, p. 75.

Host plant: *Carpinus* (from records of the F.P.R.L.).

*Material studied.* 1 L, imported from the Continent, in coll. F.P.R.L.; 3 L, no data, in coll. B.M.

*References.* None available.

**\*Chlorophorus annularis** Fabricius

[Often in imported bamboo from the Orient.]

*Mature larva.* Rather similar to that of *Clytus arietis*, from which it may be distinguished as follows. Form more slender; length up to 23 mm.; maximum breadth (at prothorax) 4 mm. *Head* with sclerotisation of mouthframe interrupted beneath antenna. Hypostoma with front margin narrowly pale testaceous, with transverse rugae; sutures very pale testaceous. Antenna with third segment slightly tapering, three times as long as broad; supplementary process elongate, conical, nearly half as long as third. Maxillary palpi with third segment distinctly longer than second. *Legs* minute, shorter than third segment of maxillary palp.

*Pupa* (fig. 213). Similar to that of *C. arietis*, from which it differs by the absence of ferruginous tubercles on the pronotum and by the arrangement of the spines on the seventh abdominal tergite.

Host plants: *Bambusa*, *Dendrocalamus strictus*, *Shorea robusta* and *Tectona grandis* (Beeson & Bhatia, 1939); *Sinocalamus* and *Spondias* (Gressitt, 1942).

*Biology.* Oviposition occurs on cut bamboo which has already lost a certain amount of sap. The first-instar larvae bore into the tissues of the walls of the bamboo, making irregular excavations which are packed with powdery wooden particles and frass. The galleries are not delimited by the nodes. The mature larva excavates a cell in the wood in which it pupates. Adults emerge from May to September but principally in June.

*Parasites.* Hymenoptera: *Eurytoma xylorechie* Ferrière (Ferrière, 1933); *Doryctes bistratus* Kieff., *D. brevipetiolus* Kieff., *D. picticeps* Kieff., *D. strioliger* Kieff., *D. tristriatus* Kieff., *Duportia cincticornis* Kieff., *Paraglypta tubigera* Kieff., *Promiscolus sequistriatus* Kieff., *Sclerodermus domesticus* Latr. (Thompson, 1943).

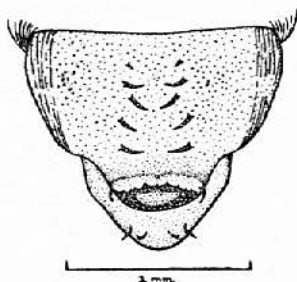


Fig. 213. *Chlorophorus annularis* Fabricius. Male pupa. Seventh and eighth abdominal tergites.

*Economic importance.* Owing to its particular type of habitat, development is often considerably retarded with the result that emergence often occurs after the bamboo has been utilised in the construction of furniture, etc. Saalas (1941) gives an account of a consignment of ski-staffs which were found to be infested with larvae of this species. In India the bamboo structure of thatched roofs and field telegraph posts are frequently extensively attacked by this species (Stebbing, 1914).

*Control.* Stebbing (1914) recommends the following treatment. Immerse the bamboos in water for five days (this causes a gelatinous exudation, and renders the bamboo more highly absorbent), and then allow to dry in a covered shed for several days. When quite dry, they should then be soaked in crude petroleum ("Rangoon oil") for forty-eight hours. This procedure, he maintains, gives complete protection. Craighead (1950) recommends fumigation or heat-treatment.

*Material studied.* 8 L, 1 P, in coll. F.P.R.L.

*References.* Beeson & Bhatia, 1939 (Biol.); Craighead, 1950 (Biol., Contr.); Ferrière, 1933 (Paras.); Gardner, 1927 (L); Gressitt, 1942 (Biol.); Maxwell-Lefroy & Howlett, 1909 (Biol.); Mukaikawa, 1922 (Biol.); Newman, 1946 (Biol.); Saalas, 1941 (Biol. fig.); Stebbing, 1914 (Biol.); Thompson, 1943 (Paras.).

**\*Euderces pini** Olivier

[Occasionally in imported timber from North America.]

*Mature larva.* No material or references available.

**\*Trachyderini****\*Trachyderes hilaris** Bates

See p. 177.

**\*Ozodes multituberculatus** Bates

[Occasionally in imported timber from South America.]

*Mature larva.* No material or references available.

Host plant: *Vochysia hondurensis*.

**6. LAMIINAE****Larval Characters**

*Head* elongate (except *Sternotomis*), with sides parallel or converging posteriorly; dorsal margins of epicranial halves behind frons fused for their entire length; tentorial cross-arm internal, at right angles to hypostoma (i.e. occipital foramen not divided). Mandible elongate, with cutting edge oblique and apex rounded. Lower boundary of frons not produced over clypeus; six (occasionally more) epistomal setae present. Clypeus trapezoidal, wide, filling space between mandibles. Labrum transverse to cordate. Ocelli, if present, never more than two pairs (although there may be one to three vestigial ocelli comprising a pigmented spot without a distinct lens), usually one pair. Gula usually broad. Maxillae rigid (only movable from stipes), cardo, maxillary articulating area and submentum fused and attached for entire distance between ventral articulations of mandibles; palpifer large, distinct, bearing lobe, and with outer margin straight (except *Acanthocinus*); process of palpifer absent. Antennae very short and retractile; two- or three-segmented. *Prothorax* having presternum and epipleurum usually distinctly separated; eusternum sometimes indistinct. Postnotal fold absent. *Abdomen* with region surrounding spiracle not protruding; epipleurum protuberant on from three to all segments; pleural discs absent; hypopleurum small; coxal lobe large. *Legs* absent or occasionally present, but then vestigial. *Spiracles* of mesothorax protruding into prothorax.

**\*Dorcadionini** (pars)**\*Moneilema** spp.

[Occasionally in imported Cactaceae from North America and Mexico.]

*Mature larva* (fig. 214). Form cylindrical, very robust. Length at least 22 mm.; maximum breadth (at prothorax) at least 7 mm. *Head* moderately depressed, with sides parallel and broadly rounded posteriorly (maximum head-width 4.4 mm.); frontal sutures indistinct; antennal foramen closed behind; six epistomal setae present. Mandible scarcely tapering, about twice as long as basal width, with cutting edge roundly emarginate. One pair of ocelli present ventrad of antenna; lens round, very strongly convex and protuberant; pigmented spot indistinct. Hypostoma short, testaceous, with sutures pithy. Gular region undefined, glabrous. Antenna two-segmented, the second segment bearing a large tapering, glabrous, hyaline process.

Labrum transversely oval, densely setose anteriorly. Ventral mouthparts very thick, fleshy and with strongly sclerotised ferruginous areas. Maxilla with third palpal segment acute, shorter than second. Labial palpi with third segment acute, less than half length of second. Sclerotisation very broad across base of labial stipes. Mentum distinct from submentum. *Prothorax* with posterior area of pronotum sparsely setose and delimited anteriorly by a short impression on each side. *Abdomen* with each dorsal ampulla (fig. 214) densely covered with irregular, spiculate tubercles, strongly

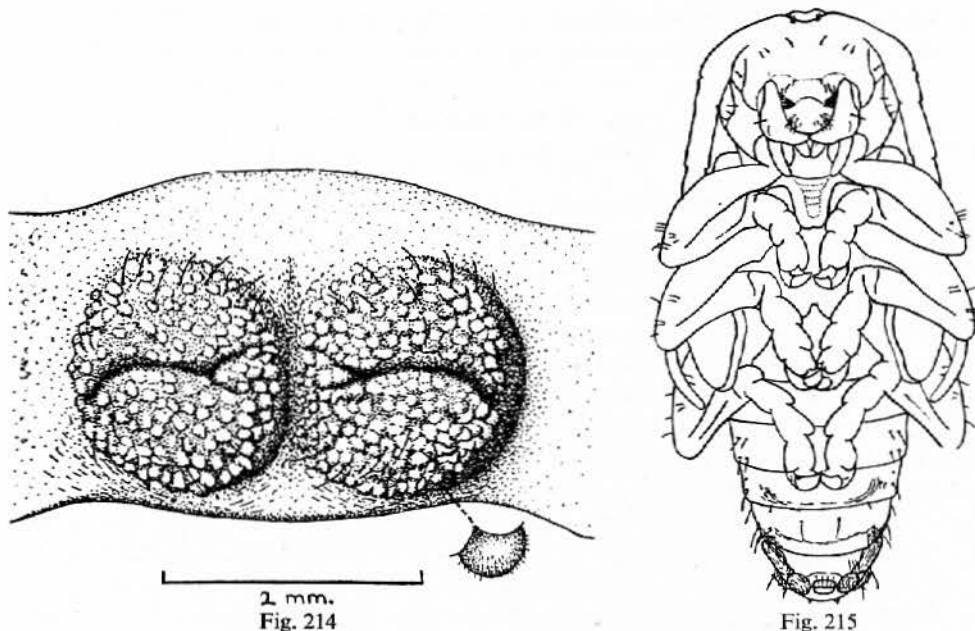


Fig. 214. *Monilema* sp. Mature larva. Sixth dorsal abdominal ampulla.

Fig. 215. *Monilema* sp. Male pupa. Ventral aspect.

protuberant, deeply bilobed and with a single transverse impression. Ventral ampullae similar but not bilobed and with the transverse impression deeper. Ninth segment without a sclerotised plate or spine. Anus trilobate, the dorsal lobe strongly protruding beyond ventral lobes. Epipleurum protuberant on all segments. Pleural tubercle broadly oval, with a sclerotised pit at each extremity and bearing several setae. *Legs* vestigial, consisting of a minute setose tubercle. *Spiracles* broadly oval, with peritreme thick, pale and with about six chambers on inner margin of posterior half.

*Pupa* (fig. 215). Length, 26 mm.; breadth, 8.25 mm. *Head* slightly elongate, triangular, rugose; vertex visible from above and rather deeply excavated between antennae; front with about eight scattered, fine setae; base of clypeus, which is strongly protuberant, with about three setae on each side. Antennae extending to fourth abdominal segment where they terminate on hind tibiae. Mandible bearing two setae near middle of outer face. Labrum semicircular, with two deep depressions at base, and with numerous fine setae along front margin. *Pronotum* bearing a pair of lateral

tubercles (absent in some species); long, fine, scattered setae present, mostly on sides and lateral tubercles. *Mesonotum* with scattered fine setae; scutellum depressed and glabrous. *Metanotum* not longer than mesonotum and with a few setae on each side of scutellar groove, which is broad and transversely striate. Elytra and wings extending to fourth abdominal segment. *Abdomen* with tergites two to six with a conspicuous transverse furrow, which has a row of short stout spines (each with a long basal seta) above and below it. Seventh tergite with small scattered groups of similar spines. Eighth tergite short, with numerous spines. Ninth tergite very short and with a pair of paramedian, short spines (urogomphi?). Sternites with sublateral groups of fine setae. *Legs* exceedingly robust; femora with a few fine setae near apex and hind femora with a stout tubercle near base and extending to fifth abdominal segment. *Functional spiracles* present on abdominal segments one to six. Peritreme narrowly oval, reniform, moderately thick, surrounded by a tubercular rim, and raised above general level of cuticle.

Host plants: Cactaceae, especially those of the genera *Echinocereus* (Psota, 1930), and *Opuntia* (Hunter, Pratt & Mitchell, 1912); *Astrophytum* (Emden, 1939-1940).

*Biology.* Eggs are laid in fresh wounds at points where branches have been gnawed off. The young larvae usually tunnel downwards towards, and often into, the roots. They are very active and frequently travel from one part of the plant to another. The larval galleries are broad, and in time become discoloured, eventually turning black. Dipterous larvae often infest the frass. The larvae feed for a single season only, and then pupate in the stem (usually near the base), where they excavate a cell lined with soft particles (from the inside of the cactus), which are bound together with a secretion. Emergence occurs from April to June, and again in September; adults which mature late in the year, however, are often unable to make their escape owing to the trunk having become hard and dry. They feed at night on the young tender joints and fruits of the plant (Hamlin, 1926; Hunter, Pratt & Mitchell, 1912; Psota, 1930). According to Dodd (1940) adults are long-lived, those of *M. variolare* having been known to survive for 529 days.

*Parasites.* Hymenoptera: *Ooencyrtus moneilemae* Gahan (Gahan, 1925); *Vipio moneilemae* Gahan, *Neocatolaccus moneilemae* Gahan (Thompson, 1943).

*Economic importance.* Species of this genus are a major pest of cacti and of definite economic importance so far as the prickly pear (which is valuable as cattle fodder) is concerned (see also p. 5). These species are, however, to a certain extent beneficial, as they promote dissemination of the plants through gnawing off branches: this partly explains the growth of prickly pear in very dense clusters around the original plant. Infested plants soon become sickly and wilt, and there is a copious exudation of black sap which soon solidifies in lumps on the outer surface of the stem.

*Control.* Hunter, Pratt & Mitchell (1912) suggest burning, hand-picking and poisoning. The immature stages are easily killed by burning the fallen infested branches. Adults are easily collected in the early morning or evening, for they are very sluggish insects. The application of lead arsenate to the young tender joints, upon which the adults feed, is an effective control measure. In the case of infested hot-house plants, the larvae should be carefully extracted, and the holes filled with flowers of sulphur.

*Material studied.* 1 P (*Moneilema* sp.), Mexico, Laredo, 20.iii.1941, in coll. U.S.N.M.; 1 L (*Moneilema* sp.), Germany, Bremen, vii.1930, from *Astrophytum*, J. D. Alfken leg., in coll. E.

*References.* Craighead, 1923 (L fig., Biol.); Dodd, 1940 (Biol.); Emden, 1939-1940 (L); Gahan, 1925 (Paras.); Hamlin, 1926 (Biol.); Hunter, Pratt & Mitchell, 1912 (L, Biol. fig.); Psota, 1930 (Biol. fig.); Thompson, 1943 (Paras.).

**\**Lepromouris gibba* Brullé**

The larva of this species appears to conform more closely to that of *Ancylonotus tribulus* (see p. 264).

**Lamiini**

**(\*) *Lamia textor* (Linnaeus)**

*Mature larva* (fig. 216). No mature larvae of this species are available. Kemner (1922) gives the following description: "Eine erwachsene Larve misst 30-40 mm. und 7-5-8 mm. breit über Prothorax. Ihre Farbe ist weissgelb, die Behaarung kräftig. Der greie Teil des Kopfes braun. Epistoma dunkel, seine dunklere Farbe aber nach

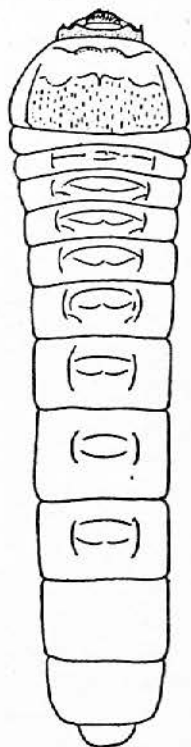


Fig. 216

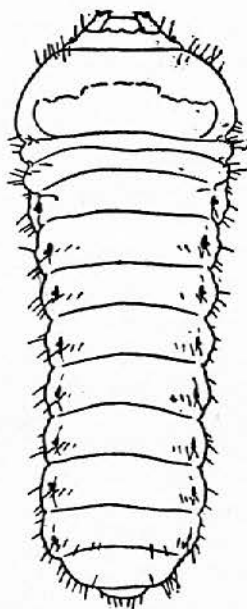


Fig. 217

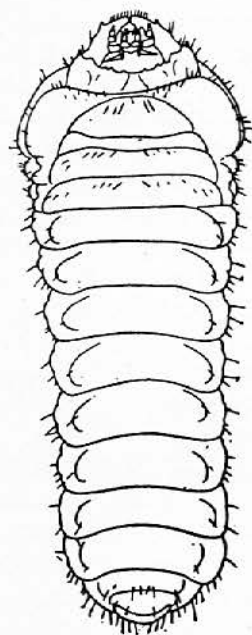


Fig. 218

Fig. 216. *Lamia textor* (Linnaeus). Mature larva. Dorsal aspect. (Kemner, 1922)

Fig. 217. *Lamia textor* (Linnaeus). First-instar larva. Dorsal aspect. (Pavan, 1948a)

Fig. 218. *Lamia textor* (Linnaeus). First-instar larva. Ventral aspect. (Pavan, 1948a)

hinten zu nicht scharf begrenzt. Der Vorderrand eingeschweift. Antennen kurz, 4-gliedrig.<sup>1</sup> Ein Auge jederseits. Beine fehlen. Pronotum besonders charakteristisch, nach vorn von einer gebogenen Linie begrenzt. Dicht hinter dieser Linie stehen in einer Querreihe einige runde vertiefte Punkte. Die Pleuren durch Linien abgegrenzt. Die Hinterhälfte des ganzen Tergites matt, mit kleinen strichförmigen Furchen. Prosternum vom Sternellum durch eine tiefe Querlinie geschieden, und Schräglinien

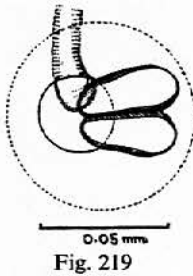


Fig. 219

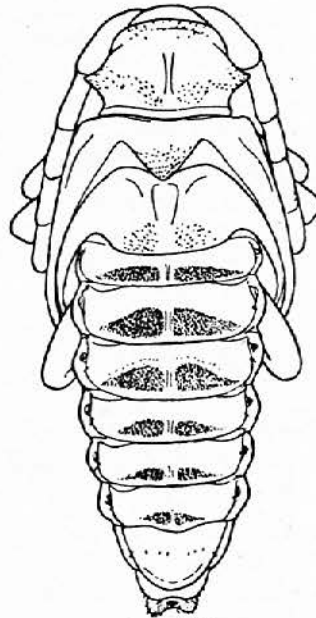


Fig. 220

Fig. 219. *Lamia textor* (Linnaeus). First-instar larva. Abdominal spiracle.

Fig. 220. *Lamia textor* (Linnaeus). Pupa. (Kemner, 1922)

grenzen die Hypopleuren ab. Mesothorax hat keine locomotorische Warzen, aber eine Reihe kräftiger Borsten. Metathorax hat eine wenig ausgebildete von einer Querlinie geteilte Warze. Am Hinterleib finden sich die locomotorischen Warzen an den 1.-7. Segmenten. Die Warzen haben eine seichte Mittelfurche und zwei deutliche Querlinien. Die Warzen der Unterseite sind hoch, ohne Querlinien aber von einer tiefen Furche geteilt. Anus ist eine Querspalte."

*First-instar larva* (figs. 217-219). This has recently been described by Pavan (1948a), who draws attention to the unusual median tooth-like projection on the outer face of the mandible (fig. 218) and to the dentate front margin of the frons (fig. 217), and hypostoma (fig. 218). The characteristic egg-bursters are shown in fig. 217, and the conspicuous biforous spiracle in fig. 219 (see also pp. 6 and 60).

*Pupa* (fig. 220). No pupae of this species are available. The following description is given by Kemner (1922): "Ein Exemplar war 35×13 mm. gross. Die grossen

<sup>1</sup> Here the antennal membrane has obviously been regarded as the basal segment of the antenna, which is no doubt actually three-segmented.

Seitendorne des Prothorax sowie die kurzen, dicken Antennen sind artcharakteristisch. Die Flügel sind kurz, reichen nur bis zu dem dritten Segmente des Abdomens. Die Tergite des 1. -6. Abdominalsegmentes mit je zwei dreieckigen, dichten Bürsten von rotbraunen Haaren versehen. Die Abdominalspitze mit einem hoch aufstehenden Mitteldorn."

Host plants: *Populus nigra*, *P. tremula* and *Salix* (Reineck, 1919).

*Biology.* Larvae infest branches and often the roots of living healthy trees. The larval galleries are usually excavated along the pith channel. Although adults have been known to emerge from the ground, it seems unlikely that this species would pupate in the soil, although it may apparently do so below ground-level in the roots. Emergence occurs in June and July.

*References.* Altum, 1879 (Biol.); Boas, 1923 (L fig., Biol.); Chapuis & Candèze, 1853 (L fig.); Clément, 1909 (Biol.); Emden, 1939-1940 (L); Henriksen, 1914 (L); Judeich & Nitsche, 1889 (L, Biol.); Kemner, 1922 (L fig., P fig., Biol.); Lunardoni, 1889 (Biol.); Pavan, 1948a (L fig., Biol.); Perris, 1877 (L); Reineck, 1919 (Biol.); Trägårdh, 1939 (Biol. fig.); Xambeu, 1898-1902 (L, Biol.), 1903 (Biol.).

#### \**Morimus funereus* Mulsant

[Occasionally in imported timber from the Continent.]

*Mature larva.* No material or references available. Goureau (1844) describes and figures a larva and a pupa which he regards as being of this species: this obviously cannot be so because the larva is described as having legs, and the pupa as having short antennae. The bionomic information, in which *Populus* is given as the host plant, is thus open to doubt.

The writer has recently received an adult which had emerged from an imported plank of *Fagus*.

#### Monochamini

##### Larval Characters

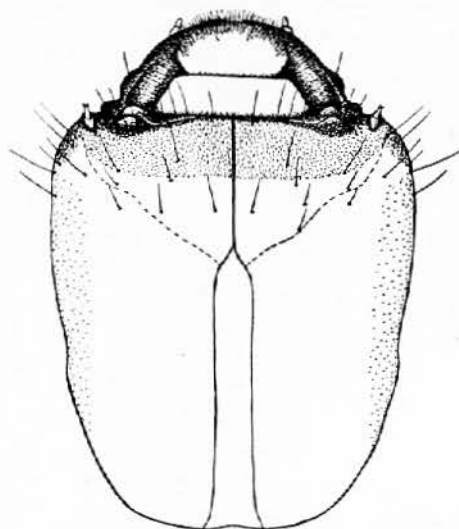
*Head* depressed (except the Indian genus *Blephaeus*); antennal foramen closed behind. One pair of ocelli present. Gula distinct, protuberant. *Prothorax* with posterior area of pronotum finely velvety pubescent or asperate. *Abdomen* with dorsal ampullae with two distinct transverse furrows, and four transverse rows of tubercles (except certain Indian species), which are usually spiculate. Epipleurum strongly protuberant on all segments, except sometimes the first two. *Spiracles* without marginal chambers.

#### \**Monochamus titillator* (Fabricius)

[Frequently in imported timber from North America.]

*Mature larva* (figs. 221-227). Form very elongate, slender, slightly depressed. Length up to 47 mm.; maximum breadth (at prothorax), 9 mm. *Head* (fig. 221) strongly depressed, slightly wider before middle, and abruptly constricted behind

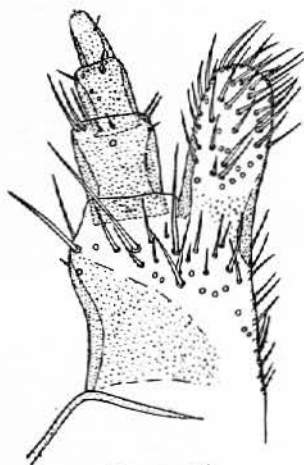
middle (maximum head-width, 5.5 mm.); frontal sutures distinct only anteriorly; antennal foramen closed behind; mouthframe very strongly and broadly sclerotised, with the transverse, dorsal, ferruginous band as broad as length of clypeus. Six epistomal setae present. Mandible slender, about three times as long as basal width;



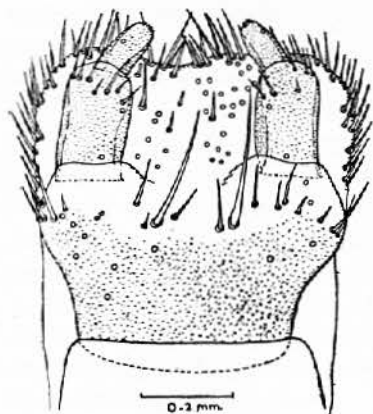
2 mm.  
Fig. 221



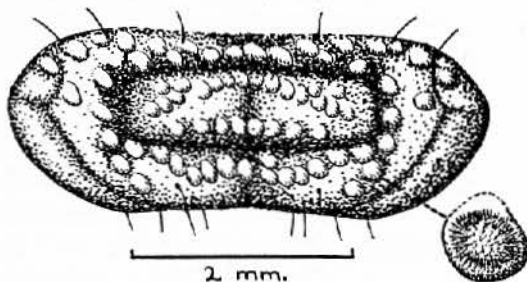
0.05 mm.  
Fig. 222



0.3 mm.  
Fig. 223



0.3 mm.  
Fig. 224



2 mm.  
Fig. 225

Fig. 221. *Monochamus titillator* (Fabricius). Mature larva. Head. Dorsal aspect.

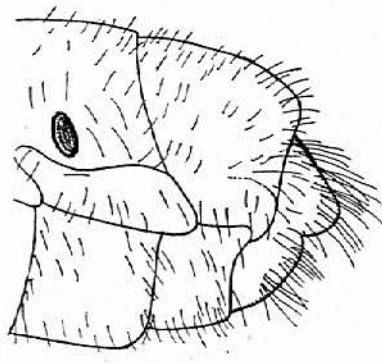
Fig. 222. *Monochamus titillator* (Fabricius). Mature larva. Apical part of right antenna. Lateral aspect.

Fig. 223. *Monochamus titillator* (Fabricius). Mature larva. Apical part of right maxilla. Ventral aspect.

Fig. 224. *Monochamus titillator* (Fabricius). Mature larva. Labial palpi and ligula. Ventral aspect.

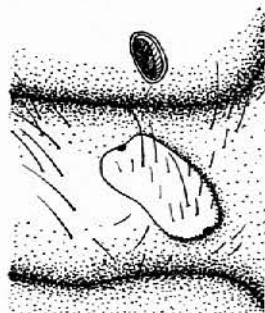
Fig. 225. *Monochamus titillator* (Fabricius). Mature larva. Sixth dorsal abdominal ampulla.

cutting-edge broadly emarginate. One pair of ocelli present; lens small, round; pigmented spot usually rather indistinct. Hypostoma ferruginous, with front margin more darkly so; sutures distinct, pitchy, incurved. Gular sutures distinctly raised. Antenna (fig. 222) minute; second segment slightly transverse; third very short, less than half length of second, transverse; supplementary process prominent, acutely conical, and as long as third segment. Labrum roundly oval and densely setose



2 mm.

Fig. 226



1 mm.

Fig. 227

Fig. 226. *Monochamus titillator* (Fabricius). Mature larva. Eighth, ninth and tenth abdominal segments. Lateral aspect.

Fig. 227. *Monochamus titillator* (Fabricius). Mature larva. Spiracle and pleural tubercle of abdominal segment.

anteriorly. Ventral mouthparts with strongly sclerotised, ferruginous areas. Maxilla (fig. 223) with third palpal segment acute, shorter than second. Labial palpi (fig. 224) with third segment cylindrical, about half length of second. Mentum distinct from submentum; one and one-half times as wide as long. Prothorax depressed, rectangular; posterior region of pronotum velvety asperate, spotted with lenticulate, glabrous areas. Mesonotum dull, velvety pubescent anteriorly, shining posteriorly. Metanotum, mesosternum and metasternum each with two transverse rows of spiculate tubercles. Abdomen with each dorsal ampulla (fig. 225) with two distinct, transverse furrows, and four distinct rows of finely spiculate, moniliform tubercles which are not interrupted by the longitudinal median furrow. Ventral ampullae with two rows of tubercles. Ninth segment without a sclerotised plate or spine. Anus (fig. 226) trilobed, the dorsal lobe almost semicircular and strongly protuberant. Epipleurum protuberant on all segments. Pleural tubercle (fig. 227) elongate, with a distinctly sclerotised pit at each extremity, and bearing two very long, and about ten much shorter, setae. Legs vestigial, consisting of a minute tubercle bearing several setae. Spiracles with peritreme broadly oval.

*Pupa* (figs. 228, 229). Length, 28–30 mm.; maximum breadth, 8.5 mm. Head faintly rugose; vertex almost entirely visible from above, very deeply excavated, and sometimes with one or two stout setae near bases of antennae; front with short stout setae as in figure. Clypeus with a deep transverse impression, and four to six setae across base. Antennae extending to between second and third abdominal segments, where

they are strongly curved downward, and each arranged in several (at least in the male) coils on top of each elytron. Eyes feebly convex, glabrous. Mandibles each with at least four stout setae near middle of outer face. Labrum bearing at least twelve stout setae along front and lateral margins. *Pronotum* with sides bearing a pair of tubercles; numerous scattered, short, stout setae present, especially on lateral tubercles. *Mesonotum* smooth, and with two oblique rows of similar setae; scutellum rather strongly protuberant and setose. *Metanotum* with two converging rows of

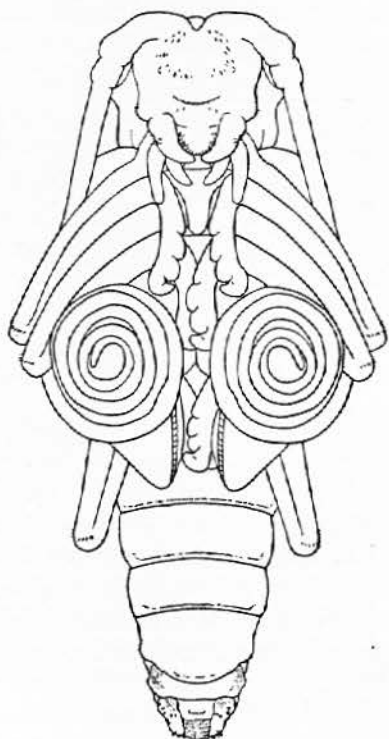


Fig. 228

Fig. 228. *Monochamus titillator* (Fabricius). Male pupa. Ventral aspect.



Fig. 229

Fig. 229. *Monochamus titillator* (Fabricius). Male pupa. Eighth and ninth abdominal segments. Lateral aspect.

similar setae. Elytra and wings extending to fourth abdominal segment. *Abdomen* with tergites one to six with a transverse band (interrupted medially) of closely-set stout setae on posterior half. Seventh tergite quadrate, slightly tapering, and bearing a band of setae across hind margin. Eighth tergite strongly transverse, very short, and with a row of setae across hind margin. Ninth tergite (fig. 229) short, and produced dorsally into a long, vertical, spine-like process, which is strongly sclerotised apically; ventrally it is deeply divided and spinose. Sternites glabrous or almost so. Pleura scarcely protuberant; each with paired stout setae. *Legs* with a transverse row of short stout setae near apex of each femur; mid and hind femora each with a blunt tubercular process near base; hind femora extending to fifth abdominal segment;

tibiae directed posteriorly. *Functional spiracles* present on first five abdominal segments, but vestigial pairs present on segments six and seven; peritreme rather narrowly oval, exceedingly thick, and slightly raised above general level of cuticle.

*Egg.* Length, 4 mm.; breadth, 1.5 mm. Form elongate-oval. Chorion opaque, white, sculptured, and with a micropyle at one end.

*Host plants:* *Pinus*, *Picea* and *Abies*.

*Biology.* The eggs are laid in felled or injured trees, healthy trees seldom being attacked. Prior to oviposition, the adult gnaws a funnel-shaped pit (sometimes it is merely a transverse slit) in the bark which extends to the soft, sappy inner bark. The

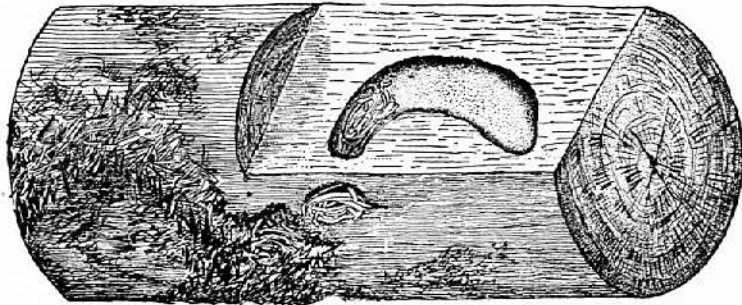


Fig. 230. *Monochamus scutellatus* Say. Pupal cell in *Pinus*. (Craighead, 1923b)

eggs are then deposited in a circle around the bottom of the pit; up to nine eggs have been noticed in a single pit. Oviposition occurs from March to October, and the incubation period lasts about five days. When about three or four weeks old the larvae penetrate the outer sapwood, and then emerge again to feed on the inner bark, wooden fibres and frass being packed between the bark and wood. Distinct channels are soon made through the detritus as the larvae move from their entrance pit to fresh feeding sites. When mature, the larva extends the pit right into the sapwood, as far as the heartwood (Pl. III, fig. 10). Here the larva usually starts to tunnel parallel to the grain of the wood for 2 or 3 in., and then turns to burrow to within about  $\frac{1}{4}$  in. from the surface, thus making a "U"-shaped gallery. The bottom of the "U" is enlarged to form the pupal cell (fig. 230). Only very rarely do larvae pupate under the bark (Webb, 1909). Fraser (1948d) gives the following account of infested timber imported from Canada: "The galleries range from 0.1 to 0.75 in. across and are disappointingly frequently empty. Examination of a large number of galleries leaves no room for doubt that the habit of the larva is to work its way into the centre of the log and, on reaching it, to return, but not by the same gallery, to the sapwood. Thus, in the majority of boards, there are two apparent galleries for each larva. It is probable that this habit of doubling back is inspired by the greater hardness of the core, not by a desire to return to the sapwood to pupate, since the size of some galleries which reveal this 'hairpin bend' indicates clearly that the occupants would not be ready to pupate for a very long time. One section of timber 6 in. by 3 in. by 2 ft. 9 in. long, selected at random, has sixty-nine holes in its surface area, ranging from 0.15 to 0.75 in. across. The frass contained in the galleries is of a most unusual nature, being in the form of

'splinters' of an average length of 0.75 cm. It is loosely and irregularly packed and therefore falls easily from the gallery so that most holes are empty for the first few centimetres. The larvae in several cases have worked back along a gallery to start a new working at right angles to the original. No instance has been observed of two separate galleries meeting nor has there been any indication of communal use of a gallery. The timber is infested more or less to the same degree throughout its entire length, usually 10 to 12 ft., a fact which is only to be expected if it is assumed that the damage is done after the felling of the tree."

According to Bowditch (1873), if the diameter of the tree exceeds 6 in., the pupal cell extends straight to the opposite side of the trunk (see also p. 46). The adult escapes by extending the arm of the cell to the surface of the sapwood and then gnawing through the bark, leaving a round exit hole about  $\frac{3}{8}$  in. in diameter. Emergence occurs chiefly in June and July. The life-cycle is normally completed in two years.

*Parasites.* Hymenoptera: *Bracon webbi* Viereck (Webb, 1909). Diptera: Craighead (1923b) states that larvae of American species of *Monochamus* are frequently attacked in the pupal cells by a Tachinid. The writer has noticed that adults of this and most other species of *Monochamus* are frequently covered with clusters of mites, especially on their dorsum.

*Control.* Webb (1909) claims that the most efficient control measure is that of placing the freshly felled logs in water. He also suggests the barking of logs up to the time when larvae normally enter the sapwood, but this is only effective providing the logs can be used soon after, before the exposed sapwood starts to decay.

*Material studied.* 5 L, 1 P, U.S.A., in coll. B.M.

*References.* Bowditch, 1873 (Biol.); Craighead, 1923b (L fig., P, Biol.); Chittenden, 1899 (Biol.); Felt, 1907 (Biol.); Fraser, 1948d (Biol.); Hopkins, 1899 (Biol.); Horn, 1885 (Biol.); Webb, 1909 (E fig., L fig., P fig., Biol. fig.).

#### \**Monochamus scutellatus* Say

[Frequently in imported timber from North America.]

*Mature larva.* Extremely similar to that of *M. titillator*. A detailed comparison of the antennae and mouthparts showed no reliable differences. Craighead (1923b) distinguishes it by the dorsal anal lobe, which is much less strongly protuberant. The gular sutures seem to be less strongly raised in the material at hand, and the tubercles of the ampullae are much less densely spiculate.

*Pupa.* No material available. Craighead (1923b) distinguishes it from that of *M. titillator* by the absence of the transverse band of spines across the anterior margin of the protergum.

*Biology.* Similar to that of *M. titillator*, except that pupation (fig. 230) occurs more frequently between the bark and wood (Craighead, 1923b).

*Parasites.* Hymenoptera: *Rhyssa persuasoria* L. (Schimitschek, 1929).

*Material studied.* 6 L, U.S.A., State College, Pa., from *Pinus*, in coll. U.S.N.M.; 5 L, U.S.A., Piedmont, W. Vc., in coll. B.M.

*References.* Craighead, 1923b (L fig., P, Biol.); Felt, 1907 (Biol. fig.); Fitch, 1857 (Biol.); Packard, 1881 (Biol.), 1890 (Biol.); Schimitschek, 1929 (Paras.).

**\**Monochamus notatus* Drury**

[Occasionally in imported timber from North America.]

*Mature larva.* Extremely similar to that of *M. titillator*. The few distinguishing characters are given in the key, p. 81.

*Pupa.* No material available. Craighead (1923b) distinguishes this pupa from those of the two preceding species by the almost total absence of spines on the protergum.

Host plants: *Pinus*. The records from *Abies* (Packard, 1890) are probably unreliable. Also from *Picea* (from records of F.P.R.L.).

*Biology.* The biology is very similar to that of *M. titillator*. Oviposition occurs from June to August, and Packard (1881) states that the female first makes a slight curvilinear gash which descends obliquely in the bark. Normally the life-cycle is completed in two years. An adult has been recorded (Packard, 1881) emerging from a pine bureau which was at least fifteen years old; almost all this period must have been passed in the larval stage, not in the adult stage, as implied.

*Parasites.* Hymenoptera: *Rhyssa persuasoria* L. (Schimitschek, 1929).

*Material studied.* 1 L, from imported Canadian *Picea*, in coll. F.P.R.L.

*References.* Craighead, 1923b (L, P, Biol.); Felt, 1907 (Biol.); Fitch, 1856 (Biol.); Morgan, 1948 (Biol.); Packard, 1881 (Biol. fig.), 1890 (Biol.); Schimitschek, 1929 (Paras.).

**\**Monochamus maculosus* Haldeman**

[Occasionally in imported timber from North America.]

*Mature larva.* Extremely similar to that of *M. titillator*, from which it may be distinguished by the non-protuberant dorsal anal lobe, and the shining, non-asperate tubercles of the ventral ampullae.

*Biology.* According to Craighead (1923b) this species is similar in habits to *M. notatus*.

*Material studied.* 6 L, from imported Canadian *Pinus*, 11.iii.1948, in coll. F.R.P.L.; 4 L, U.S.A., Colestein, Oregon, 31.xii.1914, from *Abies*, J. M. Miller leg., in coll. U.S.N.M.

*References.* Craighead, 1923b (L, Biol.).

**\**Monochamus marmorator* Kirby**

[Occasionally in imported timber from North America.]

*Mature larva.* No material available. According to Craighead (1923b), it is extremely similar to that of *M. scutellatus*, the only apparent distinction being in the number of setae present. In *M. scutellatus* the setae around the extremity of the lateral groove of the pronotum varies in number from six to ten, whereas in *M. marmorator* the variation is from twelve to twenty.

*Biology.* Craighead (1923b) points out that the larval galleries are more transverse than in other species of this genus, thus more quickly girdling the trunk.

*References.* Craighead, 1923b (L, Biol.); Felt, 1907 (Biol.); Fitch, 1856 (Biol.); Packard, 1890 (Biol.).

(\*) *Monochamus sutor* (Linnaeus)

[Frequently in imported timber from Scandinavia and the Continent.]

*Mature larva.* Very similar to that of *M. titillator*, from which it may be separated as follows. *Head* with hypostoma more strongly sclerotised, pitchy. *Abdomen* with tubercles of ampullae as in *M. ruspator*. Dorsal anal lobe much less strongly protuberant.

This comparison is based on a single mutilated specimen. More striking differences may be apparent when further material is available.

Host plants: *Picea* and *Pinus* (Trägårdh, 1929).

*Biology.* Adults of this species oviposit only on felled or sickly trees or on those which have been scorched by fire. Usually the largest and most severely scorched trees are most prone to attack. Prior to oviposition the female gnaws an "egg-funnel" in the bark. This is usually 6-7 mm. wide, 4-5 mm. long, and 4-5 mm. deep; externally it is crateriform, but at the bottom there is a transverse slit about 3 mm. long which penetrates into the cambium. At least fifty eggs are laid by a single female. The first-instar larva, after gnawing an irregular cavity in the cambium, proceeds to enter the wood by cutting a hole about 10 mm. by 5 mm.; when this tunnel extends to about 20 mm., the larva starts to enlarge it by detaching fibres—usually at both ends but sometimes only incompletely. This tunnel is eventually enlarged to twice its original width; this is accomplished by the larva through the cutting of a tunnel which bends backwards on the first tunnel and is contiguous to it. When the larva proceeds to bore deeper into the wood, the fibres are removed and pushed into the cavity under the bark; this cavity is successively enlarged into an extensive area (Trägårdh, 1929, 1930).

Trägårdh (1930) maintains that the direction of the larval gallery is largely determined by the girth of the tree. He has observed that in the autumn the young larva has penetrated the wood in a radial direction to a distance of about 7 cm. If the diameter of the trunk does not greatly exceed twice this distance, he maintains that the larva overwinters in the centre of the trunk; then the following spring when it continues boring, the larva has to cover about the same distance to reach the surface anywhere, and as a consequence of this, the gallery may extend in any direction (fig. 231). But if the diameter of the trunk greatly exceeds 14 cm., the larva is unable to reach the centre of the tree by winter, and so the second half of the gallery is directed towards the same side of the trunk, and is thus "U"-shaped (fig. 231). This discrimination is apparently quite constant, and Trägårdh suggests that the larva may be guided by its perception of the different temperatures of the wood in different parts of the trunk. For example, in small trees (in which the larva overwinters in the centre) the wood is warmed almost uniformly all round the larva in the spring. The pupal period lasts two to three weeks. Emergence occurs from June to September.

*Parasites.* Hymenoptera: *Bracon impostor* Scopoli (Xambeu, 1898-1902, Rudow, 1912); *Ephialtes tuberculatus* Fourc., *Helcon dentator* Nees, *H. ruspator* L., *Mesoleptus teredo* Htg., *Rhyssa amoena* Grav., *R. approximata* F., *R. persuasoria* L. (Schimitschek, 1936).

*Economic importance.* This species is extremely injurious to conifers. Trees or timber which are exposed to sunlight and which have thick bark are most prone to attack. As oviposition normally occurs 2 to 4 metres above ground-level, the most valuable part of the tree is destroyed. Trees which have been severely scorched by

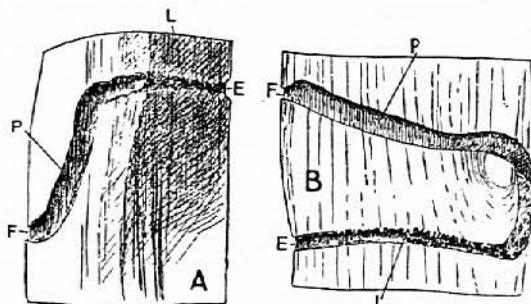


Fig. 231. *Monochamus sutor* (Linnaeus). Larval tunnels and pupal chambers: A, in a trunk about 14 cm. in diameter; B, in a considerably thicker trunk; e, entrance hole; l, larval tunnel; p, pupal chamber; f, flight hole. (Trägårdh, 1940)

fire are also very prone to attack, and according to Trägårdh, adults are often attracted to them from areas several miles away, being guided by the reek of the forest fire carried by the wind. Forsslund (1934) describes the invasion by adults of a large area in Sweden which had been devastated by fire. Adults cause minor damage through their habit of nibbling at pine-needles and young bark. White (1850) gives an account of an adult which had bored through a lead pipe.

*Control.* Trägårdh (1929) recommends decortication and submersion of felled trees. As oviposition can only take place when the bark is present, sawn timber is usually free from attack.

*Material studied.* 1 L, 1 P, Finland, Korpiselkä, Kokkari, 8.vi.1913, from *Pinus*, U. Saalas leg., in coll. U.Z.M.C.

*References.* Barbey, 1913 (Biol.); Forsslund, 1934 (Biol. fig.); Gernet, 1867 (L fig., P fig., Biol.); Hess, 1914 (Biol.); Judeich & Nitsche, 1889 (Biol.); Kemner, 1922 (L fig., P fig., Biol.); Lunardoni, 1889 (Biol.); Nördlinger, 1880 (Biol.); Reineck, 1919 (Biol.); Röthenburg, 1907 (Biol.); Rudow, 1912 (Paras.); Saalas, 1923 (Biol.); Schimitschek, 1936 (Paras.); Stark, 1926a (Biol. fig.); Trägårdh, 1918 (L fig., P, Biol. fig.), 1923 (L fig., Biol. fig.), 1929 (E fig., L fig., Biol. fig.), 1930 (Biol. fig.), 1939 (L fig., Biol. fig.); Westwood, 1839 (Biol.); White, 1850 (Biol.); Xamheu, 1898-1902 (L, P, Biol.).

(\*) *Monochamus sartor* Fabricius

[Occasionally in imported timber from the Continent.]

*Mature larva.* With the inadequate material available, it has been impossible to find any characters by which this larva can be distinguished from that of *M. sutor*.

*First-instar larva.* According to the description and figure by Kojima (1931), the larva possesses biforous spiracles and is equipped with stout, curved egg-bursting spines. In addition, the front margin of the frons is produced into a pair of small paramedian lobes.

*Egg.* Length, 4.6–5.4 mm.; breadth, 1.7–1.8 mm. Chorion rather indistinctly reticulated with irregular lines (Kojima, 1931).

Host plants: *Pinus* and *Picea*.

*Biology.* Very similar to that of *M. sutor*. Kojima (1931) remarks that the larva makes a creaking noise in its gallery.

*Parasites.* Hymenoptera: *Helcon dentator* Nees, *Rhyssa* sp. (Thompson, 1943).

*Material studied.* 1 L (poor condition), Finland, in coll. U.Z.M.C.

*References.* Barbey, 1913 (Biol.); Escherich, 1923 (Biol. fig.); Henriksen, 1914 (L fig.); Judeich & Nitsche, 1889 (Biol.); Koch, 1928 (Biol.); Kojima, 1931 (E fig., L fig., P fig., Biol.); Lunardoni, 1889 (Biol.); Saalas, 1923 (L fig.); Schiödtte, 1876 (L fig.); Thompson, 1943 (Paras.); Xambeu, 1898–1902 (L, Biol.).

**\**Monochamus rosenmülleri* (Cederhjelm) (= *quadrimaculatus* Motschulsky)**

[Occasionally in imported timber from Scandinavia and Europe.]

*Mature larva.* Very similar to that of *M. titillator*, from which it may be separated as follows. *Head* with hypostoma very strongly sclerotised, pitchy; gular sutures very strongly raised. *Abdomen* with dorsal anal lobe much less strongly protuberant.

Host plants: *Abies siberica* (Prozoroff, 1930); *Pinus*.

*Biology.* Very similar to that of *M. sutor*. Prozoroff (1930) describes the damage done to the young tender shoots of *Abies* by adults of this species.

*Material studied.* 2 L, Finland, Suomi, Vilppula, 28.ix.1912, from *Picea*, U. Saalas leg., in coll. U.S.N.M.

*References.* Prozoroff, 1930 (L, P fig., Biol. fig.); Saalas, 1923 (L fig.); Stark, 1926a (Biol. fig.).

**\**Monochamus galloprovincialis* (Olivier)**

[Occasionally in imported timber from Europe and Scandinavia.]

*Mature larva.* Extremely similar to that of *M. sutor*, from which it may be distinguished by the less strongly sclerotised hypostoma and the glabrous shining tubercles of the ventral ampullae (see key, p. 81).

Host plants: *Pinus*, *Picea* and *Pinus halepensis* (Villiers, 1946).

*Biology.* Very similar to that of *M. sutor*.

*Material studied.* 1 L, London, ix.1949, in imported *Pinus*, from Poland, in coll. D.

*References.* Barbey, 1913 (Biol.); Butovitsch, 1930 (Biol.); Feytaud, 1950 (L fig., Biol.); Kaltenbach, 1874 (Biol.); Perris, 1856 (L fig., P, Biol.), 1877 (L); Polozhentzev, 1934 (Biol.); Saalas, 1923 (Biol.); Villiers, 1946 (Biol.); Xambeu, 1898–1902 (L, P, Biol.).

**\**Monochamus ruspator* Fabricius**

[Occasionally in imported timber from West Africa.]

*Mature larva* (fig. 232). Very similar to that of *M. titillator*, from which it may be separated as follows. *Head* with third segment of antenna (fig. 232) elongate.

Gular sutures not or scarcely raised. Ventral mouthparts with sclerotised areas pale testaceous. *Abdomen* with tubercles of ampullae with spicules shorter and less dense, so that when viewed with a  $\times 15$  lens they appear to be glabrous and shining. Dorsal anal lobe much less strongly protuberant. Pleural tubercle with long stout setae only (occasionally with at most one or two very short setae).



Fig. 232. *Monochamus ruspator* Fabricius. Mature larva. Apical part of right antenna. Lateral aspect.

Host plant: *Citrus*.

*Biology*. Apparently unknown.

*Material studied*. 6 L, Uganda, Kampala, vi.1933, H. Hargreaves leg., in coll. B.M.

*References*. None available.

**\**Monochamus griseoplagiatus* Thompson**

[Occasionally in imported timber from West Africa.]

*Mature larva*. No material or references available.

**\**Deliathis incana* Forster**

[Very occasionally in imported timber from Mexico.]

*Mature larva*. No material or references available.

***Neoptychodes* (= *Ptychodes*) *trilineatus* (Linnaeus)**

[Very occasionally in imported timber from North America and Mexico.]

*Mature larva* (figs. 233, 234). Craighead (1923b) gives the following description: "Form large, elongate; integument firm, shining, beset with rather stiff brownish hairs. *Head* depressed, about one and one-half times as long as wide, sides gradually tapering behind; mouthframe heavily chitinized; epistoma straight, abruptly raised; labrum roundly rectangular, about one and one-half times as wide as long, anterior half densely hairy; mandible about twice as long as basal width, dull, black, cutting edge obliquely emarginate; antennal ring entire; one pair of distinct ocelli. Ventral mouthparts somewhat chitinized, palpi slender, each maxillary palpal joint successively longer from base outward, last shorter than last labial, one-half length of first labial; ligula cylindrical, prominent; lacinia cylindrical, fleshy; mentum not distinctly defined; hypostoma heavily chitinized; gula protuberant. *Prothorax* (fig. 233) rectangular,

depressed; pronotum defined posteriorly, by lateral impressions, anteriorly light yellowish, shining, with an anterior border of hairs, posteriorly densely velvety pubescent, spotted with minute lenticular glabrous spots; sternum anteriorly hairy, laterally yellowish, chitinized; eusternum shining, sparsely haired. Mesonotum anteriorly velvety pubescent, posteriorly shining; metanotum, mesosternum and metasternum tuberculate. Legless. *Abdomen* having seven pairs of well developed

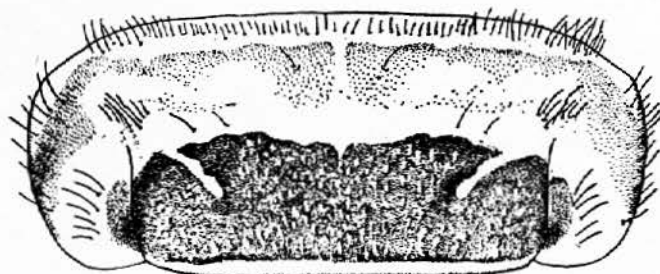


Fig. 233

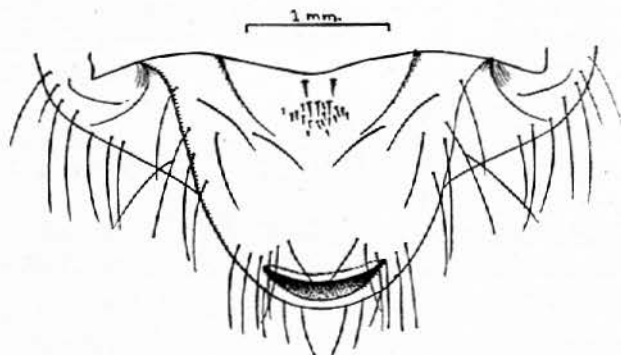


Fig. 234

Fig. 233. *Neoptychodes trilineatus* (Linnaeus). Mature larva. Pronotum. (Craighead, 1923b)

Fig. 234. *Neoptychodes trilineatus* (Linnaeus). Mature larva. Tenth abdominal segment. Ventral aspect.

ampullae, these transversely oval, bearing dorsally four irregular rows of shining tubercles, ventrally two. Epipleurum distinctly protuberant on all segments, tubercle rectangularly oval, bearing four to five setae, no chitinous pores. Spiracles large, oval, chitinous rimmed. Anus transverse (fig. 234), two-lobed, the lower one bearing beneath a group of five to eight short, acutely subulate setae or spines."

*Pupa.* Very similar to those of *Monochamus* species, from which it may be distinguished by the characters given in the key, p. 97.

*Egg.* Length, 3.52 mm.; breadth, 0.91 mm. Form elongate, subcylindrical. Chorion white (sometimes faintly yellowish or greenish), more or less patterned like the grain of the fig-wood (Horton, 1917).

Host plants: *Ficus*, *Alnus*, *Morus* (Craighead, 1923b); Fairmaire (1850) mentions *Spondias dulcis* and *Inocarpus edulis* being attacked in Tahiti.

*Biology.* The eggs are deposited in the bark of the larger branches or trunk of partly dead or decaying trees. Prior to oviposition the female makes a double transverse incision in the bark to a depth of 0.125–0.25 in. Sometimes two or three eggs are placed in the same incision. About 100–184 eggs are laid by a single adult. The incubation period is about five days. The first-instar larva usually devours most of the egg-shell before boring into the bark. Several days later, the larva enters the sapwood and bores towards the heartwood, tightly packing the gallery with frass and debris. Within six months the larva is usually mature and has tunnelled near to the surface ready for pupation. The pupal cell is formed by enlarging the end of the gallery; it is completely lined within with wooden particles and frass which have been glued together with a secretion. The pupal period lasts on an average twenty-four days. Generations are irregular, and emergence takes place practically throughout the whole year. The average duration of the life-cycle is 3.5 months (Horton, 1917).

*Economic importance.* This species causes considerable damage to certain trees, especially *Ficus carica*. Abrazed or diseased parts of the tree are most prone to attack, healthy green trees hardly ever being infested.

*Control.* Horton (1917) recommends the following measures. Keep trees in as perfect condition as possible. Whenever a branch is broken off, the stump should be smoothed down and painted with a mixture of five parts coal-tar and one part creosote. Two or three coats should be applied. Heavily infested branches or trunks should be cut down and burned.

*Material studied.* 1 L, U.S.A., Louisiana, Franklin, 5.x.1927, from *Ficus*, J. B. Miller leg., in coll. U.S.N.M.; 8 L, 1 P, U.S.A., New Orleans, 24.viii.1899, from *Ficus*, L. M. Harris leg., in coll. U.S.N.M.

*References.* Craighead, 1923b (L fig., Biol.), 1950 (Biol., Contr.); Horton, 1917 (E fig., L fig., P fig., Biol. fig., Contr.); Le Beau, 1938 (Biol.); Risbec, 1946 (E fig., L fig., Biol.).

#### \*Batocerini

##### \**Batocera wyliei* Chevrolat

[Very occasionally in imported timber from West Africa.]

*Mature larva.* The larva of this species is not available, but it should be essentially the same as that of *B. lineolata* Chevrolat. The latter is rather similar to those of the Monochamini, from which it may be distinguished as follows. Form robust. Length up to at least 70 mm.; maximum breadth (at prothorax) at least 12 mm. *Head* with gular region indistinct. Hypostoma transversely rugose. Labrum with a longitudinal median impression. *Prothorax* with posterior two-thirds with coarse, transverse asperities which are larger laterally; each asperity is flattened, with its posterior margin elevated. Eusternum anteriorly setose, posteriorly coarsely asperate; sternellum similarly asperate. *Abdomen* with tubercles of ampullae very densely spiculate. Anus a transverse cleft.

*First-instar larva* (fig. 235). It may safely be presumed that abdominal egg-bursting spines are present, and that the spiracles are biforous, since this is the case in *B. rufomaculata* Degeer (Husain & Kahn, 1941).

*Pupa* (Frontispiece). The pupa of this species is not available, but it should be

essentially the same as that of an unidentified species of *Batocera* which differs from those of the Monochamini as follows. Length up to 65 mm.; maximum breadth, 20 mm. *Head* with front more densely setose. Antennae each arranged in a single coil. Mandibles with at least twelve stout setae near middle of outer face. Labrum densely setose (50–100 stout setae). *Pronotum* with lateral regions glabrous. Scutellum extremely protuberant. *Abdomen* with setae on tergites longer and much denser.

Host plants: *Aucoumea klaineana* (Eidmann & Schlüter, 1944).

*Biology.* Oviposition occurs usually in forest clearings where trees have recently been felled. Trunks lying in shady places are most prone to attack. The eggs are



Fig. 235

Fig. 235. *Batocera rufomaculata* Degeer. Egg-bursting spine and spiracle of first-instar larva. (Husain & Khan, 1941)

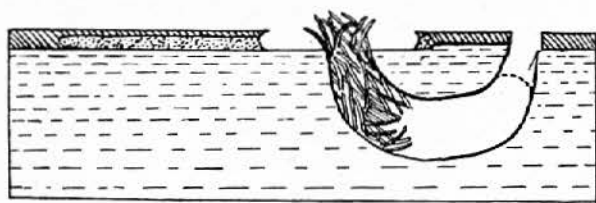


Fig. 236

Fig. 236. *Batocera wyliei* Chevrolat. Pupal cell. (Eidmann, 1943)

inserted in the bark of the underside of the trunk nearest the ground. The larva feeds subcortically (fig. 236) until nearly mature. According to Eidmann & Schlüter (1944), the larva then excises a circular disc of bark of about 10 cm. in diameter (fig. 236) before starting to bore into the sapwood. This remarkable habit appears to be unique in the biology of the Cerambycidae: Eidmann & Schlüter infer that this habit is characteristic of the genus as a whole, but this is certainly not the case at least in so far as certain Indian species are concerned. It is difficult to conjecture the reason for this unusual behaviour on the part of the larva unless it be, as is suggested, to promote a more rapid drying-out of the pupal cell to discourage fungoid growths. The comparatively enormous area excised can in no way facilitate the ejection of frass or shavings for the diameter far exceeds that of the entrance hole of the larva; neither can it facilitate the emergence of the adult, which takes place at a point well beyond the extent of the excision. The authors unfortunately do not make it clear as to whether a complete disc is excised in its entirety, or whether the aperture is gradually enlarged by the larva gnawing round it.<sup>1</sup> But whichever is the case, the larva must obviously be almost completely exposed to parasites and predators during the process of entering the wood. Perhaps further observations will clarify this seemingly pointless and suicidal habit of the larva. While the larva penetrates the sapwood to pupate, it pushes behind it coarsely shredded particles of wood with which it plugs the entrance hole. The pupal cell (fig. 236), which is about 5 cm. beneath the surface of the

<sup>1</sup> Similar excisions in the bark are apparently made by *Lagochirus araneiformis* Linnaeus (Beard, 1942) but in this case, according to the author, the excavation is performed by the adult.

sapwood, is short, stout, curved and about 5 cm. in diameter. As the larva does not reverse its position to pupate, the adult is forced to gnaw through the end of the pupal cell right up to, and through, the bark in order to make its escape.

*Material studied.* 1 P (*Batocera* sp.), no data, in coll. B.M.; 1 L (*B. lineolata*), Japan, Tokyo, Hino, 1936, K. Nakamura leg., in coll. B.M.

*References.* Eidmann, 1943 (L fig., P fig., Biol. fig.); Eidmann & Schlüter, 1944 (L fig., P fig., Biol. fig.); Husain & Khan, 1941 (E fig., L fig., P fig. of *B. rufomaculata*).

### Mesosini

#### Larval Characters

*Head* abruptly and strongly constricted near posterior third; strongly sclerotised and bearing eight setiferous pores. Antennal foramen open behind and entered by frontal suture. One pair of ocelli present. Antenna with third segment elongate; supplementary process strongly tapering. Hypostoma ferruginous, with anterior region steeply sloping down to anterior margin; a pair of paramedian setiferous pores present. Gular sutures indiscernible, but a pale median ventral cleavage line present. *Abdomen* with ampullae with one transverse furrow and two transverse rows of smooth glabrous tubercles, anterior to which are a few irregularly arranged ones; the two rows are interrupted by a median longitudinal furrow. Ninth tergum with a small median spine which has no basal pigmented zone. *Spiracles* with marginal chambers.

#### *Mesosa nebulosa* (Fabricius)

*Mature larva* (figs. 237-240). Length up to 23 mm.; maximum breadth (at prothorax), 5 mm. *Head* (fig. 237) moderately depressed, slightly elongate, widest at middle (maximum head-width, 2.75 mm.) and abruptly and strongly constricted near posterior third; frontal sutures distinct for entire length; antennal foramen open behind; mouthframe strongly and broadly sclerotised. Frons entirely ferruginous, distinctly longitudinally striate and with eight distinct setiferous pores; six epistomal setae present. One pair of ocelli present; ocellar lens round, feebly convex; pigmented spot rather indistinct. Hypostoma (fig. 238) ferruginous, with front margin more darkly so; posterior half convex; anterior half steeply sloping down to front margin; one pair of distinct setiferous pores present; sutures distinct, pitchy and slightly incurved. Gular region with a pale median, ventral cleavage line. Antenna (fig. 239) with second segment strongly transverse, nearly three times as long as broad; third segment dome-shaped, slightly elongate and at least as long as second; supplementary process attenuated, as long as third segment. Maxilla with third palpal segment acutely conical, as long as second. Labial palpi with third segment cylindrical, about half length of second. Mentum not distinct from submentum. *Prothorax* with pronotum very faintly striate and glabrous. *Abdomen* with each dorsal ampulla with a single transverse, curved furrow and two transverse rows of glabrous tubercles, anterior to which are a few irregularly arranged ones; the two rows are interrupted by the median longitudinal furrow. Ventral ampullae with two rows of tubercles. Ninth segment (fig. 240) with a small, erect spine (which is not inserted on a sclerotised plate) on middle of posterior margin. Epipleurum protuberant on all segments. Pleural tubercle

small, with only the ventral sclerotised pit distinct. *Legs* absent. *Spiracles* with peritreme broadly oval and with about six marginal chambers.

*Pupa* (fig. 241). Length, 9.25–15.25 mm.; maximum breadth, 4.75 mm. *Head* with vertex entirely visible from above; rather deeply excavated between bases of antennae, and bearing a row of three long setae opposite base of each antenna; front with

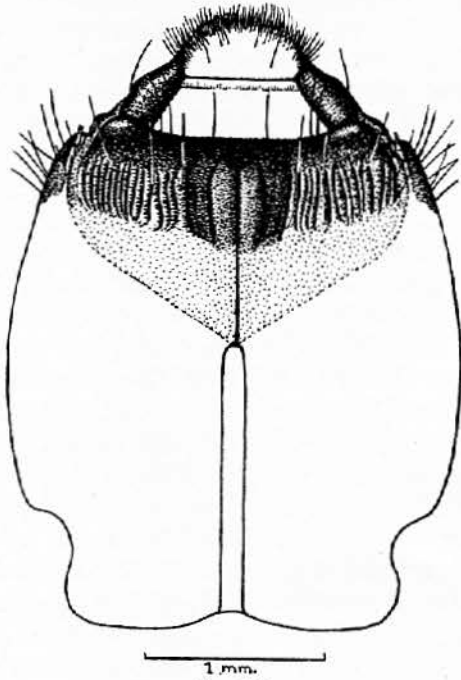


Fig. 237

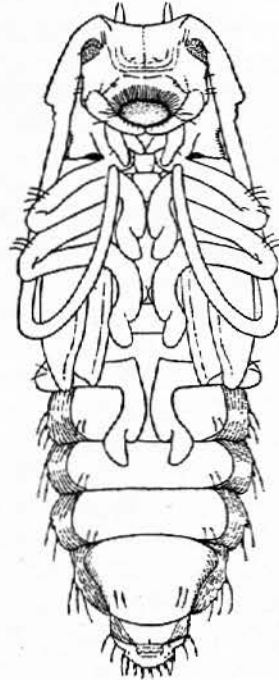


Fig. 241

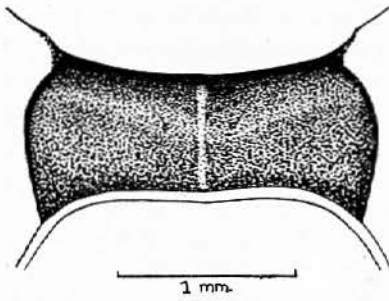


Fig. 238

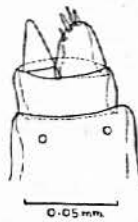


Fig. 239

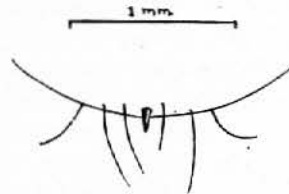


Fig. 240

Fig. 237. *Mesosa nebulosa* (Linnaeus). Mature larva. Head. Dorsal aspect.

Fig. 238. *Mesosa nebulosa* (Linnaeus). Mature larva. Hypostoma.

Fig. 239. *Mesosa nebulosa* (Linnaeus). Mature larva. Apical part of right antenna. Lateral aspect.

Fig. 240. *Mesosa nebulosa* (Linnaeus). Mature larva. Posterior margin of ninth abdominal segment. Dorsal aspect.

Fig. 241. *Mesosa nebulosa* (Linnaeus). Male pupa. Ventral aspect.

setae as figured; clypeus with a deep transverse impression, and a pair of short setae near basal margin. Antennae extending as far as third abdominal segment where they are strongly recurved to terminate near front coxae. Eyes scarcely convex; each with a single seta. Mandibles with a pair of setae near middle of outer face. Labrum transverse, with front margin broadly rounded; exceptionally protuberant and very densely setose at base. *Pronotum* rugose; front margin with numerous short spines; disc usually with a longitudinal median impression, on each side of which are several similar spines. *Mesonotum* rugose and with a few short setae on each side of scutellum, which is protuberant and spinose laterally. *Metanotum* generally smooth, and with an oblique row of short spines on each side of scutellar groove, which is very distinct. Elytra and wings extending as far as fourth abdominal segment. *Abdomen* with tergites one to six each with two more or less complete transverse rows of stout curved spines. Seventh tergite slightly elongate, with sides converging posteriorly, and bearing numerous slightly stouter spines, some of which are recurved. Eighth tergite short, transverse, and with a row of similar spines. Ninth tergite very short, with hind margin bearing a row of almost straight, stouter spines. Sternites, except last two, each with a pair of fine setae near each lateral margin. Pleura moderately protuberant, and with two or three short spines. *Legs* with femur bearing about four fine setae near apex; mid and hind femora each with a small blunt tubercle near base; hind femora extending to fourth abdominal segment; all tibiae more or less at right angles to longitudinal axis of body. *Functional spiracles* present on first six abdominal segments. Peritreme narrowly oval, reniform and slightly raised above general level of cuticle.

Host plants: *Quercus*, *Castanea*. Xambeu (1898-1902) also gives *Salix*, *Populus*, *Alnus*, *Fagus*, *Tilia*, *Acacia*, *Pyrus malus* and *Robinia*; Kemner (1922) lists *Betula*, *Carpinus*, and *Corylus*, and Peyerimhoff (1919) mentions *Ilex aquifolium*. *Quercus* is undoubtedly the preferred host.

*Biology*. Oviposition usually takes place on the uppermost branches of recently dead or unhealthy trees. The larva feeds subcortically for only a short period and soon starts to tunnel into the sapwood. If the branch is small, the larva usually bores along the pith channel. When mature, it tunnels towards the outer sapwood in which it excavates a short, curved, oval pupal cell parallel to the grain of the wood. Pupation occurs in July and August. The adult overwinters in the pupal cell and emerges the following July.

*Material studied*. 12 L, 3 P, Surrey, Cutmill, 13.v.1945, in felled *Quercus*, D. leg., in coll. D. [Adults reared.]

*References*. Duffy, 1945c (Biol.); Emden, 1939-1940 (L); Fraser, 1950a (Biol.); Henriksen, 1914 (L fig.); Kaltenbach, 1874 (Biol.); Kemner, 1922 (L fig., P, Biol.); Passerini, 1851 (Biol.); Perris, 1877 (L fig., P, Biol.); Peyerimhoff, 1919 (Biol.); Reineck, 1919 (Biol.); Schiödte, 1876 (L fig., P); Tappes, 1873 (Biol.); Xambeu, 1898-1902 (L, P, Biol.).

#### \**Coptops aedificator* Fabricius

[Occasionally in imported timber from Africa and India.]

*Mature larva* (figs. 242, 243). Similar to that of *Mesosa nebulosa*, from which it may be distinguished as follows. Length up to 36 mm.; maximum breadth (at

prothorax), 7.5 mm. *Head* with frons not longitudinally striate but with setiferous pores feebly longitudinally impressed. Hypostoma with an abrupt, widely-curved ridge across middle. Antenna (fig. 242) with second segment only slightly transverse; third segment cylindrical, three times as long as broad, and as long as second segment; supplementary process shorter than third segment. *Abdomen* with pleural tubercle

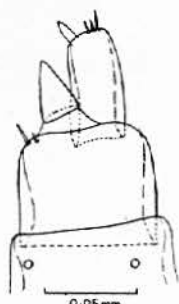


Fig. 242



Fig. 243

Fig. 242. *Coptops aedificator* Fabricius. Mature larva. Apical part of antenna. Lateral aspect.

Fig. 243. *Coptops aedificator* Fabricius. Mature larva. Peritreme of abdominal spiracle.

with ventral sclerotised pit rather large and very distinct. *Spiracles* (fig. 243) with about twenty-four marginal chambers.

*Host plants*: *Acacia arabica*, *Acacia* sp., *Acrocarpus fraxinifolia*, *Aegle marmelos*, *Albizia lebbek*, *Bauhinia purpurea*, *B. retusa*, *B. vahlii*, *B. variegata*, *Bombax malabaricum*, *Buchanania latifolia*, *Butea frondosa*, *Coffea arabica*, *Careya arborea*, *Cassia siamea*, *Cudrania javanensis*, *Dalbergia paniculata*, *Excaecaria agallocha*, *Ficus glomerata*, *F. religiosa*, *F. sp.*, *Garuga pinnata*, *Hevea braziliensis*, *Holoptelea integrifolia*, *Lannea grandis*, *Manihot glaziovii*, *Millettia auriculata*, *Mucuna imbricata*, *Pavetta indica*, *Pongamia glabra*, *Pterocarpus marsupium*, *Pueraria tuberosa*, *Semecarpus anacardium*, *Shorea robusta*, *Spatholobus roxburghii*, *Terminalia belerica*, *T. tomentosa*, *Wrightia tinctoria* (Beeson & Bhatia, 1939). Fraser (1949c) records this species from *Azelia* sp., and the present writer has recently received a specimen from *Artocarpus* sp. Also from *Funtumia* (Lepesme, 1948).

*Biology*. According to Beeson and Bhatia (1939) larvae of this species feed either subcortically or actually in the inner bark, and the damage they do to the sapwood is only superficial, for even the pupal cells are constructed almost entirely in the bark. Fraser (1949c) confirms this, although he noticed that three larvae under observation had burrowed deeply into the sapwood to pupate; but this change of habit, as he points out, was probably occasioned by the excessive drying-out of the wooden block. The emergence hole is circular, but usually somewhat ragged (owing to the thinness of the bark?). Emergence occurs more or less throughout the year, although the main period in India is in June. The life-cycle normally lasts a year.

*Parasites*. Hymenoptera: *Sclerodermus immigrans* Bridw. (Thompson, 1943).

*Material studied.* 4 L, 2 I, Lancs., Liverpool, viii.1948, in *Afzelia* from E. Africa. M.C.F. leg., in coll. D.

*References.* Beeson & Bhatia, 1939 (Biol.); Fraser, 1949c (Biol.); Thompson, 1943 (Paras.).

**\*Niphonini**

**\**Niphona hookeri* Gahan**

[Rarely in imported bamboo from the Orient.]

*Mature larva* (fig. 244). Similar to those of the Mesosini.<sup>1</sup> The distinguishing characters are given in the key, p. 78.

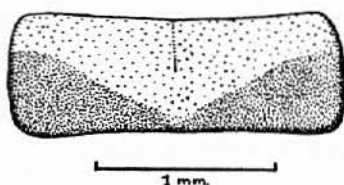


Fig. 244. *Niphona hookeri* Gahan. Mature larva. Hypostoma.

Host plant: *Bambusa*.

*Biology.* According to Gressitt (1942), adults, which emerge in May or June, feed on the young bark of certain fruit-trees such as *Citrus*.

*Material studied.* 1 L (dried exuvia), in imported Chinese *Bambusa*, in coll. B.M.

*References.* Gressitt, 1942 (Biol.).

**\*Phrynetini**

**\**Phryneteta leprosa* Fabricius**

[Occasionally in timber imported from Africa.]

*Mature larva* (figs. 245-247). Length up to 55 mm.; maximum breadth (at prothorax), 14 mm. *Head* moderately depressed, elongate, subparallel-sided, widest before middle (maximum head-width, 7.5 mm.), slightly constricted at middle; frontal sutures distinct for entire length; antennal foramen open behind; mouthframe strongly and broadly sclerotised. Frons with at least anterior half ferruginous, smooth, with numerous scattered setae; six epistomal setae present. One pair of ocelli present; lens round, scarcely convex; pigmented spot indistinct. Hypostoma convex, ferruginous, with front margin broadly pitchy; setiferous pores absent; sutures pitchy, slightly incurved. Gular region with a pale, median, ventral cleavage line. Antenna (fig. 245) two segmented, the second segment slightly elongate and bearing a hyaline process. Maxilla with third palpal segment acutely conical, slightly shorter than second. Labial palpi with third segment less than half length of second. Mentum distinct from submentum. Labrum semicircular. Clypeus with a few minute, pale setae near each lateral margin. *Prothorax* depressed, with pronotum (fig. 246) glabrous testaceous and covered with a network of ferruginous ridges. *Abdomen* with each

<sup>1</sup> Although this larva has no caudal spine, the larvae of certain Indian species of *Niphona* bear a caudal spine similar to those of larvae of the Mesosini (see Gardner (1927, 1931)).

dorsal ampulla with an anterior, transverse, curved furrow and two pairs of lateral furrows; median longitudinal furrow distinct; tubercles absent; microscopically pubescent; each ventral ampulla with only one pair of lateral furrows. Ninth tergite (fig. 247) with a very stout curved spine (see also p. 12), the base of which is concealed beneath the posterior margin; tenth segment (fig. 247) with dorsum dome-shaped,



Fig. 245

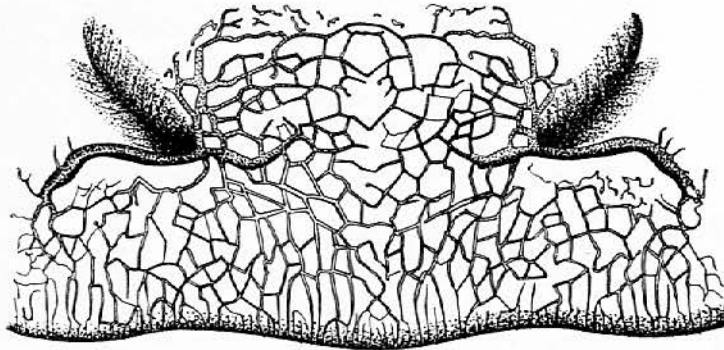


Fig. 246

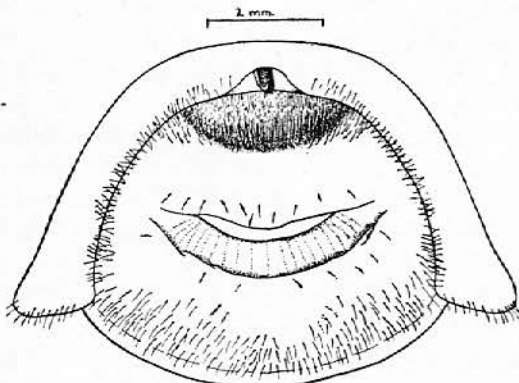


Fig. 247

Fig. 245. *Phryneteta leprosa* Fabricius. Mature larva. Apical part of antenna. Lateral aspect.

Fig. 246. *Phryneteta leprosa* Fabricius. Mature larva. Median region of pronotum.

Fig. 247. *Phryneteta leprosa* Fabricius. Mature larva. Ninth and tenth abdominal segments. Caudal aspect.

rather strongly sclerotised and very finely longitudinally striate; anus a simple transverse cleft. Epipleurum protuberant on all segments. Pleural tubercle without sclerotised pits. *Legs* absent. *Spiracles* with peritreme exceedingly thick and broadly oval.

*Pupa*. As only a single, very mutilated pupa is available, it is not possible to furnish a detailed description. Sufficient characters are discernible, however, to permit of its inclusion in the pupal key, p. 97.

Host plants: *Chlorophora excelsa*, *Morus* (Ghesquière, 1928). (See Lapesme (1948).)

*Biology*. Oviposition occurs at night, and from forty to fifty eggs are usually laid by a single adult (Ghesquière, 1928).

*Parasites.* Hymenoptera: *Stirostoma longicornis* Cam. (Ghesquière, 1928).

*Material studied.* 4 L, 1 P, 1 I, Africa, Uganda, C. C. Gowdey leg., in coll. B.M.; 1 L, Africa, Uganda, Kampala, 24.x.1936, H. Hargreaves leg., in coll. B.M.

*References.* Ghesquière, 1928 (Biol.); Lepesme, 1948 (Biol.).

**\*Phryneta spinator** Fabricius

[Occasionally in imported timber from Africa.]

*Mature larva.* No material available.

*Egg.* Length, 6 mm. Form, elongate-oval. Chorion white, opaque, turning slightly yellow and finally becoming pinkish (Tooke, 1935b).

*Host plants:* *Ficus* and *Salix*; occasionally in *Pyrus communis* and *Prunus persica* (Tooke, 1935b). Gunn (1919) gives also *Pyrus malus*, *Prunus domestica*, *Vitis vinifera*, *Melia azedarch*, *Cupressus lusitanica* and *C. horizontalis*. *Funtumia* (Lepesme, 1948).

*Biology.* The eggs are deposited usually in batches of up to four, each batch being inserted in a transverse, vertical, or "T"-shaped slit in the bark made by the mandibles of the adult. Sometimes oviposition occurs below ground-level. The incubation period varies from ten to eighteen days. The young larva feeds subcortically, making a broad irregular gallery. From time to time the larva perforates the bark, thus forming a series of holes through which frass is periodically ejected. When mature, that is, after about two and one-half years of feeding, the larva excavates a pupal cell 1-2 in. long and  $\frac{3}{4}$ -1 $\frac{1}{2}$  in. deep; the entrance to the cell is plugged with coarse, stringy wooden fibres. Emergence occurs throughout the period November to March. The life-cycle averages three years in duration (Gunn, 1919; Tooke, 1935b).

*Parasites.* Adults have been found to be infested with a parasitic fungus (*Isaria* sp.).

*Economic importance.* Trees heavily infested with this species usually die or are killed through the entrance of fungi in the galleries.

*Control.* Larvae may be killed by making an incision with a knife at one end of the ejection holes, and then pushing a strong flexible wire along the gallery. Heavily infested trees should be dug out and burned. When damage is confined to exposed roots, a small quantity of kerosene or carbon bisulphide should be injected (Tooke, 1935b).

*References.* Distant, 1904 (Biol.); Lounsbury, 1918 (Biol.); Gunn, 1919 (E, L fig., Biol., fig.); Lepesme, 1948 (Biol.); Tooke, 1935b (L fig., P fig., Biol.).

**\*Ancytonotini.**

**\*Ancytonotus tribulus** Fabricius

[Occasionally in imported timber from Africa.]

*Mature larva.* Length up to 33 mm.; maximum breadth (at prothorax), 9 mm. *Head* moderately depressed, slightly elongate, subparallel-sided, widest before middle (maximum head-width, 5.5 mm) and slightly constricted at middle. Frontal sutures distinct for entire length; antennal foramen open behind; mouthframe strongly and broadly sclerotised. Anterior half of frons ferruginous and smooth. Gena very

strongly sclerotised, pitchy. Ocelli indiscernible. Hypostoma slightly convex, ferruginous, with front margin narrowly pitchy; setiferous pores absent; sutures straight, strongly converging posteriorly, pitchy. Gular region with a very thin pale, median cleavage line. Antenna two-segmented, the second segment about twice as long as broad, and bearing a minute hyaline process. Maxilla with third palpal segment acutely conical, shorter than second. Labial palpi with third segment less than half length of second. Mentum distinct from submentum. Clypeus glabrous. *Prothorax* depressed, with posterior half of pronotum microscopically spiculate and with scattered coarse setae. *Abdomen* with each dorsal ampulla with two transverse furrows, and entirely covered with small oval spiculate tubercles. Ninth tergite without a spine or sclerotised plate. Anus trilobate. Pleural tubercles without sclerotised pits. Legs absent. *Spiracles* with peritreme thick and broadly oval.

*Pupa* (fig. 248). Rather similar to that of *Batocera* species, from which it may be distinguished as follows. Length not exceeding 27 mm.; maximum breadth not exceeding 10 mm. *Head* with front sparsely setose. Mandibles with only two or three setae on middle of outer face. *Pronotum* with a pair of paramedian, tuberculate, conical protuberances. Elytra each with a pair of tuberculate protuberances near base.

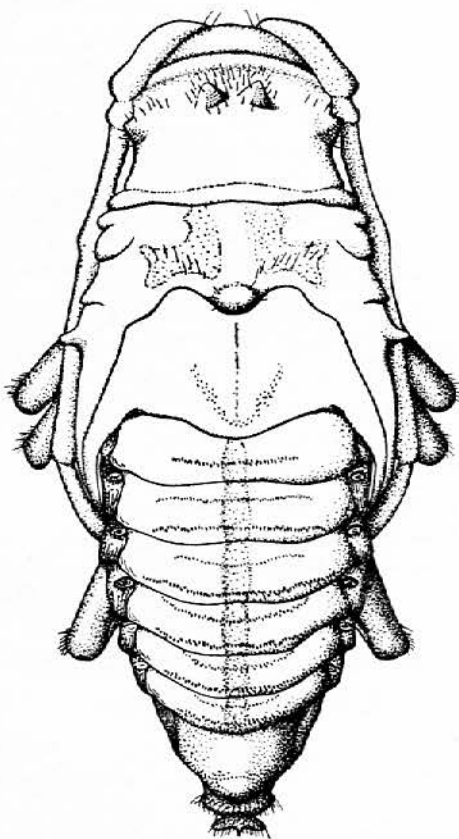


Fig. 248.  
*Ancylonotus tribulus* Fabricius.  
Male pupa. Dorsal aspect.

*Abdomen* with tergites two to five bearing two transverse rows of stout, closely-set spines.

Host plants: *Triplochiton scleroxylon* (from records of F.P.R.L.) and *Coffea*.

*Material studied*. 2 L, 1 P, in imported *Triplochiton* from Nigeria, in coll. F.P.R.L.; 2 L, 1 P, in imported *Triplochiton* from W. Africa, 16.vi.1950, W. G. Marshall leg., in coll. D. [Adults reared.]

*References*. Lepesme, 1948 (Biol.).

**\*Dorcadionini (pars)**

**\* *Lepromouris gibba* Brullé**

[Imported in ornamental plants from Canary Is.]

*Mature larva* (fig. 249). Rather similar to that of *Ancylonotus tribulus*, from which it may be distinguished by the characters given in the key, p. 79.

Host plant: *Euphorbia sylvatica canariensis*.

*Biology.* Oviposition takes place on the slightly decaying sections of the plant, where the milky sap is less abundant. These decaying sections are, according to

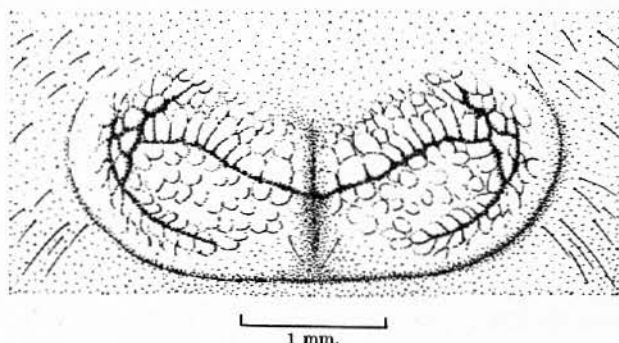


Fig. 249. *Lepromouris gibba* Brullé. Mature larva. Fourth dorsal abdominal ampulla.

Uyttenboogaart (1932), frequently blown off by the wind, and he maintains that larvae are able to crawl over the ground from one section to another should their food supply become exhausted. Such behaviour would seem unlikely, however, considering that the larvae are apodous.

*Material studied.* 2 L, in *Euphorbia* imported from the Canary Is., presented by M. G. Fraser, in coll. D.

*References.* Uyttenboogaart, 1932 (Biol.); Wollaston, 1862 (Biol.), 1864 (Biol.), 1865 (Biol.).

#### \* Apomecynini

##### \* *Diaxenes dendrobii* Gahan

This species shows far closer affinities to the Tetraopini (see p. 299).

#### Pogonocherini

##### Larval Characters

Form slender, subcylindrical. *Head* depressed, with sides slightly constricted behind middle. Mandible short, reticulate on outer face. Antennal foramen closed behind. Setiferous pores of hypostoma absent. Antenna two-segmented and bearing a hyaline process. Maxillary palp two- or three-segmented. Gular region without distinct sutures or ventral cleavage line. *Prothorax* with posterior region of pronotum shining and glabrous. *Abdomen* with ampullae feebly tuberculate and with a broad, longitudinal, median furrow. Epipleurum protuberant on last three segments only. Pleural tubercles without sclerotised pits and with a single seta. Ninth tergum with a sclerotised process or plate. *Spiracles* with about six marginal chambers.

Considerable confusion has arisen in previous accounts of larvae of this tribe. The larval characters which Kemner (1922) and Emden (1939-1940) attribute to *Tetrops praeusta* L. actually apply to *P. hispidus*, and the larval descriptions of *P. hispidulus*

by Perris (1877) and Xamheu (1898-1902) obviously apply to some other species. This confusion may probably be explained by the fact that larvae of *Tetrops*, and one or even two species of *Pogonocherus* are often to be found together infesting the same wood.

***Pogonocherus* (s.g. *Pogonocherus*) *hispidus* (Linnaeus)**

*Mature larva* (figs. 250, 251). Length up to 12 mm.; maximum breadth (at prothorax), 2 mm. *Head* depressed, slightly wider before middle (maximum head-width, 1.2 mm.), with sides slightly constricted behind middle; antennal foramen closed behind; mouthframe narrowly sclerotised; frons feebly sclerotised and with a row of eight setiferous pores; six epistomal setae present. One pair of ocelli present; lens

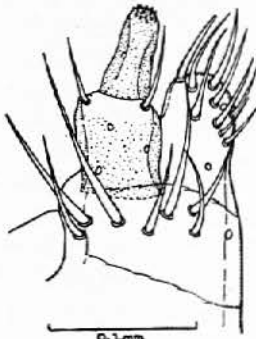


Fig. 250



Fig. 251

Fig. 250. *Pogonocherus hispidus* (Linnaeus). Mature larva. Apical part of right maxilla. Ventral aspect.

Fig. 251. *Pogonocherus hispidus* (Linnaeus). Mature larva. Sclerotised plate of ninth tergite.

convex; pigmented spot distinct. Hypostoma flat, testaceous, with front margin very narrowly ferruginous; sutures fine, strongly curved; setiferous pores absent. Gular region undefined. Antenna two-segmented (as in *P. hispidulus*, fig. 254), the second segment slightly elongate and bearing a tapering, hyaline process. Maxillary palpi two-segmented (fig. 250); second segment elongate, tapering, as long as first. Labial palpi with third segment elongate, cylindrical, as long as second. Mentum not distinct from submentum. *Prothorax* with pronotum feebly rugose, glabrous and shining. Eusternum feebly defined, with a few scattered setae. *Abdomen* with each dorsal ampulla feebly tuberculate and with a broad, rather deep, longitudinal furrow. Ninth tergum with a subcircular, sclerotised, striate plate (fig. 251), the centre of which is produced into a short spine. Epipleurum strongly protuberant on last three segments. Pleural tubercle with sclerotised pits absent and bearing a single seta. Anus trilobed. *Legs* absent. *Spiracles* with peritreme rather thick and round.

*Pupa* (fig. 252). Length, 4.75-7.25 mm.; maximum breadth, 2 mm. *Head* with vertex visible from above and rather deeply excavated between bases of antennae, and bearing one to three long setae opposite base of each antenna; front with two groups of about four similar setae; clypeus with a deep, transverse impression and a row of six setae at base. Antennae extending as far as second abdominal segment,

where they are strongly recurved to terminate near front coxae. Eyes scarcely convex, glabrous. Mandibles each with two fine setae, one above and one below middle of outer face. Labrum quadrate, with front margin strongly rounded; sometimes with two or three minute setae. *Pronotum* with sides bearing a pair of acutely pointed tubercles; several long fine setae present. *Mesonotum* smooth and bearing about eight fine setae; scutellum depressed, very short and glabrous. *Metanotum* smooth,

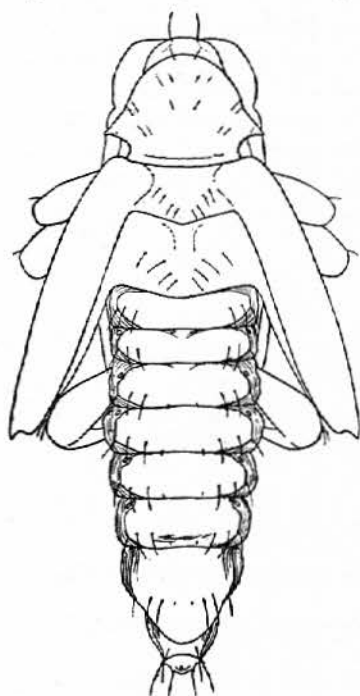


Fig. 252.

*Pogonocherus hispidus* (Linnaeus).  
Female pupa. Dorsal view.

and with about four fine setae on each side of scutellar groove, which is indistinct. Elytra and wings extending as far as fourth or fifth abdominal segment. *Abdomen* with tergites one to six each with a single transverse row of long fine setae. Seventh tergite elongate and with a similar row of setae. Eighth tergite short, transverse and with a pair of similar setae. Ninth tergite short, produced upward medially into a conical process which bears a short stout spine; hind margin with four to six very short spines. Sternites with a fine seta near each lateral margin. Pleura moderately protuberant, rugose and glabrous. *Legs* with each femur with about five fine setae near apex; mid and hind femora with a long tuberculate process near base; hind femora extending to fourth abdominal segment; all tibiae more or less at right-angles to longitudinal axis of body. *Functional spiracles* present on first six abdominal segments; peritreme broadly oval, thin and very slightly raised above general level of cuticle.

*Egg*. Length, 1 mm.; breadth, 0.3 mm. Form elongate, subcylindrical, with rounded ends. Chorion light brown (sometimes with a pinkish tint), dull.

Host plants: *Quercus*, *Pyrus malus*, *Ilex*, *Alnus*, *Hedera*, *Prunus*, *Viscum album* (Perris, 1877); *Ficus*, *Fagus*, *Corylus*, *Rubus*, *Lonicera* (Honnorat, 1878a, 1878b); *Castanea*, *Pyrus communis* (Buysson, 1879); *Tilia*, *Ulmus*, *Pinus*, *Picea* (Reineck, 1919); *Sorbus aucuparia*, *Cotoneaster* (Kemner, 1922); *Laurus nobilis* (Duffy, 1946c). The coniferous hosts listed by Reineck are questionable, and probably apply to *P. fasciculatus*.

*Biology*. The eggs are usually deposited singly in the bark of slender, recently dead or slightly decaying twigs (seldom in branches or boles). The incubation period is about twenty days. The larvae feed almost entirely under the bark, where they make shallow, meandering galleries. This usually results in causing the thin bark to crack and curl outward, thereby exposing small patches of the yellowish sapwood which show up conspicuously in contrast with the dark-coloured bark (Pl. V, fig. 21). When mature (usually in July), the larvae bore into the sapwood in which they excavate a short, slightly curved pupal cell which is later plugged at the entrance with frass.

Adults occasionally emerge during the autumn months if the weather is mild, but normally they overwinter in the pupal cells and emerge the following April or May.

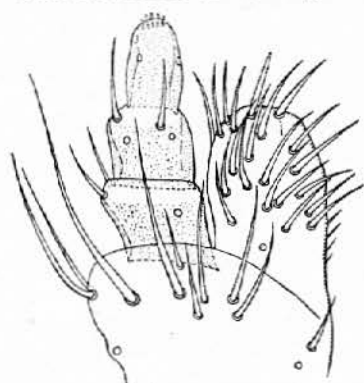
*Parasites.* Hymenoptera: *Doryctes undulatus* Rtz., *Eurytoma eccoptogastri* Rtz., *Ephialtes manifestator* L., and *E. terebrans* Rtz. (Reineck, 1919).

*Material studied.* 30 L, Surrey, Mytchett, 2.ix.1944, in dead stems of *Laurus*, E. W. Classey leg., in coll. D. [Adults reared.]

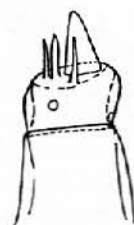
*References.* Bouché, 1947 (Biol.); Buysson, 1878a (Biol.), 1878b (Biol.); Chapuis & Candèze, 1853 (L fig.); Duffy, 1946c (Biol.); Emden, 1939–1940 (L fig. (under *Tetrops praeusta*)); Fairmaire, 1847 (Biol.); Henriksen, 1914 (L fig.); Honnorat, 1878a (Biol.), 1878b (Biol.); Kaltenbach, 1874 (Biol.); Kemner, 1922 (L fig. (under *T. praeusta*), Biol. fig.); Passerini, 1851 (Biol.); Perris, 1877 (L fig., P, Biol.); Poussielgue, 1880 (Biol.); Reiche, 1865 (Biol.); Reineck, 1919 (Biol.); Schiödte, 1876 (L fig., P); Xambeu, 1898–1902 (L, P, Biol.).

***Pogonocherus* (s.g. *Pogonocherus*) *hispidulus* (Piller & Mitterpacher)**

*Mature larva* (fig. 253–255). Similar to that of the preceding species, from which it may be distinguished as follows. *Head* with mouthframe more broadly and strongly sclerotised. *Antenna* as in fig. 254. *Maxillary palpi* (fig. 253) three-segmented. *Abdomen* with ninth tergite with a transversely oval, sclerotised plate (fig. 255), on which is a series of from eight to twelve longitudinal furrows; no median spine present.



0.1 mm.  
Fig. 253



0.05 mm.  
Fig. 254



0.25 mm.  
Fig. 255

Fig. 253. *Pogonocherus hispidulus* (Piller & Mitterpacher). Mature larva. Apical part of right maxilla. Ventral aspect.

Fig. 254. *Pogonocherus hispidulus* (Piller & Mitterpacher). Mature larva. Apical part of right antenna. Lateral aspect.

Fig. 255. *Pogonocherus hispidulus* (Piller & Mitterpacher). Mature larva. Sclerotised plate of ninth tergite.

*Host plants:* *Alnus* (Perris, 1877); *Pyrus communis*, *Viscum album* (Xambeu, 1898–1902); *Hedera*, *Picea*, *Pinus* (Reineck, 1919); *Corylus avellana*, *Carpinus betulus* (Kemner, 1922). The coniferous hosts listed by Reineck are questionable and probably refer to *P. fasciculatus*. The present writer has found larvae in *Sambucus nigra* and *Pyrus malus*; the latter appears to be the preferred host.

*Biology.* Very similar to that of *P. hispidus*.

*Parasites.* Hymenoptera: *Bracon palpebrator* Ratz., *Doryctes undulatus* Ratz., *Caenocoelius agriculator* L. (Xambeu, 1898–1902).

*Material studied.* 17 L, I.o.W., Parkhurst Forest, ix.1947, in dead *Pyrus malus*, D leg., in coll. D.; 8 L, 4 P, Surrey, Effingham, vii.1949, from *Pyrus malus*, D leg., in coll. D. [Adults reared.]

*References.* Emden, 1939–1940 (L fig.); Henriksen, 1914 (L); Kaltenbach, 1874 (Biol.); Kemner, 1922 (L fig., Biol. fig.); Perris, 1877 (L, Biol.); Reineck, 1919 (Biol.); Xambeu, 1898–1902 (L, P, Biol.).

### ***Pogonocherus* (s.g. *Pithyphilus*) *fasciculatus* (Degeer)**

*Mature larva* (fig. 256). Similar to that of *P. hispidus*, from which it may be distinguished as follows. *Head* with maxillary palpi three-segmented. *Prothorax* with

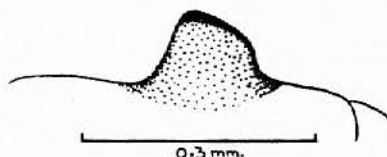


Fig. 256. *Pogonocherus fasciculatus* (Degeer). Mature larva. Sclerotised plate of ninth tergite.

pronotum coarsely rugose. *Abdomen* with tubercles of ampullae more clearly defined. Ninth tergum with a tubercular protuberance (fig. 256), which bears a longitudinally oval, sclerotised plate, the centre of which is raised to form a single longitudinal ferruginous keel.

*Pupa.* No material available. It is figured by Kemner (1922), but there is not sufficient detail shown for a comparison to be made.

*Host plants:* *Pinus* and *Picea* (Xambeu, 1898–1902; Reineck, 1919).

*Biology.* Very similar to that of *P. hispidulus*.

*Parasites.* Hymenoptera: *Doryctes igneus* Rtz., *Bracon flavulatus* Rtz., *Ephialtes manifestator* L., *Hemiteles melanarius* Grav., *H. aestivalis*, var. *modestus* Grav., *Ephialtes sagax* Htg., *E. terebrans* Rtz., *Pteromalus dahlbomi* Rtz., *P. guttatus* Rtz., *P. pogonocheri* Rtz., *P. undulatus* Rtz. (Reineck, 1919). *Cenocoelius agriculator* L., *Iphiaulax extricator* Nees (Thompson, 1943).

*Material studied.* 3 L, Ruovesi, Nimetön, 27.ix.1912, from *Pinus*, U. Saalas leg., in coll. U.Z.M.C.; 2 L, 30.xi.1949, from Scandinavian *Picea*, in coll. F.P.R.L.

*References.* Altum, 1875 (Biol.); Barbey, 1913 (Biol. fig.); Emden, 1939–1940 (L fig.); Escherich & Baer, 1908 (Biol.); Judeich & Nitsche, 1889 (Biol.); Kaltenbach, 1874 (Biol.); Kemner, 1922 (L fig., P fig., Biol. fig.); Lunardoni, 1889 (Biol.); Nördlinger, 1856 (Biol.); Nüsslin, 1905 (Biol.); Ratzeburg, 1839 (Biol.); Reineck, 1919 (Biol.); Rothenburg, 1905 (Biol.); Rudow, 1912 (Paras.); Salaas, 1923 (L fig.); Thompson, 1943 (Paras.); Torika, 1907 (L, P); Trägårdh, 1921 (Biol. fig.), 1939 (Biol. fig.); Xambeu, 1898–1902 (L, Biol.).

**Acanthocinini**  
**Larval Characters**

Form depressed, rather slender. *Head* strongly depressed, with sides abruptly constricted before or at middle; antennal foramen closed or very narrowly open behind; gena with a conspicuous transverse furrow immediately in front of ocellus. Gula with sutures not raised, but with a small rugose area on each side (bearing two to six setae); six epistomal setae present. Ocellus with pigmented spot indistinct. Mentum distinct from submentum. Antenna two-segmented and bearing a conical, hyaline process. Maxilla with outer margin of palpifer strongly rounded and protuberant. *Prothorax* with posterior part of pronotum velvety asperate (except in certain North American species of *Leiopus*). *Abdomen* with ampullae dull and spiculate or shining and tuberculate. Epipleurum very strongly protuberant on last three segments. Pleural tubercle with sclerotised pits distinct. *Spiracles* circular, with posterior margin of peritreme with marginal chambers.

**Acanthocinus aedilis** (Linnaeus)

*Mature larva* (figs. 257-260). Form elongate, slender, depressed. Length up to 37 mm.; maximum breadth (at prothorax), 6.5 mm. *Head* (fig. 257) strongly depressed, with sides slightly constricted before middle (maximum head-width, 3.5 mm.) and slightly converging posteriorly; antennal foramen closed behind; mouthframe very strongly and rather broadly sclerotised, the transverse, dorsal, ferruginous band as broad as half length of clypeus; frons with a transverse row of eight setiferous pores, behind which it is feebly sclerotised and testaceous. Genae strongly shouldered and protuberant, strongly sclerotised and pitchy and with a conspicuous transverse furrow immediately in front of ocellus; broadly rugose and ferruginous posteriorly. One pair of ocelli present; lens ferruginous; pigmented spot indistinct owing to sclerotisation of gena. Clypeus with two to four widely separated, longitudinal impressions. Hypostoma flat, smooth, testaceous, with front and hind margins ferruginous; sutures ferruginous and slightly curved. Gular region with a pale ventral cleavage line, on each side of which is a ferruginous rugose area bearing four to six setae. Antenna (fig. 258) two-segmented; second segment subquadrate, and bearing a small conical, hyaline process. Maxilla (fig. 259) strongly sclerotised, with palpi three-segmented; third segment tapering about two-thirds length of second; palpifer with outer margin strongly rounded and protuberant. Labial palp with third segment cylindrical, about one-third length of second. Mentum distinct from submentum. *Prothorax* with a transverse row of setae just behind front margin; posterior region of pronotum with two ferruginous areas of very fine dense asperities, with numerous interspaced glabrous spots as in *Arhopalus* (fig. 108). *Abdomen* with ampullae with one transverse furrow, a conspicuous pair of lateral furrows and a broad, rather deep longitudinal median furrow; non-tuberculate, dull, velvety spiculate or pubescent. Ninth segment simple. Epipleurum protuberant on last three segments only. Pleural tubercle broadly oval, with a pair of sclerotised pits and at least ten setae. Anus trilobed. *Legs* absent. *Spiracles* round, with five to eight marginal chambers present on posterior margin of peritreme (fig. 260).

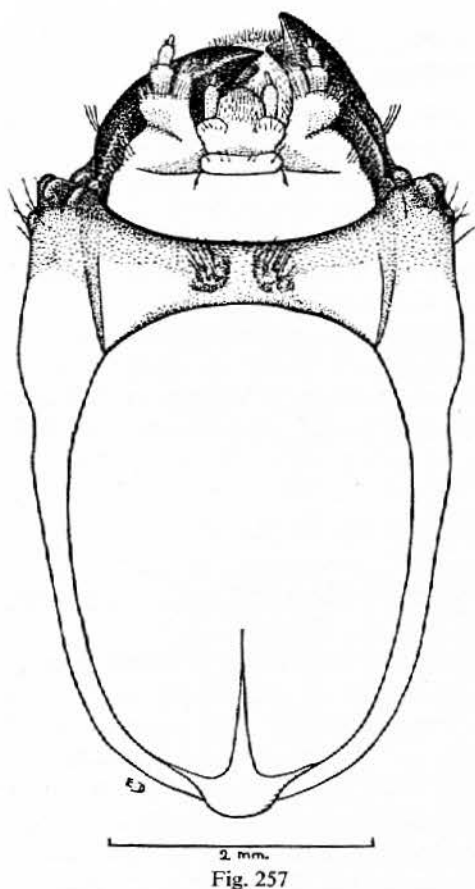


Fig. 257

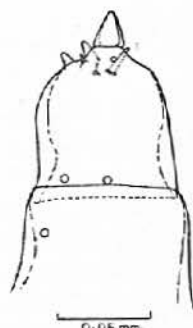


Fig. 258



Fig. 260

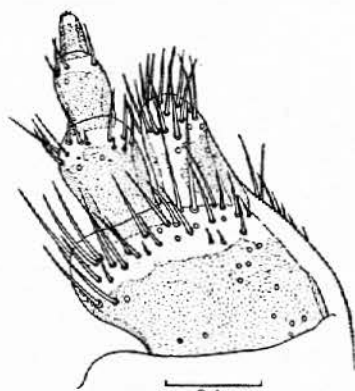


Fig. 259

- Fig. 257. *Acanthocinus aedilis* (Linnaeus). Mature larva. Head. Ventral aspect. (Duffy, 1950)
- Fig. 258. *Acanthocinus aedilis* (Linnaeus). Mature larva. Apical part of antenna. Lateral aspect.
- Fig. 259. *Acanthocinus aedilis* (Linnaeus). Mature larva. Apical part of right maxilla. Ventral aspect.
- Fig. 260. *Acanthocinus aedilis* (Linnaeus). Mature larva. Peritreme of abdominal spiracle.

*Pupa* (figs. 261, 262). Length, 20–24 mm.; maximum breadth, 6.25 mm. *Head* with vertex visible from above and deeply excavated between antennae; bearing a few minute spines (each with a fine basal seta); front with a few scattered similar spines, smooth; clypeus with a deep transverse impression at base and with two or three spines near each basal angle. Antennae extending as far as seventh abdominal segment, where, in the female, they are strongly recurved and directed anteriorly to terminate near their basal segments; in the male, they are crossed beneath the seventh abdominal segment, then strongly curved to cross again beneath the fourth abdominal segment, then directed anteriorly to just beyond vertex of head where they are strongly recurved and directed posteriorly to near the base of the seventh abdominal segment,

where they are again recurved to terminate near apices of elytra. Eyes feebly convex, glabrous. Mandibles with one or two setae near middle of outer face. Labrum transverse and with front margin slightly rounded; glabrous or almost so. *Pronotum*

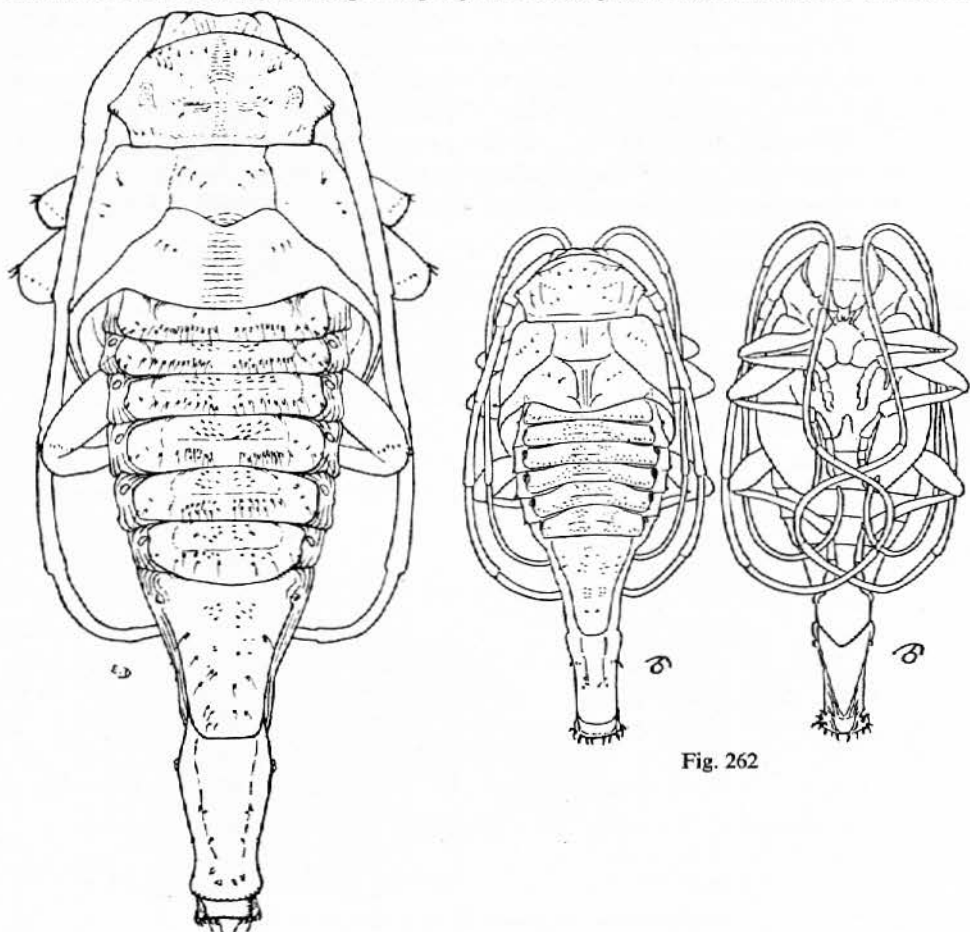


Fig. 261

Fig. 261. *Acanthocinus aedilis* (Linnaeus). Female pupa. Dorsal aspect. (Duffy, 1950)

Fig. 262. *Acanthocinus aedilis* (Linnaeus). Male pupae. Dorsal and ventral aspects. (Kemner, 1922)

with sides bearing a pair of tubercles; numerous short spines are present, mostly near front angles; an elongate-oval protuberance present near each lateral tubercle. *Mesonotum* smooth, and with about six short spines; scutellum depressed, glabrous. *Metanotum* smooth except near scutellar groove where it is transversely striate; bearing about six spines; scutellar groove indistinct. Elytra each with a conspicuous spine near base and sometimes with two or three smaller spines near by. Elytra and wings extending as far as fourth abdominal segment. *Abdomen* with tergites one to six with posterior half with a transverse row (interrupted medially) of slender spines; each anterior half of tergites bearing two groups of spines which are curved inward.

Seventh tergite strongly elongate and bearing numerous scattered spines. Eighth tergite extremely elongate and with a few similar spines. Ninth tergite very short, truncate apically and bearing about six inwardly-curved spines. Sternites glabrous. Pleura rather strongly protuberant, strongly rugose and bearing a minute seta. *Legs* with fore and mid femora clavate; each femur with a row of spines near apex; mid and hind femora each with a long tuberculate process near base; hind femora extending to fourth abdominal segment; all tibiae more or less at right-angles to longitudinal axis of body. *Functional spiracles* present on first six abdominal segments, but vestigial pairs present on segments seven and eight, where they are placed laterally; peritreme rather narrowly oval, moderately thick and very slightly raised above general level of cuticle.

*Egg.* Length, 3 mm.; breadth, 0.75 mm. Form elongate-oval. Chorion yellowish white (Xambeu, 1898-1902; Kemner, 1922).

*Host plants:* *Pinus*, *Picea* (Reineck, 1919). The reference to *Alnus* given by Kaufmann (1948) would seem to be questionable.

*Biology.* The eggs are laid in trunks or branches of recently dead or felled conifers. Prior to oviposition, the adult gnaws a funnel-shaped pit (fig. 5) in the bark; this is then deepened by the extremity of the abdomen which is used as a drill. According to Fraser (1949a), the larva feeds entirely subcortically, the galleries being confined

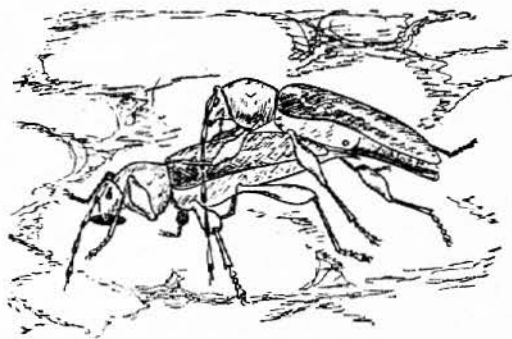


Fig. 263

Fig. 263. *Acanthocinus aedilis* (Linnaeus). Copulation. (Neander, 1928)

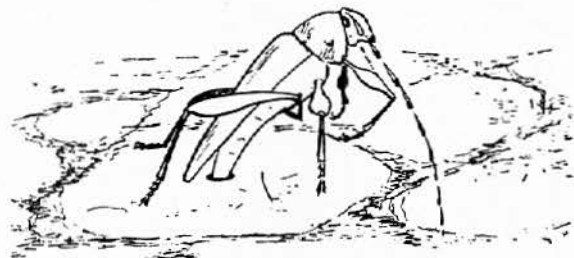


Fig. 264

Fig. 264. *Acanthocinus aedilis* (Linnaeus). Oviposition. (Neander, 1928)

to the inner bark, so that the surface of the sapwood is not even superficially damaged. Bartlett (1918), however, describes the galleries as running parallel to the grain of the wood. Fraser has observed that the larva, when mature, tunnels into the sapwood in which the pupal cell is prepared; this is to be found immediately below the surface of the sapwood so that the entire cell is contained in the outer 10 mm. But according to Kemner (1922) the pupal cell, although sometimes excavated in the sapwood, is more often constructed under the bark. The present writer maintains that the position of the pupal cell is governed by the thickness of the bark, and that only when it is unusually thick does pupation occur subcortically. The pupal cell is 3-5 cm. in length and slightly curved. The observations of Bartlett (1918) indicate that both larvae and pupae are highly resistant to immersion in sea water. The adults emerge

either through the larval gallery or by making a fresh, circular exit hole, and Fraser has observed that the antennae do not straighten and harden until three or four days after emergence. Adult emergence varies considerably, although the main period appears to be from August to September. Adults have frequently been observed overwintering in their cells. On the Continent there are often two main emergence periods a year. The copulation (fig. 263) and oviposition (fig. 264) of this species have been thoroughly investigated by Neander (1928). Trägårdh (1930) has proved by the examination of the gut that adults consume at least a small quantity of bark, but whether this occurs during emergence or oviposition has yet to be ascertained.

*Parasites.* Hymenoptera: *Xorides filiformis* Grav., *X. irrigator* F., *Coeloides initiator* F., *Bracon praecisus* Rtz., *Doryctes imperator* Hal. (Xambeu, 1898-1902, Reineck, 1919); *Meteorus neesi* Marsh (Fahrenger, 1925); *Ephialtes tuberculatus* Fourc. (Thompson, 1943).

*Economic importance.* Although a British species, the majority of records of captured adults refer to specimens which have emerged from imported timber. There are numerous records of this species from coal-mines, the adults having emerged from imported pit-props. The technical damage to timber, however, is too slight to be regarded as at all serious.

*Material studied.* 6 L, 4 P, Lancs., Bootle, ix.1948, from *Pinus*, M.G.F. leg., in coll. D.; 1 P, Sweden, Råde Hegn, in coll. U.Z.M.C.

*References.* Barbey, 1913 (Biol.), 1917 (L fig., P fig., Biol. fig.); Bartlett, 1918 (Biol.); Della Beffa, 1915 (L fig., Biol.); Duffy, 1949b (L fig., P fig., Biol.); Emden, 1939-1940 (L); Feytaud, 1950 (L fig., Biol.); Fraser, 1949a (Biol.); Henriksen, 1914 (L fig.); Houlbert & Monnot, 1908 (L fig., Biol.); Judeich & Nitsche, 1889 (Biol.); Kaufmann, 1948 (Biol.); Kemner, 1922 (L fig., P fig., Biol.); Kontkanen, 1929 (Biol.), 1932 (L fig.); Lascols, 1879 (Biol.); Lunardon, 1889 (Biol.); Neander, 1928 (Biol. fig.); Nördlinger, 1848 (Biol.), 1856 (Biol.); Perris, 1856 (L fig., P, Biol.); Ratzeburg, 1837 (L fig., P fig.); Reineck, 1919 (Biol.); Rothenburg, 1907 (Biol.); Saalas, 1923 (L fig., Biol.); Schiödt, 1876 (L fig., P); Sedlaczek, 1918 (Biol.); Šlais, 1941 (L fig., Biol. fig.); Thompson, 1943 (Paras.); Trägårdh, 1929 (L fig.), 1930 (Biol.), 1939 (L fig., Biol. fig.); Voet, 1769 (Biol.); Westwood, 1839 (Biol. fig.); Xambeu, 1898-1902 (E, L, P, Biol.).

**\*Lagochirus tuberculatus** Fabricius

[Occasionally in imported timber from South America.]

*Mature larva.* No material or references available.

Host plants: *Viola koschnyi* and *Symphonia globulifera*.

**\*Leptostylus jamaicensis** Gahan

[Occasionally in imported timber from Jamaica.]

*Mature larva.* No material or references available.

**Leiopus nebulosus** (Linnaeus)

*Mature larva.* Rather similar to that of *Acanthocinus aedilis*, from which it differs as follows. Length up to 12 mm.; maximum breadth (at prothorax), 3 mm. *Head*

less elongate with sides slightly constricted at middle; antennal foramen narrowly but distinctly open behind. Ocellus with lens large, oval, pale and very distinct. Gular region with the rugose areas pale, each bearing two setae only. Maxilla with

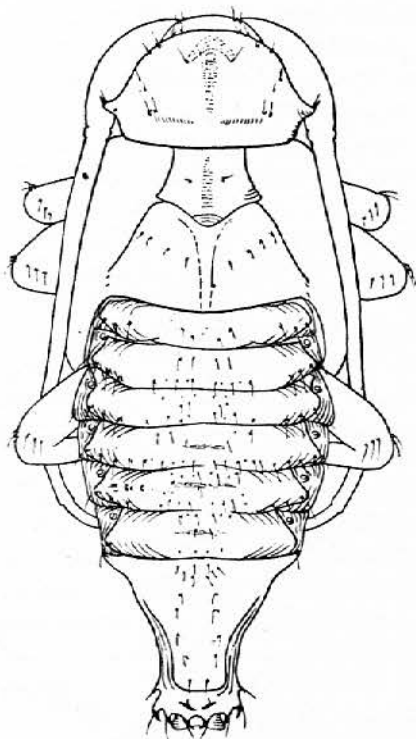


Fig. 265.  
*Leiopus nebulosus* (Linnaeus).  
Female pupa. Dorsal aspect.

third segment of palp as long as second; outer margin of palpifer less strongly protuberant. *Prothorax* with posterior part of pronotum testaceous and undivided by a median line. *Abdomen* with ampullae bearing irregular, shining glabrous tubercles. Pleural tubercle with about five setae.

*Pupa* (fig. 265). Length, 6–10 mm.; maximum breadth, 2.5 mm. *Head* with vertex visible from above, deeply excavated between bases of antennae and bearing three or four short spines near base of each antenna; front with about five short spines near mesal margin of each eye; clypeus with a transverse impression and with about six short spines at base. Antennae extending as far as sixth abdominal segment, where they are strongly recurved and directed anteriorly to terminate alongside the head. Eyes scarcely convex, glabrous. Mandible with a pair of long setae near middle of outer face. Labrum quadrate, with front margin strongly rounded, glabrous. *Pronotum* transversely striate medially; sides with a pair of tubercles each with a conspicuous apical spine and a smaller spine near base; several short setae present, chiefly

along front margin. *Mesonotum* faintly striate medially and with two to four short spines. *Metanotum* smooth and with an oblique row of about four spines on each side of scutellar groove which is indistinct. Elytra and wings extending as far as fifth abdominal segment. *Abdomen* with tergites one to six each with a transverse row of short spines near posterior margin and, usually, a shorter row near anterior margin. Seventh tergite strongly elongate, with numerous scattered spines. Eighth tergite very short and explanate laterally; a pair of inwardly curved spines present near middle and posterior margin bearing six to eight very stout, inwardly curved spines. Ninth tergite very short, truncate, partly retracted in eighth, obliquely explanate and rather strongly sclerotised ventro-laterally. Sternites glabrous. Pleura rather strongly protuberant, strongly rugose and each bearing a minute seta. *Legs* with femur with a row of small spines near apex; mid and hind femora with a very long tuberculate process near base; hind femora extending to fourth abdominal segment; all tibiae more or less at right-angles to longitudinal axis of body. *Functional spiracles* present on first six abdominal segments; peritreme broadly oval, moderately thick, and very slightly raised above general level of cuticle.

*Egg.* Length, 2 mm.; breadth, 0.6 mm. Form elongate-oval, tapering, but rounded at both ends. Chorion smooth and white (Heeger, 1856).

*Host plants:* *Prunus armeniaca*, *Ulmus*, *Quercus*, *Alnus*, *Castanea*, *Robinia*, *Corylus*, *Pyrus malus*, *Prunus persica*, *Rosa*, *Baccharis halimifolia* (Perris, 1877); *Carpinus* (Nowicki, 1874); *Fagus sylvatica*, *Prunus aucuparia* (Henriksen, 1922); *Acer*, *Betula*, *Cydonia vulgaris*, *Juglans*, *Pinus*, *Salix* (Reineck, 1919); *Pyrus communis*, *Crataegus*, *Larix*, *Picea* (Duffy, 1946c). *Quercus* and *Castanea* are undoubtedly the preferred hosts.

*Biology.* Oviposition takes place on the bark of recently dead or decaying branches and slender trunks. Until mature, the larvae feed entirely subcortically (Pl. VI, fig. 29). It has been the writer's experience that the thickness of the bark determines the position and structure of the pupal cell. If the bark is moderately thick (e.g. as in *Quercus*), then the cell is formed under the bark or in the outer sapwood: here it consists of an elongate, shallow, oval excavation surrounded by a low wall of frass, which is usually much wider around the two extremities. If the bark is thin (e.g. as in *Castanea*), then the cell extends right into the sapwood or even the heartwood or the pith channel (Pl. VI, fig. 29): in this case the cell is elongate, rather broad and compressed, and is plugged with frass at the orifice. Pupation takes place sometimes in the autumn, but more usually in April or May. Adults emerge in June and July.

*Parasites.* Hymenoptera: *Meteorus tabidus* Wesm., *Xorides filiformis* Grav., *Deuterxorides albitarsus* Grav., *Helcon carinator* Nees, *H. tardator* Nees, *Ephialtes tuberculatus* Fourc. (Rudow, 1912); *Xorides brachylabris* Kriechb. (Fromont, 1882). *Ischnocerus seticornis* Kr., *Xorides praecatorius* F. (Seyrig, 1924).

*Material studied.* 18 L, Surrey, Mytchett, 3.i.1944, from *Quercus*, D leg., in coll. D.; 12 L, 7 P, Hants, Crookham, 24.v.1944, from *Quercus*, D leg., in coll. D.; 14 L, I.o.W., Parkhurst Forest, ix.1947, from *Castanea*, D leg., in coll. D. [Adults reared.]

*References.* Barbey, 1913 (Biol. fig.); Della Beffa, 1915 (L fig.); Duffy, 1946c (Biol.); Emden, 1939-1940 (L); Fromont, 1882b (Biol.); Heeger, 1855 (Biol. fig.), 1856 (Biol. fig.); Henriksen, 1914 (L fig.); Houlbert & Monnot, 1908 (L fig.); Kaltenbach, 1874 (Biol.); Kemner, 1922 (L fig., P fig., Biol. fig.); Lesne, 1893 (Biol.); Nördlinger, 1880 (Biol.); Nowicki, 1874 (Biol.); Perris, 1877 (L fig., P fig., Biol.); Reineck, 1919 (Biol.); Rudow, 1912 (Biol.); Schiödte, 1876 (L fig., P); Seyrig, 1924 (Paras.); Westwood, 1839 (L); Xambeu, 1898-1902 (E, L, P, Biol.).

**\* *Nyssodrys porifera* Bates**

[Occasionally in imported timber from South America.]

*Mature larva.* No material or references available.

*Host plants:* *Virola koschnyi*.

**\* *Nyssodrys ophthalmica* Lameere**

[Occasionally in imported timber from South America.]

*Mature larva.* No material or references available.

*Host plant:* *Gossypiospermum praecox*.

## Agapanthini

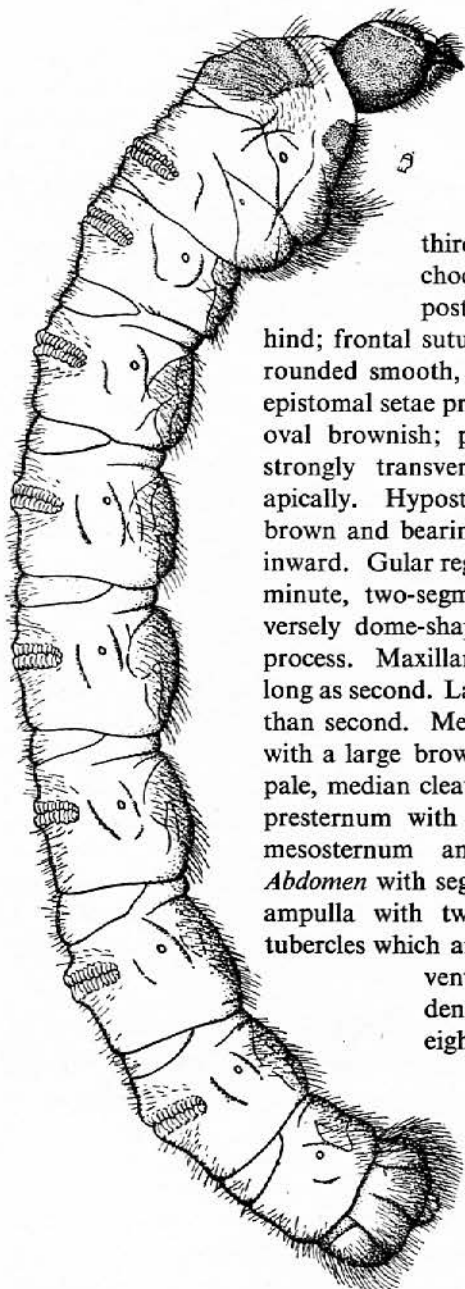
*Agapanthia villosoviridescens* (Degeer)

Fig. 266. *Agapanthia villosoviridescens* (Degeer). Mature larva. Lateral aspect.

*Mature larva* (figs. 266–268). Form very elongate, slender, curved and cylindrical. Length up to 27 mm.; maximum breadth (at prothorax), 5 mm. *Head* (fig. 267) salient, oval in cross-section (maximum head-width, 2.5 mm.), with sides slightly rounded and converging for posterior third; almost entirely uniformly sclerotised and chocolate-brown in colour; occipital foramen postero-ventral; antennal foramen closed behind; frontal sutures distinct for entire length; genae broadly rounded smooth, sparsely setose; numerous (at least twenty) epistomal setae present. One pair of ocelli present; lens large, oval brownish; pigmented spot indistinct. Labrum thick, strongly transverse, densely setose. Mandibles bidentate apically. Hypostoma slightly convex, smooth, chocolate brown and bearing a few fine setae; sutures strongly curved inward. Gular region denoted by a broad, pale area. Antenna minute, two-segmented; second segment very short, transversely dome-shaped and bearing a small tapering, hyaline process. Maxillary palpi three-segmented; third segment as long as second. Labial palpi with third segment slightly shorter than second. Mentum distinct from submentum. *Prothorax* with a large brown sclerotised plate (which is bisected by a pale, median cleavage line) on dorsum; lateral groove absent; presternum with a pair of large brown sclerotised plates; mesosternum and metasternum extremely protuberant. *Abdomen* with segments elongate and cylindrical, each dorsal ampulla with two transverse rows of glabrous, elongate tubercles which are broadly interrupted by a median furrow; ventral ampullae absent. Ninth segment swollen; densely setose, as wide and high as apex of eighth. Epipleurum protuberant on all segments; tubercle with sclerotised pits indiscernible and bearing several setae. Anus trilobed, and in centre of apical truncature of ninth. *Legs* absent. *Spiracles* round, with about thirty marginal chambers which occupy the entire inner margin of the peritreme (fig. 268).

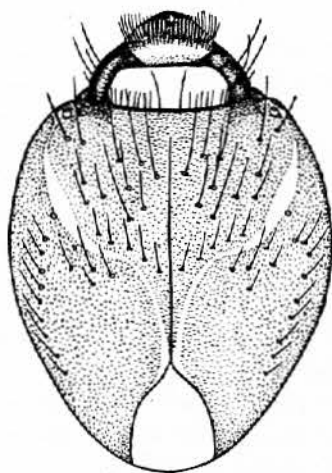
*First-instar larva*. A detailed account of the extreme modification and unusual

behaviour of the first-instar larva of this species has recently been published (Duffy, 1951).

*Pupa* (figs. 269-271). Length, 13-19 mm.; maximum breadth, 3.75 mm. *Head* with vertex entirely visible from above, deeply excavated and with two longitudinal rows of long setae between bases of antennae; front with two groups of similar setae immediately below bases of antennae, and a small group on each gena; clypeus with a transverse impression and about twelve setae across base. Antennae extending as far as first abdominal segment where they are strongly curved downward and directed anteriorly as far as vertex of head, where they are curled over dorsally to terminate near hind margin of head. Eyes feebly convex, glabrous. Mandibles with three fine setae near middle of outer face. Labrum bearing numerous long setae at base and a few shorter setae along front margin. *Pronotum* bearing numerous long, fine setae, especially along lateral margins. *Mesonotum* smooth and with a few fine setae; scutellum scarcely protuberant, glabrous. *Metanotum* smooth and with a few fine setae on each side of scutellar groove. Elytra and wings extending to fourth abdominal segment. *Abdomen* with tergites one to six with very strongly protuberant, bilobed ampullae, which each bear a transverse group of hook-like spines which are strongly curved in a posterior direction (fig. 270). Seventh tergite elongate, slightly tapering; bearing numerous straight spines, and with a conspicuous bifurcated tuberculate protuberance at middle of base (fig. 271). Eighth tergite short, transverse, with hind margin broadly rounded and bearing a row of short stout spines. Ninth tergite very short, and concealed beneath eighth; bearing a few shorter spines and setae. Sternites without ampullae but with scattered fine setae. Ninth sternite with a pair of strongly protuberant lobes, each bearing long, dense setae. Pleura scarcely protuberant, each with long fine seta. *Legs* with a few fine setae near apex of each femur; mid and hind femora each with a straight tuberculate process near base; hind femora extending to third abdominal segment; tibiae directed posteriorly. *Functional spiracles* present on first seven abdominal segments and a vestigial pair present on segment eight; peritreme broadly oval, thick, and very slightly raised above general level of cuticle.

Host plants: *Aconitum napellus*, *A. anthora*, *Heracleum sphondylium*, *Senecio aquaticus*, *Eupatorium cannabinum*, *Carduus nutans* (Perris, 1876, 1877); *Artemisia vulgaris* (Pierre, 1902); *Urtica dioica* (Guignon, 1912). In this country *Heracleum* and *Carduus* species are the preferred hosts.

*Biology*. Oviposition takes place in living healthy stems of various herbaceous plants. The eggs are inserted in the walls of the stem, usually near the extremity. The first-instar larva gnaws its way through into the pith channel, and starts to tunnel down towards the base of the stem, which it soon completely hollows, and sometimes it even penetrates the roots. The mature larva, which in form and coloration is not at all typical of Cerambycid larvae, is extremely active, and could easily be mistaken for a stem-feeding Lepidopterous larva. It is capable of moving both backward and forward in quick, jerky movements, and when exposed it will squirm and wriggle actively. The mature larva pupates in a simple cell comprising the inside of the hollowed dead stem (Pl. VI, fig. 26). At the base (i.e. beneath the pupa) there is a plug, often an inch or so in length, of rather loosely-packed fibrous shreds, and, higher up the



1 mm.  
Fig. 267



0.1 mm.  
Fig. 268



Fig. 270

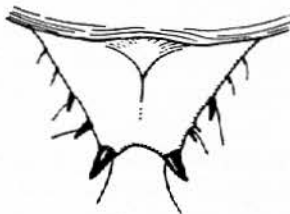


Fig. 271

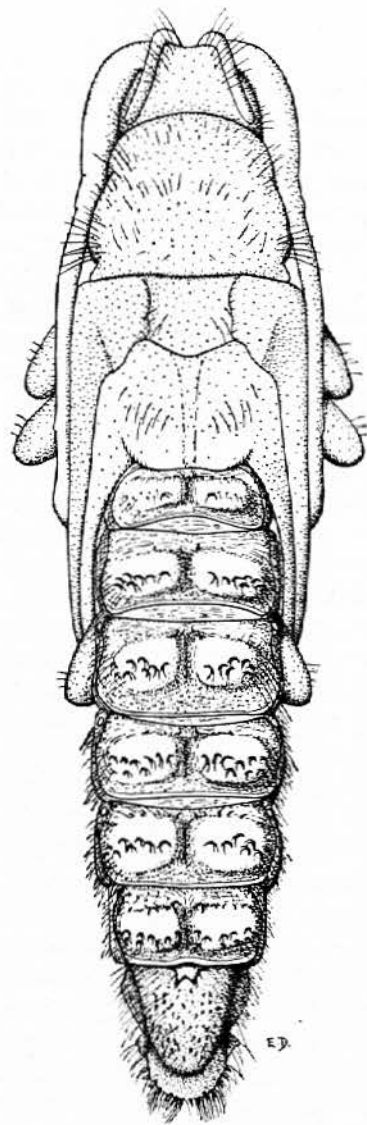


Fig. 269

- Fig. 267. *Agapanthia villosoviridescens* (Degeer). Mature larva. Head. Dorsal aspect.  
 Fig. 268. *Agapanthia villosoviridescens* (Degeer). Mature larva. Peritreme of abdominal spiracle.  
 Fig. 269. *Agapanthia villosoviridescens* (Degeer). Female pupa. Dorsal aspect.  
 Fig. 270. *Agapanthia villosoviridescens* (Degeer). Pupa. A typical group of the specialised spines of the tergites (greatly enlarged).  
 Fig. 271. *Agapanthia villosoviridescens* (Degeer). Pupa. Bifurcated protuberance of the seventh abdominal tergite (greatly enlarged).

stem (some two to six inches), there is often another very incomplete plug of shredded material. Pupation occurs in April and May. It is not uncommon to find two or even three pupae (each within its own partitions) in a single stem, especially if it be a large one. The pupa, like the larva, is exceedingly active, and is capable of ascending and descending its cell with speed (see also p. 19). Adults emerge in June and July. The life-cycle is usually completed in one year. It has since been observed that before oviposition, the female first gnaws a small cavity in the stem with its mandibles. It then turns round and forces its ovipositor into the cavity until it has punctured the inner wall of the stem. Usually two eggs only are deposited (one opposite the other); the posterior end of each egg is secured by a secretion to the inner wall of the stem. The incubation period varies from eighteen to twenty-three days.

*Material studied.* 8 L, Leicester, Barrowden, iii.1944, in dead stems of *Carduus*, D. Tozer leg., in coll. D. [Adults reared.]

*References.* Emden, 1939-1940 (L); Fairmaire, 1888 (Biol.); Girard, 1868 (Biol.); Goureau, 1868 (Biol.); Guignon, 1912 (Biol.); Henriksen, 1914 (L); Kaltenbach, 1874 (Biol.); Perris, 1876 (Biol.); 1877 (L, P, Biol.); Pierre, 1902 (Biol.); Reineck, 1919 (Biol.); Rouget, 1870 (Biol.); Tappes, 1870 (Biol.); Xambeu, 1898-1902 (L, Biol.).

### Saperdini

#### Larval Characters

Form elongate, cylindrical. *Head* depressed, with sides subparallel, and broadly rounded at base; antennal foramen closed behind. Clypeus with two to six pairs of lateral setae. Antennae two-segmented and bearing a tapering, hyaline process. Mentum setose and not distinct from submentum. Gula indiscernible, with one or more fine setae present on each side. Mandible slender, about twice as long as basal width, with cutting edge obliquely emarginate. *Prothorax* with pronotum oblique (except *Stenostola*) and anteriorly sclerotised; posteriorly covered with coarse asperities; sublateral impressions transverse, semicircular or subcircular, and pale; eusternum semicircular or trapezoidal, usually asperate, distinct. *Abdomen* with dorsal ampullae finely asperate (very coarsely in *Stenostola*), bearing two transverse furrows and a distinct longitudinal median furrow. Ninth segment simple. Epipleurum protuberant on all segments. Pleural tubercle oval, without sclerotised pits, but bearing several setae.

#### *Saperda carcharias* (Linnaeus)

*Mature larva* (figs. 272-275). Length up to 37.5 mm.; maximum breadth (at prothorax) 6 mm. *Head* depressed, with sides subparallel (maximum head-width, 3.5 mm.), slightly constricted before middle and broadly rounded at base; antennal foramen closed behind; mouthframe rather strongly and broadly sclerotised, with the transverse ferruginous band as broad as clypeus; frons with a transverse row of eight to ten setae; six epistomal setae present; genae strongly shouldered, sclerotised and pitchy. One pair of ocelli present; lens circular, strongly protuberant; pigmented spot indistinct. Clypeus with two or three pairs of lateral setae. Hypostoma slightly bulging, smooth, testaceous, with front and hind margins ferruginous; sutures ferruginous

and slightly curved. Gula indiscernible, with one or two setae present on each side of gular region. Antenna (fig. 272) two-segmented; second segment quadrate and bearing a tapering, hyaline process. Maxilla strongly sclerotised, with a three-segmented palp; third segment tapering, slightly longer than second; lobe very elongate,



Fig. 272

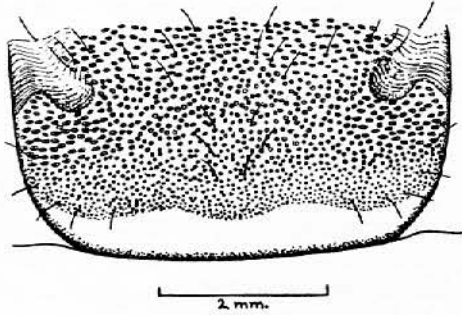


Fig. 273

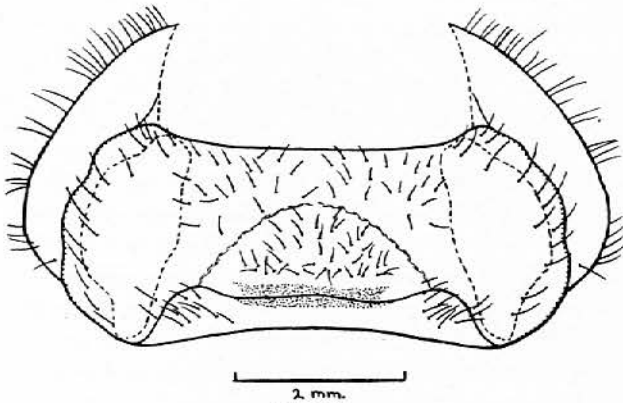


Fig. 274

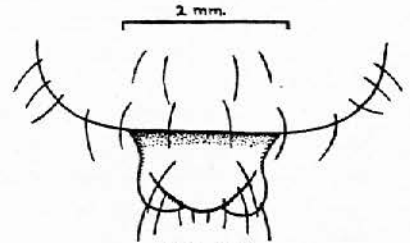


Fig. 275

Fig. 272. *Saperda carcharias* (Linnaeus). Mature larva. Apical part of antenna. Lateral aspect.

Fig. 273. *Saperda carcharias* (Linnaeus). Mature larva. Posterior part of pronotum.

Fig. 274. *Saperda carcharias* (Linnaeus). Mature larva. Prothorax. Ventral aspect.

Fig. 275. *Saperda carcharias* (Linnaeus). Mature larva. Posterior part of abdomen. Dorsal aspect.

nearly as long as palp; palpifer elongate, subparallel-sided. Labial palp with third segment cylindrical, about two-thirds length of second. Mentum setose, not distinct from submentum. *Prothorax* obliquely slanting and sclerotised anteriorly; posterior region of pronotum (fig. 273) covered with coarse individually distinguishable asperities of varying size;<sup>1</sup> sublateral impressions shallow. Presternum (fig. 274) not asperate but with scattered stout setae. Posterior margin of eusternum and anterior margin of sternellum with a transverse band of asperities. *Abdomen* with dorsal ampullae

<sup>1</sup> The largest asperities vary from one and one-half to more than twice as wide as long.

with two curved, transverse furrows, and a distinct narrow median furrow; each ampulla rather densely covered with short blunt asperities. Ninth segment simple. Epipleurum protuberant on all segments. Pleural tubercle oval, with several setae, but without sclerotised pits. Anus (fig. 275) strongly protuberant, trilobate. Legs absent. *Spiracles* with peritreme thick, pale and broadly oval.

*Pupa*. Similar to that of *S. populnea* from which it may be distinguished by the characters given in the key, p. 99.

*Egg*. Length, 3.5–4.1 mm.; breadth, 1.5–1.8 mm. Form elongate, oval in cross-section, with rounded ends. Chorion leathery, smooth, dull yellow ("overwintered" eggs are dark brown) (Ritchie, 1920).

Host plants: *Populus tremula*, *P. monilifera*, *P. ontariensis*, *P. nigra*, *P. dilatata* (Ritchie, 1920); Xambeu (1898–1902) mentions *Salix*, and Schabliovsky (1938) gives *Salix caprea* and *S. viminalis*. *Populus tremula* would appear to be the preferred host.

*Biology*. Oviposition takes place in the bark of boles or the larger branches of trees. Prior to oviposition, the female gnaws a vertical (occasionally oblique) incision, which is about 4.75 mm. long, in the bark. Each egg is covered with a sticky secretion which is spread by the ovipositor as it is forced out. Only one egg is placed in each incision, and it usually lies horizontally. The first-instar larva, having eaten part of the egg-shell, bores into the sapwood for a distance of about 1 in. It then tunnels downward deeper and deeper into the sapwood until eventually it reaches the heartwood and medullary canal. It then tunnels up the centre and later abruptly changes its direction, and starts to bore towards the surface of the sapwood. Here the exit hole for the adult is opened; this is later plugged with gnawed particles of wood. The larva then returns to the vertical part of the gallery, and continues to bore upward for a foot or more, by which time it is mature. Here the larva slightly enlarges the gallery to form the pupal cell, which it plugs behind it with fibres and then reverses its position (Pl. II, fig. 5). The pupal cell is about 1½ in. long. Pupation occurs in May or June, and the adults emerge in July or August. The life-cycle lasts about four years, a considerable part of this time being spent in the "overwintering egg stage". Ritchie (1920) has observed that eggs deposited in August hardly ever hatch until the following June—a period of about ten and a half months. He points out that the incubation period is normal (i.e. about four weeks), which infers that the first-instar larva remains inside the egg-shell for about nine and a half months before attempting to emerge. As this has been observed in the field as well as in the laboratory there is no reason to doubt the reliability of this apparently unique phenomenon in the biology of Cerambycids. There seems to be no conceivable explanation for such behaviour on the part of the larva, particularly as its food supply is available throughout the year.

The adults readily feed on the leaves of the larval host plant, especially at dusk. Bites are made usually well away from the edges of the leaves; these are enlarged into holes of various shapes, with serrated edges (fig. 276). Leaf-veins and leaf-stems are frequently damaged. After oviposition, females cease to feed.

*Parasites*. Hymenoptera: *Ischnoceros rusticus* Grav. (Xambeu, 1898–1902); *Ischnoceros filicornis* Kriechb., *Xylophrurus lancifer* Grav. (Thompson, 1943).

The fungus *Entomophthora grylli* has been recorded infesting larvae of this species (Anon., 1918).

*Economic importance.* This species is sometimes of considerable economic importance, since it is very injurious to healthy young poplars, especially those between five and twenty years old. Although *Populus tremula* is its preferred host, this species will readily attack other species of *Populus* which are of greater commercial value. Damage may be caused by adults in three ways: by perforating the leaves; by nibbling at basal

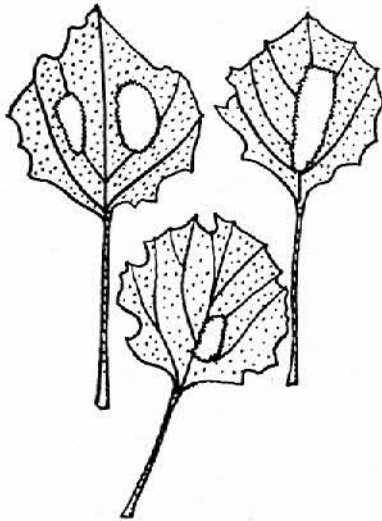


Fig. 276

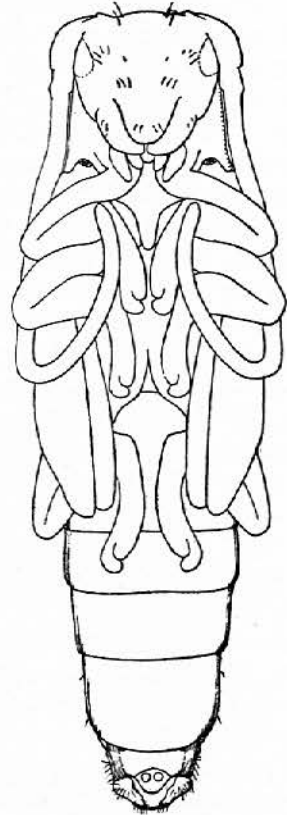


Fig. 277

Fig. 276. *Saperda carcharias* (Linnaeus). Leaves damaged by adults. (Ritchie, 1920)

Fig. 277. *Saperda populnea* (Linnaeus). Female pupa. Ventral aspect.

portions of stems; and by gnawing the bark prior to oviposition. Larval damage is, of course, considerably more serious, and often renders the commercial value of the timber worthless. According to Ritchie, attack is usually confined to young smooth-stemmed trees, and oviposition occurs not higher than one foot from the ground. The present writer however, has seen extensive damage by this insect to very old poplars of considerable girth which was most evident at a height of about 10 ft. above ground-level. The bark, moreover, was very rugged.

*Control.* Ritchie (1920) recommends the collecting of adults by hand at dusk, and the burning of infested trees before the end of June. As a preventive measure for isolated trees of ornamental value, he suggests ensheathing the lowermost portion

of the stem for a foot or two about ground-level, either with close-meshed netting or with a coating of repellent wash which may be prepared as follows. In six gallons of a saturated solution of washing soda dissolve one gallon of soft soap, and then add one pint of carbolic acid and mix thoroughly; then slake enough lime in four gallons of water so that when added, a thick whitewash results; to this add half a pound of paris green and mix thoroughly. Barbey (1913) recommends a more primitive but probably quite satisfactory measure—that of applying a coating of a mixture of cow dung and clay or glue!

*Material studied.* 2 L, Yarmouth, x.1930, from *Populus* in coll. B.M.; 1 P, London, vi.1950, from *Populus*, in coll. D. [Adults reared.]

*References.* Anonymous, 1918 (Paras.); Barbey, 1913 (L, P fig., Biol. fig., Contr.); Blanco-Fernandez, 1859 (Biol.); Boas, 1896 (Biol.), 1923 (L fig., Biol. fig.); Bofill y Pitxot, 1918 (Biol.); Bongini, 1920 (Biol., Contr.); Chrystal, 1937 (Biol.); Collinge, 1912 (L fig., Biol. fig.); Della Beffa, 1915 (L fig., Biol.); Emden, 1939-1940 (L); Fabre, 1891 (Biol.); Fridrichi, 1860 (Biol.); Ganglbauer, 1881 (Biol.); Goedart, 1662 (L); Goureau, 1867 (Biol.); Griffith, 1832 (Biol.); Henriksen, 1914 (L fig.); Hepp, 1928 (Biol.); Houlbert & Monnot, 1908 (L fig.); Judeich & Nitsche, 1889 (Biol.); Kaltenbach, 1874 (Biol.); Kemner, 1922 (L fig., Biol. fig.); Lunardoni, 1889 (L fig., Biol.); Perris, 1877 (Biol.); Ratzeburg, 1837 (Biol. fig.); Reineck, 1919 (Biol.); Ritchie, 1920 (E, L fig., P fig., Biol. fig., Contr.); Schabliovsky, 1938 (Biol.); Schiödte, 1876 (L fig., P); Sselistschenskaja, 1935 (Biol. fig.); Thompson, 1943 (Paras.); Trägårdh, 1939 (Biol. fig.); Xambeu, 1902 (L, P, Biol.).

### *Saperda populnea* (Linnaeus)

*Mature larva.* Extremely similar to that of *S. carcharias*, from which it differs as follows. Length up to 22 mm.; maximum breadth, 3 mm. *Prothorax* with the sub-lateral impressions of pronotum much deeper, particularly along their hind margins where they are very sharply defined. *Abdomen* with asperities of ampullae proportionately longer, and sharply pointed.

*Pupa* (fig. 277). Length, 10-15 mm.; maximum breadth, 3.75 mm. *Head* with vertex entirely visible from above; not excavated between antennae but bearing a single seta near base of each antenna; front with setae as figured; clypeus with six setae across base, but transverse impression very feeble. Antennae extending as far as second abdominal segment, where they are curved downward to terminate near hind coxae. Eyes feebly convex, glabrous. Mandibles each with one to four short setae near middle of outer face. Labrum almost semicircular and with two to six short setae. *Pronotum* with sides almost straight and parallel; bearing numerous scattered fine setae chiefly along front and lateral margins. *Mesonotum* smooth and with about four setae on each side of scutellum which is moderately protuberant. *Metanotum* smooth and with four to eight short setae on each side of scutellar groove which is usually transversely striate. Elytra and wings extending to fourth abdominal segment. *Abdomen* with tergites one to six each with a transverse row of very short spines near posterior margin. Seventh tergite elongate with sides slightly converging and with a row of smaller but similar spines across middle. Eighth tergite rather

short, transverse, sometimes bearing two or three small setae. Ninth tergum very short, transverse, and bearing a few fine setae. Sternites glabrous except ninth, which is bilobed, each lobe bearing several fine setae. Pleura scarcely protuberant, generally glabrous. *Legs* with femora glabrous at apex; hind femora extending to fifth abdominal segment; tibiae directed posteriorly. *Functional spiracles* present on first six abdominal segments; peritreme extremely narrowly oval, unusually thick and slightly raised above general level of cuticle.

*Egg.* Length, 2.8 mm.; breadth, 0.8 mm. Form strongly elongate, one end slightly tapering, the other broadly rounded. Chorion light brown, often with a pinkish tint, with dark brown reticulation. At first, apparently, it is white, but becomes discoloured and stained by the bruised stem.

*Host plants:* *Populus tremula*, *P. nigra*, *P. balsamifera*, *P. canadensis*, *P. canescens*, *P. heterophylla*, *P. alba*, *P. italica*, *P. ontariensis*, *Salix caprea* (Eggers, 1896); *Salix alba*, *S. fragilis* (Czech, 1878); *Salix viminalis* (Boas, 1900); *Populus trichocarpa* (Craighead, 1923b). *Populus tremula* appears to be the preferred host. The present writer has recently found saplings of *Betula* infested with larvae of this species.

*Biology.* The eggs are deposited in twigs and slender stems (usually between  $\frac{1}{4}$  and  $\frac{1}{2}$  in. in diameter) of young healthy bushes or saplings. Prior to oviposition the female makes a horseshoe-shaped abrasion on the bark, in the middle of which is a minute puncture which is just visible to the naked eye. Eggs are laid singly, and are inserted in the inner wall of the bark in a vertical position. The larva produces in the stem a conspicuous swelling or gall, which is a habit characteristic only of this species so far as the British Cerambycids are concerned. Very often both galls of *Saperda* and of the Clearwing moth *Aegeria flaviventris* Staud. are to be found on the same bushes, but those of the latter are smaller and less pronounced. Similar galls are sometimes made by the weevil *Cryptorrhynchus lapathi* L., but these are much larger and occur on thicker stems. The structure and development of these galls have been carefully worked out by Boas (1900, 1907). Each gall is outwardly surmounted by a dark-brown patch of partly decayed bark, and is packed internally with light orange frass. Sometimes several galls are to be found on the same stem and may be even less than an inch apart. The pupal cell, which is formed either immediately above or below the larval gall is short, slightly curved, and plugged at both ends with wooden fibres. Pupation takes place in April and May, the pupal period being about four weeks. Adults emerge in May and June. The life-cycle takes one year to be completed.

*Parasites.* Hymenoptera: *Atanycolus denigrator* L. (Escherich, 1923); *Iphiaulax impostor* Scop., *Bracon discoideus* Ratz., *B. multiarticulatus* Ratz., ? *Chelonus laevigator* Grav., *Entydon chalybaeus* Ratz., *Ephialtes manifestator* L., *E. messor* Grav., *E. populneus* Ratz., *E. tuberculatus* Fourc., *Proscus suspicax* Wesm., *Pteromalus aeneocornis* Ratz., *Torymus macrocentrus* Ratz. (Seyrig, 1924, Reineck, 1919); *Apanteles hoplites* Ratz.<sup>1</sup> (Pickard, 1922); *Idiolispa analis* Grav., *Hemiteles modestus* Grav., *H. melanarius* Grav., *Habrocytus tenuicornis* Först., *Glypta ephippigera* Kriechb., *Ephialtes luteipes* Thoms., *E. insignis* Hab., *E. heteropus* Thoms., *E. extensor* L., *E. abbreviatus* Thoms., *Echthrus populneus* Giraud., *E. nuberculatus* Grav., *Ascogaster rufidens* Wesm.,

<sup>1</sup> Apparently this is the only species of *Apanteles* known to parasitise Cerambycid larvae.

*Helcostizus brachycentrus* Grav., *Chelonus nigrinus* Ratz., *Cryptus viduatorius* F., *Dacnusa gedanensis* Ratz., *Diadromus subtilicornis* Grav., *Lycorina triangulifera* Hlgr., *Meteorus tabidus* Wesm., *Pachyneuron aeneicorne* Ratz., *Pimpla alternans* Grav., *P. capulifera* Kriechb., *Torymus quercinus* Boh., *Xylophrurus lancifer* Grav. (Thompson, 1943).

Diptera: *Billaea irrorata* Mg. (Austen, 1922); Emden (1950) regards the following as doubtfully parasitic on *Saperda populnea*: ? *Sarcophaga albiceps* Meig., ? *Dionaëa nitidula* Meig., ? *Digonochaeta setipennis*, ab. *spinipennis* Meig., *Pelatachina tibialis* Fln., ? *Masicera silvatica* Fln.

*Natural enemies.* Woodpeckers (*Gecinus* spp.).

*Material studied.* 1 P, Sweden, Rådeheyn, v.1894, Rosenberg leg., in coll. U.Z.M.C.; 8 L, Surrey, Mytchett, 18.xii.1943, in twigs of *Salix viminalis*, D leg., in coll. D.; 6 L, Surrey, Mytchett, 16.iii.1945, in galls on *Betula*, D leg., in coll. D.; 1 L, Surrey, Bookham, 18.i.1930, C. N. Hawkins leg., in coll. B.M. [Adults reared.]

*References.* Austen, 1922 (Paras.); Barbey, 1913 (Biol. fig.); Benich, 1904 (Biol.); Boas, 1900 (Biol. fig.), 1907 (Biol. fig.), 1923 (Biol. fig.); Bouché, 1834 (L fig., P fig.); Chrystal, 1937 (Biol.); Collinge, 1912 (Biol. fig.); Craighead, 1923b (L, P, Biol.); Czech, 1878 (Biol.); Della Beffa, 1915 (L fig., Biol.); Dimmock, 1884 (Biol.); Eggers, 1896 (Biol.); Eidmann, 1935 (Biol.); Emden, 1939-1940 (L fig.); Escherich, 1923 (Paras.); Fallou, 1873 (Biol.); Felt & Joutel, 1904 (Biol.); Goureau, 1867 (Biol.); Harrington, 1884 (Biol.); Henriksen, 1914 (L); Judeich & Nitsche, 1889 (Biol. fig.); Kaltenbach, 1874 (Biol.); Kemner, 1922 (L fig., P fig., Biol. fig.); Kieffer, 1892 (Biol.); Kleine, 1919 (Biol.); Landois, 1887 (Biol.); Lucas, 1846 (Biol.); Lunardoni, 1889 (L fig., Biol.); Nowicki, 1874 (Biol.); Packard, 1890 (Biol.); Perris, 1877 (Biol.); Pickard, 1922 (Paras.); Pissot, 1889 (L fig., Biol. fig.); Ratzeburg, 1837 (Biol.); Reineck, 1919 (Biol.); Rudow, 1912 (Biol.); Saunders, 1874 (L, P, Biol.); Schabliovsky, 1938 (Biol.); Scheidter, 1917 (Biol.); Schiödte, 1876 (L, P); Seyrig, 1924 (Paras.); Špaček, 1931 (Biol.); Thompson, 1943 (Paras.); Trägårdh, 1939 (Biol. fig.); Xambeu, 1898-1902 (L, P, Biol.).

### *Saperda scalaris* (Linnaeus)

*Mature larva.* Length up to 25 mm.; maximum breadth (at prothorax), 5 mm. *Head* with ocellus not protuberant, and very indistinct. Maxillary palpi with third segment, about as long as second; maxillary lobe less elongate, not extending beyond second palpal segment. *Prothorax* with asperities of pronotum almost uniform in size on anterior half of asperate area. Presternum very finely asperate, with numerous fine setae. Eusternum with posterior part not asperate. Asperities of sternellum extremely fine, not individually distinguishable with a  $\times 15$  lens. *Abdomen* with asperities of ampullae extremely fine and dense and not distinguishable with a  $\times 15$  lens.

*Pupa* (fig. 278). Extremely similar to that of *S. populnea*, from which it differs as follows. Length, 14-20 mm.; maximum breadth, 4.29 mm. *Head* bearing rather stout spines, each of which is tuberculate at base and equipped with a long basal seta. Antennae terminating just beyond fore coxae. *Pronotum* with numerous scattered stout spines which arise from pale tuberculate bases. *Meso-* and *metanotum* with similar but smaller spines. *Abdomen* with spines on tergites longer and stouter;

eighth and ninth tergites with stout ferruginous spines (each with a basal seta). *Legs* with hind femora extending to sixth abdominal segment.

*Egg*. Length, 3 mm.; breadth, 0.9 mm. Form very elongate, subcylindrical, one end more attenuated than the other. Chorion smooth, creamy white.

*Host plants*: *Prunus cerasus*, *Ulmus*, *Pyrus communis*, *Corylus* (Xambeu, 1902); *Quercus* (Taylor, 1869); *Alnus* (Chappell, 1869); *Fagus* (Masson, 1883); *Populus alba*

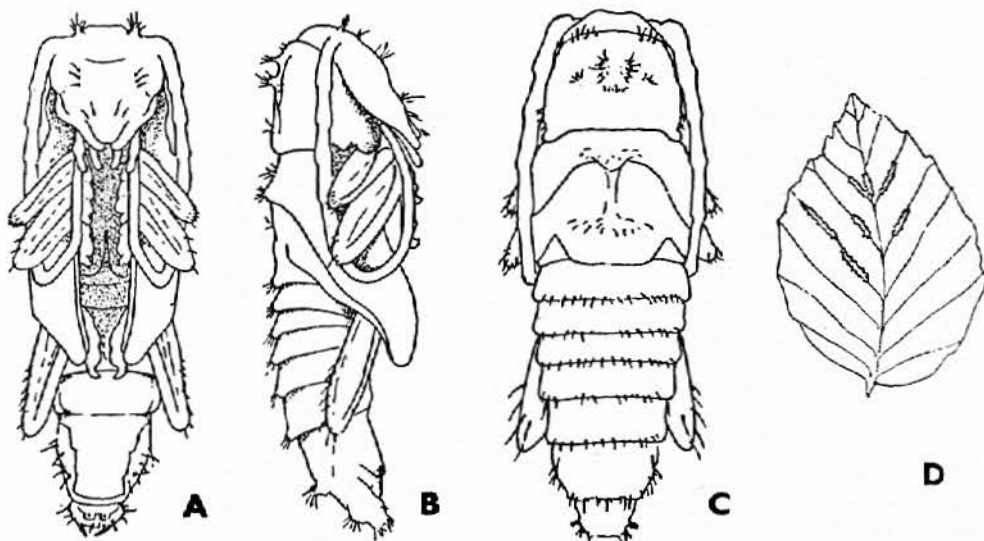


Fig. 278. *Saperda scalaris* (Linnaeus). Pupa (a) ventral aspect; (b) lateral aspect; (c) dorsal aspect; and (d) leaf showing characteristic nibbling of adults. (Fraser, 1950a)

(Rupertsberger, 1893); *Betula*, *Prunus cerasus*, *P. padus*, *Acer* (Houlbert & Monnot, 1908); *Pyrus aucuparia*, *Populus*, *Salix* (Kemner, 1922); *Sambucus nigra* (Emden, 1939); *Juglans*, *Prunus spinosa*, *P. padus*, *P. avium*, *Pyrus malus* (Reineck, 1919); *Ilex* (Peyerimhoff, 1919). Recently taken by M. G. Fraser and the writer in *Quercus*, *Castanea* and *Fagus* (Fraser, 1948f, 1950a, 1950b).

*Biology*. The following observations by M. G. Fraser and the writer have been extracted from recent papers (Fraser, 1948f, 1950a, 1950b): "Six male and five female beetles were kept in a large cage and supplied with foliage of beech, oak, elm, and apple, upon all of which they fed, showing a marked preference for beech. About three weeks after introduction to the cage, two pairs were observed "in cop". Thereafter, copulation was observed to take place on a number of occasions during the next seven days, and on all occasions took place during the late evening. Seven days after copulation was first noticed, a female was observed in the act of oviposition, this, also, occurring during the late evening, but before sundown. In spite of the fact that the bark of the small oak logs provided was damaged in several places, it was apparent that the insect ignored all ready-made crevices as sites for oviposition. After a somewhat protracted inspection of the bark, the beetle selects a suitable spot and attacks the bark with the mandibles, continuing to work until they are buried so deeply in the bark that the clypeus is in contact with it. She then turns and gropes

for the incisions with the ovipositor. The ovipositor is then plunged into the incision, and the attitude adopted by the insect at this stage is such that the body is at so abrupt an angle to the surface of the wood that the anterior legs are unable to reach it at all. For some three or four minutes the insect remains in this position, the only noticeable movement being the "oar-like" waving of the antennae, and a rhythmic backward and forward rocking of the body. The body is then raised to an even sharper angle to the surface of the wood, so that only the ovipositor and the posterior legs are in contact with it, and it is, apparently, at this stage that the egg is passed. The insect then turns and appears to examine the incision before moving off to repeat the process. One female was observed to lay six eggs within a space of some thirty minutes, all the ova being placed in one small log. It should be pointed out, however, that only a very small amount of wood was available to her at the time. Inspection of the log after oviposition revealed that, although the scar in the bark is visible to the naked eye, the egg is inserted so deeply as to be undetectable.

"It is apparent that the larval stage lasts for two years, for in the early spring two distinct generations of larvae may be found, one fully fed and about to pupate, and the other apparently half-grown. In the laboratory, larvae have continued to feed for at least part of a third year, but this may well have been due to the excessive dryness of the wood in which they were feeding, for all the larvae that did so were kept in the same piece of oak. No larvae were found in living wood, though both living wood and dead wood upon standing trees were assiduously, though fruitlessly, searched. The dead wood in which larvae were found varied considerably in dryness, hardness and state of decay, though it was noticeable that, in April, 1949, prepupal larvae and pupae were found in the greatest numbers in the wood of fence-posts which were known to have been *in situ* for exactly three years.

"The larva feeds subcortically for almost the whole of the larval existence. The frass is typically fibrous and dry, and the gallery mainly straight and without ramifications. The species apparently suffers very considerably from the depredations of birds, for it was soon discovered that the surest indication of the presence of larvae was the damage done to the bark by the birds in their efforts to get at the larvae underneath. In many cases they were found in wood that was infested by other species of Cerambycidae, most of the posts in the area being heavily infested with *Leiopus nebulosus* L., and *Clytus arietis* L. In two cases larvae were found in chestnut posts that also contained larvae of *Rhagium bifasciatum* F., and in a single case a pupa was taken from an oak post in which there were both adults and larvae of *Rhagium mordax* Deg. It was further apparent that these species suffered much less heavily from the attacks of the birds.

"The larva is full grown by the autumn of the second year, at which time it normally burrows into the sapwood to a depth of about  $\frac{1}{8}$  in. and prepares a pupal chamber about 1 in. distant from the point at which it entered the wood, the entry hole being packed with loose dry shavings. . . . Occasionally the larva will pupate in the bark, where it is of sufficient thickness, and, rather more rarely, it will pupate in what is no more than a widening of the larval gallery.

"Although the adults do move to a certain extent during the night, they are markedly diurnal in habit, and are most active when exposed to strong sunshine.

They feed freely, gnawing ragged holes along the ribs of leaves (fig. 278). A marked preference was shown for beech leaves, but this may have been due to the fact that the only oak leaves available in the vicinity of the laboratory were very small and undeveloped whereas the beech was well advanced. There was no evidence that the beetles are attracted to artificial light."

*Parasites.* Hymenoptera: *Meteorus tabidus* Wesm. (Xambeu, 1898-1902).

*Material studied.* 8 L, 2 P, 3.iv.1948, in logs of *Quercus*, M.G.F. & D leg., in coll. D. [Adults reared.]

*References.* Chappell, 1869 (Biol.); Emden, 1939-1940 (L); Fabre, 1891 (Biol.); Fallou, 1883 (E, Biol.), 1887 (Biol.); Fraser, 1948f (Biol.), 1950a (Biol.), 1950b (P fig., Biol. fig.); Goureau, 1844 (L fig., P fig., Biol.); Henriksen, 1914 (L); Houlbert & Monnot, 1908 (L fig., Biol.); Kaltenbach, 1874 (Biol.); Kemner, 1922 (L, P, Biol. fig.); Lesne, 1893 (Biol.); Masson, 1883 (Biol.); Nördlinger, 1855 (Biol.); Perris, 1877 (L, P, Biol.); Peyerimhoff, 1919 (Biol.); Rudow, 1912 (Biol.); Rupertsberger, 1893 (E, Biol.); Stark, 1926a (L fig., P fig., Biol. fig.), 1926b (Biol.); Taylor, 1869 (Biol.); Trägårdh, 1939 (Biol. fig.); Xambeu, 1898-1902 (E, L, P, Biol.).

#### \**Saperda discoidea* Fabricius

[Occasionally in imported timber from North America.]

*Mature larva* (fig. 279). Similar to that of *S. carcharias*, from which it differs as follows. Length up to 22 mm.; maximum breadth (at prothorax), 5 mm. *Head* with ocellar lens flat. *Prothorax* (fig. 279) with presternum with numerous long fine setae; eusternum and sternellum with numerous coarse asperities scattered across entire breadth in a broad band.

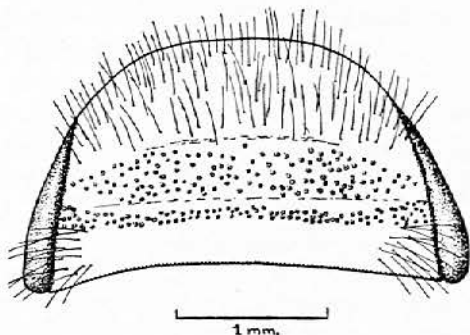


Fig. 279. *Saperda discoidea* Fabricius. Mature larva. Presternum, eusternum and sternellum.

*Host plants:* *Hicoria*, *Juglans* (Hamilton, 1885); *Caryocar*, *Ulmus* (Blackman & Stage, 1924).

*Biology.* Oviposition occurs on dying or recently dead trees, especially those already killed by *Scolytus quadrispinosus* Say. Larvae feed subcortically, partly

on the bark and partly on the sapwood. Pupation takes place either in the bark or in the sapwood. Adults emerge in June and July (Felt & Joutel, 1904). The life-cycle is usually one year.

*Parasites.* Hymenoptera: *Xorides albopictus* Cress., *Deuteroxorides caryae* Harrington, and probably *Atanycolus simplex* Cress. and *Capitonius erythrogaster* Rohw. (Blackman & Stage, 1924).

*Material studied.* 2 L, in imported logs of *Hicoria*, in coll. F.P.R.L.

*References.* Blackman & Stage, 1924 (Biol.); Craighead, 1923b (L, P, Biol. fig.), 1950 (Biol.); Felt, 1907 (Biol.); Felt & Joutel, 1904 (Biol. fig.); Hamilton, 1885 (Biol.).

**\*Saperda calcarata** Say

[Occasionally in imported timber from North America.]

*Mature larva.* No material available. Craighead (1923b) gives the following description: "Large, robust; integument finely rugulose, clothed with coarse castaneous hairs; labrum semicircular, widest at base, densely and coarsely haired; pronotum slightly wider than long, asperities very coarse, extending over three-fourths of length; eusternum coarsely haired, bearing a few fine (about twenty) asperities; sternellum having a very narrow band entirely across. Ampullae coarsely asperate; pleural tubercle bearing two strong setae and fine pubescence. Spiracles oval, peritreme strongly chitinised."

From *S. discoidea* it may be distinguished by the proeusternum and sternellum which bear far fewer asperities.

Host plant: *Populus* (Craighead, 1923b).

*Biology.* Craighead (1923b) gives the following account: "The eggs are laid in June and July on the trunks or larger branches of trees. They are inserted into the cambium in an irregular hole gnawed through the bark. For the first season the young larvae extend transverse galleries between the bark and wood which often entirely cut the cambium, killing the tree. During the second and third seasons large extensive mines are made in the heartwood, where pupation takes place. The trees are so honeycombed that great numbers of them break off in the wind. A knotty swelling is often caused at the point where the young larvae are feeding. Piles of frass several inches deep are noticed below infested trees."

*Economic importance.* Many poplar plantations have been totally ruined by this insect. According to Hofer (1920) living, healthy, or injured trees of from two inches in diameter are attacked, while dead trees are avoided. One of the chief causes of death to the tree is a fungus (*Formes ignarius*) which spreads along the larval galleries and destroys the heartwood. The larvae seldom mature unless they are almost full-grown before the timber is felled.

*Control.* Hofer (1920) recommends the felling of all "brood trees" (i.e. trees infested with two or more generations of larvae), and the application of creosote or carbolineum to egg scars soon after the eggs have hatched.

*References.* Craighead, 1923b (E fig., L fig., P fig., Biol. fig.), 1950 (Biol.); Dury, 1893 (Biol.); Felt & Joutel, 1904 (L fig., P fig., Biol. fig.); Gee, 1912 (Biol.); Hardy & Preece, 1927 (Biol.); Hofer, 1920 (E fig., L fig., P fig., Biol. fig.); Packard, 1881 (Biol.); Riley, 1880 (Biol.); Walsh, 1866 (Biol.).

**Stenostola ferrea** (Schrank)

*Mature larva* (fig. 280). As the following characters show, this larva conforms more closely to the characteristics of the Saperdini rather than to those of the Phytoeciini (in which it has been placed on adult characters). *Head* depressed, with sides subparallel and broadly rounded at base. Gular region with one or two setae on each side. Clypeus setose. Mentum not distinct from submentum. *Prothorax* with sublateral impression semicircular and pale. *Abdomen* (fig. 280) with ampullae coarsely

asperate, and with two transverse furrows. Pleural tubercle with several setae. *Spiracles* with peritreme broadly oval.

It may be distinguished from larvae of *Saperda* spp. as follows. *Head* with pigmented spot of ocellus very distinct. *Prothorax* with pronotum horizontal. Posterior part of eusternum not asperate. *Abdomen* with each dorsal ampulla (fig. 280) with a transverse row of widely separated asperities on each side of each of the two transverse furrows (i.e. four distinct rows in all, although occasionally there may be one or two additional incomplete rows present); each asperity pointed and spine-like.

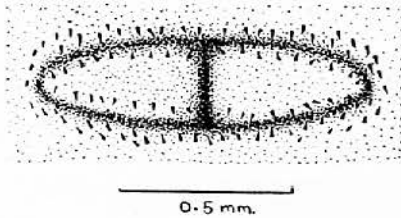


Fig. 280. *Stenostola ferrea* (Schrank). Mature larva. Fourth dorsal abdominal ampulla.

to pupae of *Saperda* spp., but may be separated from them by the characters given in the key, p. 99.

*Host plants*: *Tilia*, *Salix*, *Populus tremula* (Reineck, 1919); *Salix caprea* (Xambeu, 1898–1902). *Tilia* is undoubtedly its preferred host.

*Biology*. Eggs are laid in recently dead or freshly cut branches, especially those not more than one inch in diameter. It has been the writer's experience that recently cut, slightly decaying branches lying on moist ground are most prone to attack. The larva feeds subcortically until about half-grown and then starts to tunnel into the sapwood, and eventually, if the branch is slender, along the pith channel where pupation usually takes place in a slightly curved cell (Pl. VI, fig. 30) in April or May. Adults emerge in May or June. They readily feed on the leaves of *Tilia*, often causing extensive damage. The perforations made in the leaf are similar to those made by *Saperda carcharias*.

*Material studied*. 19 L, Worcester, vi.1948, from *Tilia*, D leg., in coll. D.; 4 L, Worcester, 1947, from *Tilia*, G. H. Ashe leg., in coll. D. [Adults reared.]

*References*. Emden, 1939–1940 (L); Kemner, 1922 (L fig., Biol. fig.); Kleine, 1930 (Biol. fig.); Reineck, 1919 (Biol.); Schiödte, 1876 (L fig.); Xambeu, 1898–1902 (L, Biol.), 1899 (Biol.).

### Phytoeciini

#### Larval Characters

*Head* thick, widest across posterior limit of frons, with sides strongly converging posteriorly rather as in *Agapanthia*. One pair of ocelli present; one, two, or three pairs of vestigial ocelli sometimes present. Clypeus glabrous. Hypostoma with a transverse row of setae. Gula indiscernible. Antenna two-segmented. Mentum distinct from submentum. *Prothorax* with posterior part of pronotum coarsely asperate; sublateral impressions linear, straight, long and brownish. *Abdomen* with each dorsal ampulla with a single transverse furrow. Pleural tubercle with two stout setae but no sclerotised pits. *Spiracles* with peritreme thick and very narrowly oval.

***Phytoecia cylindrica* (Linnaeus)**

*Mature larva* (fig. 281). Form elongate, slender, cylindrical. Length up to 20 mm.; maximum breadth (at prothorax), 2 mm. *Head* thick, subovate in cross-section, widest across posterior limit of frons, with sides strongly converging posteriorly; antennal foramen closed behind; mouthframe rather feebly sclerotised; frons with a transverse row of eight (?) setae; six epistomal setae present. One pair of ocelli present; lens small, slightly protuberant; pigmented spot rather indistinct. Mandible short, less than twice as long as basal width. Clypeus glabrous. Hypostoma smooth, testaceous, with a transverse row of setae; sutures slightly curved, ferruginous. Gula indiscernible. Labrum transversely oval. Antenna two-segmented; second segment bearing a slender, strongly tapering, hyaline process. Maxilla (fig. 281) with a three-segmented palp; third segment slightly longer than second; lobe short and stout. Labial palp with third segment conical, slightly longer than second. Mentum setose, distinct from submentum. *Prothorax* obliquely slanting, with sides diverging posteriorly; anterior part of pronotum with scattered fine setae; posterior half with asperities which increase in size towards base; sublateral impression linear, straight, long, and brownish. Presternum setose; eusternum distinct, setose. *Abdomen* sparsely setose; each dorsal ampulla very strongly protuberant, bilobed (as in *Obrium*), with a single deep, transverse furrow, glabrous, non-tuberculate and microscopically reticulate. Ninth segment simple, sparsely setose. Tenth segment stout, protuberant, trilobate, setose. Epipleurum protuberant on all segments. Pleural tubercle with two setae but no sclerotised pits. *Legs* absent. *Spiracles* with peritreme thick and very narrowly oval.

*First-instar larva*. Length up to 2 mm.; maximum breadth, 0.6 mm. Egg-bursting spines minute; form rather as in *Rhagium bifasciatum*.

*Pupa* (fig. 282). Length, 8–11 mm.; maximum breadth, 2.25 mm. *Head* entirely visible from above, feebly excavated, and with three to four fine setae opposite base of each antenna; front with three to four setae near mesal margin of each eye; clypeus with a transverse impression and about six setae across base. Antennae extending as far as first abdominal segment where they are strongly curved downward to terminate alongside maxillary palpi. Eyes moderately convex, glabrous. Mandibles with two short setae near middle of outer face. Labrum triangular, glabrous. *Pronotum* bearing several scattered fine setae, especially along front and lateral margins. *Mesonotum* smooth and usually bearing two to four setae; scutellum scarcely protuberant, glabrous. *Metanotum* smooth, and with two to three fine setae on each side of scutellar groove, which is narrow and very distinct. Elytra and wings extending to fourth abdominal segment. *Abdomen* with tergites one to seven with strongly

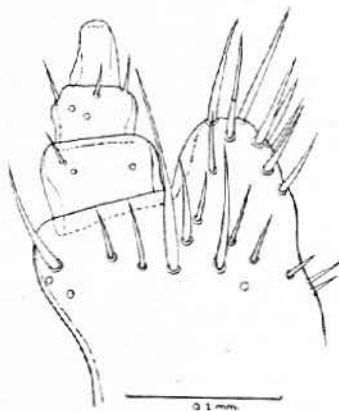


Fig. 281. *Phytoecia cylindrica* (Linnaeus). Mature larva. Apical part of maxilla. Ventral view.

protuberant bilobed ampullae, which bear several short straight spines (each arising from a papillate base), some of which are inclined anteriorly. Seventh tergite elongate. Eighth tergite rather short, transverse and with a row of similar spines near base. Ninth tergite very short, the posterior margin bearing several similar but slightly stouter spines. Sternites four to seven with ampullae, each bearing a minute seta. Pleura moderately protuberant on segments five to eight and each with two or three short spines. *Legs* with hind femora extending to fourth abdominal segment; tibiae directed posteriorly. *Functional spiracles* present on first seven abdominal segments, and a vestigial pair present on segment eight; peritreme rather narrowly oval, moderately thick, surrounded by a tubercular rim, and raised above general level of cuticle.

*Egg.* Length, 2 mm.; breadth, 0.5 mm. Form strongly elongate, cylindrical, one pole being much more attenuated than the other. Chorion orange-yellow, dull, very feebly shagreened, but not reticulated.

*Host plants:* Umbelliferae, including *Daucus carota* (Scopoli, 1786); *Chaerophyllum temulum*, *Heracleum sphondylium*, *Anthriscus silvestris* (Bedel, 1889); Westwood's records from *Corylus* and *Prunus* are obviously erroneous. The writer has reared adults from eggs laid in *Daucus carota*.

*Biology.* The eggs are laid singly in living although often stunted Umbelliferae, and are usually inserted in a horizontal position right in the walls of the stem just below the flower-head. This causes a slight brownish discoloration by which the presence of the egg may be detected. The first-instar larva gnaws its way through to the pith channel, and then starts to tunnel down towards the base of the stem, which it completely hollows as it proceeds (if a stem be held against the light, the larva is plainly visible). This soon kills the stem, which becomes dry and brown, but the larva continues to feed on the inner walls until mature. The pupal cell is simple, comprising the inside of the hollowed stem; at the base there is usually a basket-shaped plug of neatly interlaced, fibrous shreds, a few inches above which there is sometimes another plug of loosely-packed fibres. Generally, not more than one pupa is to be found in a single stem. The pupa, like the larva, is very active, and is capable of ascending and descending its cell, although not so speedily as does the pupa of *Agapanthia*. Pupation takes place in July or August. Adults eclose in the autumn, but remain in their cells until the following May or June. The life-cycle is completed in one year, although the larval period itself does not exceed three months.

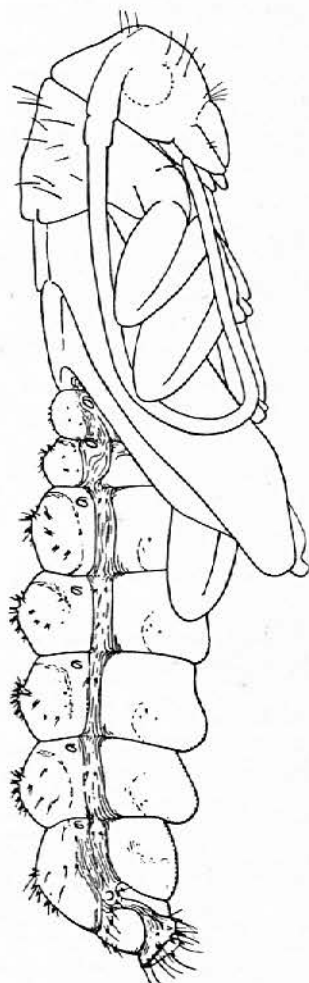


Fig. 282.  
*Phytoecia cylindrica* (Linnaeus).  
Female pupa. Lateral aspect.

*Economic importance.* There have been occasional reports of this species severely damaging seed carrots (Kemner, 1918).

*Material studied.* 3 L, 2 P, reared *ab ovo* from adults taken at Middlesex, Northwood, 15.vi.1947, on *Daucus carota*, D leg., in coll. D.

*References.* Bedel, 1889 (Biol.); Duffy, 1945 (Biol.), 1946c (Biol.); Emden, 1939 (L); Fiori, 1947 (L fig., Biol. fig.); Kaltenbach, 1874 (Biol.); Kemner, 1918a (Biol. fig.), 1922 (L fig., P fig., Biol. fig.); Scopoli, 1786 (Biol.); Westwood, 1839 (Biol.); Xamheu, 1898-1902 (Biol.).

### *Oberea oculata* (Linnaeus)

*Mature larva* (figs. 283-285). No larvae of this species are available, but the characters should be essentially the same as those of the North American *O. ruficollis* F., which differs from *Phytoecia cylindrica* as follows. Length up to 27 mm.; maximum breadth (at prothorax), 4.5 mm. *Head* (fig. 283) with at least two pairs of vestigial ocelli present.<sup>1</sup> *Prothorax* with asperities of pronotum decreasing in size towards base (fig. 284). *Abdomen* with each ampulla finely asperate, moderately protuberant (not bilobed), and with the transverse furrow distinctly callose. Pleural tubercle and spiracle as in fig. 285.

*Pupa* (fig. 286). No pupae of this species are available but that of the North American *O. ocellata* Hald., here described, should be essentially similar. Length, 9.5-12 mm.; maximum breadth, 3.5 mm. *Head* with vertex entirely visible from above, and with three to six setae near base of each antenna; front with a few fine scattered setae, and base of clypeus with a row of about six setae. Antennae extending as far as first abdominal segment, where they are strongly recurved to terminate near apex of each front tibia. Eyes convex, glabrous. Mandibles with two stout setae near middle of outer face. Labrum triangular, smooth, glabrous. *Pronotum* with disc bearing a group of very fine ferruginous setae and sides with a few similar setae near middle. *Mesonotum* and *metanotum* with two groups of fine setae; scutellar groove rather narrow and transversely striate. Elytra and wings extending to fourth abdominal segment. *Abdomen* with tergites one to seven each bearing a transverse group of short spines. Seventh tergite strongly elongate and with scattered spines. Eighth tergite short, with a row of setae across middle. Ninth tergite extremely short, scarcely visible from above and with numerous long setae. Sternites glabrous. Pleura scarcely protuberant; each with a pair of short spines. *Legs* with hind femora extending to third abdominal segment; tibiae directed posteriorly. *Functional spiracles* present on first six abdominal segments; peritreme very narrowly oval, moderately thick and surrounded by a tuberculate rim and raised above general level of cuticle.

*Egg.* Length, 4 mm.; breadth, 0.8 mm. Form elongate, fusiform, with rounded poles. Chorion yellowish white and finely shagreened (Xamheu, 1904).

*Host plants:* *Salix* spp. Xamheu (1904) gives *Salix babylonica*.

*Biology.* Eggs are deposited on the smooth bark of twigs and very slender stems of living healthy bushes. The young larva usually bores into the pith channel in

<sup>1</sup> Larvae of this genus, besides having the usual ocellus outward and ventrad of the antenna, have from one to three vestigial ocelli behind it; each consists of a greyish pigmented spot without a distinct lens.

which it excavates a straight longitudinal gallery which is sometimes more than 30 cm. long. If the stem is more than a few centimetres in diameter the gallery is excavated in the sapwood. The larva is very active, and moves quite rapidly by using the protuberant asperate ampullae. From time to time the frass is ejected through one or more perforations in the bark. Accumulations of ejected frass, which often cling to the twigs, are the only external indication that the larva is present. Pupation occurs near the surface of the stem in June and July. The pupal cell is constructed

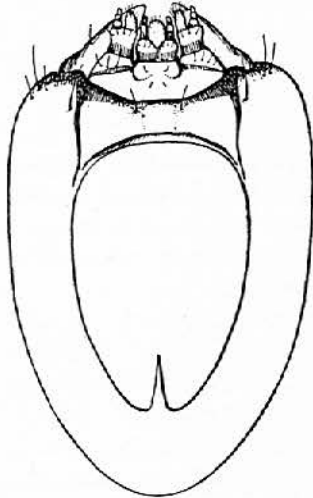


Fig. 283

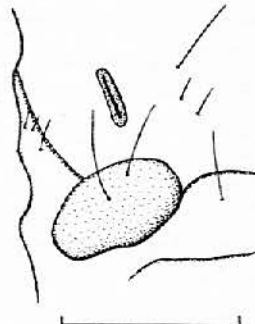
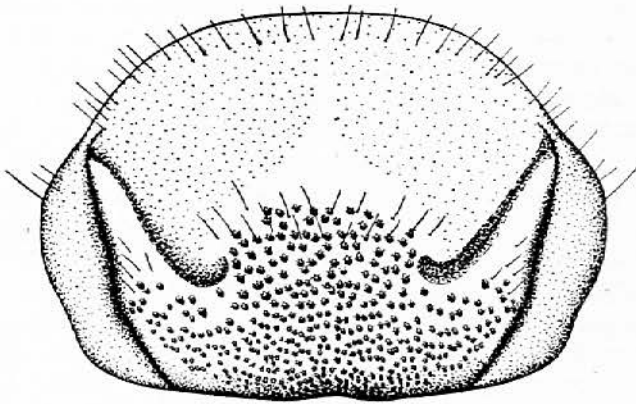
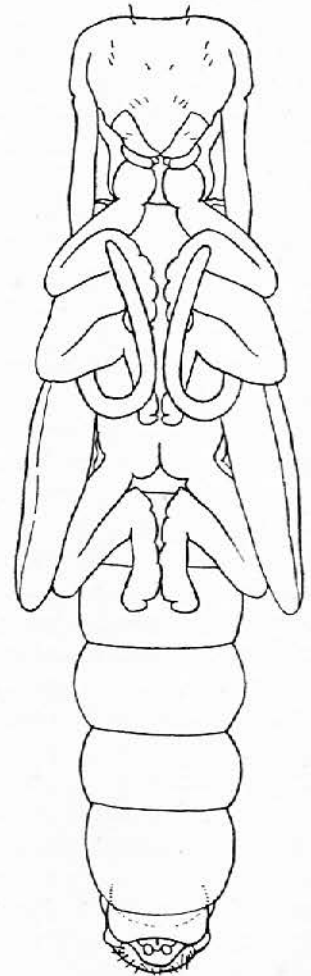
1 mm.  
Fig. 2852 mm.  
Fig. 284

Fig. 286

Fig. 283. *Oberea ruficollis* Fabricius. Mature larva. Head. Ventral view. (Craighead, 1923b)

Fig. 284. *Oberea ruficollis* Fabricius. Mature larva. Prothorax. Dorsal aspect.

Fig. 285. *Oberea ruficollis* Fabricius. Mature larva. Spiracle and pleural tubercle of first abdominal segment.

Fig. 286. *Oberea ocellata* Haldeman. Female pupa. Ventral aspect.

by plugging off a section of the gallery with two wads of fibrous frass. Adults emerge in July and August.

*Parasites.* Hymenoptera: *Ephialtes manifestator* L., *E. varius* Hgr., *E. terebrans* Ratz., *Pimpla examinatrix* F., *P. instigator* F., *Pseudovipio guttiventris* Thms. (Rudow, 1912).

*Material studied.* 2 P (*O. ocellata* Hald.), U.S.A., Elk City, Oklahoma, 2.v.1940, N. D. Wygant leg., in coll. U.S.N.M.; 1 L (*O. ruficollis*), U.S.A., in coll. U.S.N.M.

*References.* Barbey, 1913 (Biol. fig.); Della Beffa, 1915 (Biol.); Escherich, 1923 (Biol. fig.); Judeich & Nitsche, 1889 (L); Kaltenbach, 1877 (Biol.); Lunardoni, 1889 (L, Biol.); Mokrzecki, 1900 (Biol. fig.); Nördlinger, 1880 (Biol.); Perris, 1877 (L fig., P, Biol.); Ratzeburg, 1854 (Biol.); Reineck, 1919 (Biol.); Rudow, 1912 (Biol.); Xambeu, 1898-1902 (L, P, Biol.), 1904 (E, Biol.).

### *Stenostola ferrea* (Schrank)

See Saperdini, p. 291.

## Tetraopini

### *Tetrops praeusta* (Linnaeus)<sup>1</sup>

*Mature larva* (figs. 287, 288). Form elongate, slender, cylindrical. Length up to 7 mm.; maximum breadth (at prothorax), 1.5 mm. *Head* rather thick but slightly depressed, widest across posterior limit of frons (maximum head-width, 1.1 mm.), with

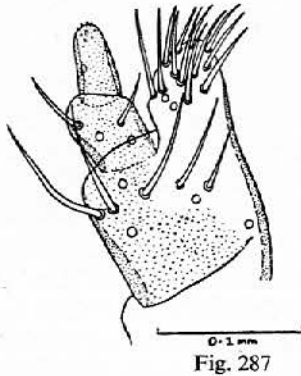


Fig. 287

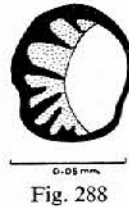


Fig. 288

Fig. 287. *Tetrops praeusta* (Linnaeus). Mature larva. Apical part of right maxilla. Ventral aspect.

Fig. 288. *Tetrops praeusta* (Linnaeus). Mature larva. Peritreme of abdominal spiracle.

sides slightly constricted at middle and narrowing posteriorly; antennal foramen closed (or very narrowly open?) behind; mouthframe feebly sclerotised, testaceous and bearing a few long setae. One pair of ocelli present; lens round, protuberant; pigmented spot very distinct. Clypeus glabrous. Hypostoma feebly transversely rugose, testaceous; sutures slightly darker, curved. Gula indiscernible. Labrum transversely semi-circular. Antenna two-segmented; second segment bearing a digitiform, hyaline

<sup>1</sup> The larval characters which Kemner (1922) attributes to this species actually apply to *Pogonocherus hispidus* L. The true larva of *T. praeusta* apparently has not been adequately described before.

process. Maxilla (fig. 287) feebly sclerotised, with a two-segmented palp; second segment elongate, as long as first; lobe rather short and stout. Labial palp with third segment cylindrical, much longer than second. Mentum setose, distinct from submentum. *Prothorax* obliquely slanting, with sides straight and diverging posteriorly; anterior part of pronotum rather densely setose; posterior area glabrous and faintly rugose; sublateral impressions and asperities absent. Metanotum tuberculate; presternum setose; eusternum setose, distinct, protuberant. *Abdomen* rather densely setose and distinctly pale yellowish green. Each dorsal ampulla with two transverse rows of regular glabrous tubercles. Segments four to seven with postero-dorsal and dorso-lateral regions with scattered irregular spicules. Ninth segment simple but rather densely setose. Anus trilobate, strongly protuberant and setose. Epipleurum slightly protuberant on all segments. Pleural tubercle with numerous setae but no sclerotised pits. *Legs* absent. *Spiracles* with peritreme thick, ferruginous, very broadly oval; inner margin produced into several digitiform processes which are inclined upward to support (?) a crescentic membrane (fig. 288).

Host plants: *Fraxinus*, *Pyrus malus*, *P. communis*, *Prunus domestica*, *P. spinosa*, *Rosa*, *Tilia* (Reineck, 1919); *Prunus persica*, *P. Armeniaca*, *Quercus*, *Ulmus*, *Crataegus* (Noel, 1909b). These hosts may not necessarily be reliable owing to past confusion over the larval characters. The writer has found *Pyrus malus* to be the preferred host.

*Biology*. Oviposition occurs on slightly decaying or recently dead twigs and slender branches. The larval habits are extremely similar to those of *Pogonocherus hispidus* L. Both species are frequently found together, which no doubt explains the erroneous descriptions in past literature. Pupation takes place in March, and adults emerge during April.

*Parasites*. Hymenoptera: *Elachistus leucogramma* Ratz., *Eurytoma eccoptogastris* Ratz., *E. ischioxanthos* Ratz., *Pteromalus bimaculatus* Ratz., *P. nodulosus* Ratz. (Reineck, 1919); *Caenocoelius analis* Nees (Thompson, 1943). These may not necessarily be reliable owing to past confusion over the larval hosts.

*Material studied*. 5 L, Surrey, Ashted, iv.1948, in twigs of *Pyrus malus*, D leg., in coll. D. [Adults reared.]

*References*. Della Beffa, 1915 (Biol.); Henriksen, 1914 (L fig.); Kemner, 1922 (P fig., Biol.); Mulsant, 1863 (Biol.); Noel, 1909b (L, P, Biol.); Perris, 1877 (L fig., P, Biol.); Polak, 1878 (Biol.); Reineck, 1919 (Biol.); Rudow, 1912 (Biol.); Thompson, 1943 (Paras.); Xamheu, 1902 (L, P, Biol.).

\**Chreonoma* sp.

[Occasionally in imported orchids from Burma and China.]

*Mature larva* (fig. 289). Gardner (1931) gives the following description: "Slender, slightly widest at the prothorax, tapering weakly posteriorly. Setae rather long. Length about 28 mm. *Head* depressed, flattened above, about twice as wide as thick, widest before the slightly constricted middle, narrower posteriorly. Frontal suture entering antennal ring. Gula not defined. Ocelli one on each side. Labrum with basal third testaceous, more or less corneous; anteriorly with numerous setae, some of which are long. Maxillary palpi three-jointed; mala with numerous long setae.

Labial palpi short, not projecting beyond ligula and widely separated; ligula very wide (about two-thirds as wide as labrum) and with numerous long setae towards the apex. *Prothorax* with testaceous plates anteriorly. Posterior zone of pronotum closely covered with fine asperities, with three fine subdistinct glabrous lines on each side; lateral to this zone and separated from it by a groove is a narrow asperate line. Eusternum and sternellum with a small asperate patch on each side. Abdominal ampullae with distinct, smooth tubercles arranged for the most part in two transverse lines. Pleural tubercles without distinct chitinous pits. Anal lobe with three clefts. *Spiracles* very small, sub-circular, that of thorax not much larger than the others."

In a later paper (1944) Gardner draws attention to the curious spiracles characteristic of larvae of this genus. Each spiracle has extending from the inner margin to well beyond the outer margin of the peritreme a pair of conspicuous, contiguous tubular structures. The spiracle of *C. dioica* Fairmaire is shown in fig. 289.

Host plants: Orchids; *Nauclea excelsa* (Gardner, 1931).

*Biology.* No references available. The writer has recently seen leaves of an orchid damaged by adults belonging to this genus (Pl. V, fig. 20).

*Material studied.* 2 L (*C. dioica*), Chengtu, from *Pyrus malus*, in coll. U.S.N.M.

*References.* Gardner, 1931 (L), 1944 (L fig.).



Fig. 289. *Chreonoma dioica* Fairmaire. Mature larva. Peritreme of abdominal spiracle.

#### \*Apomeccynini

##### \**Diaxenes dendrobii* Gahan

[Occasionally in imported orchids from India and Burma.]

*Mature larva.* As the following characters show, this larva conforms more closely to the characteristics of the Tetraopini than to those of the Phrynetini and Pogonocherini, between which this species has been placed on adult classification.

Form slender, cylindrical. Length up to 21.5 mm.; maximum breadth (at prothorax), 3 mm. *Head* scarcely depressed, slightly wider before middle (maximum head-width, 2 mm.), with sides rather strongly converging for posterior half; antennal foramen very narrowly open behind; mouthframe very narrowly sclerotised, with a row of eight setiferous pores; six epistomal setae present. One pair of ocelli present; lens very strongly convex; pigmented spot very distinct. Hypostoma flat, testaceous, with front margin very narrowly ferruginous; two pairs of paramedian, setiferous pores present; sutures distinct, ferruginous, slightly curved. Gular region undefined. Antenna (similar to that of *Phryneteta*, fig. 245), two-segmented, the second segment slightly elongate and bearing a tapering, hyaline process. Maxilla with third segment bulbous, distinctly shorter than second. Labial palp with third segment bulbous, less than half length of second. Mentum not distinct from submentum. *Prothorax* with pronotum feebly rugose and with rather long scattered setae near margins. Eusternum well defined, with several long setae. *Abdomen* with each dorsal ampulla with a single transverse furrow, and two transverse rows of glabrous tubercles, anterior to which are a few irregularly arranged ones. Ventral ampullae with two rows of tubercles. Ninth

segment simple. Epipleurum slightly protuberant on all segments. Pleural tubercle with sclerotised pits absent. Anus trilobed. *Legs* absent. *Spiracles* with peritreme rather thick, almost round.

*Pupa* (fig. 290). Length, 10-15.25 mm.; maximum breadth, 5.25 mm. *Head* with vertex partly visible from above, very deeply and broadly excavated between bases of antennae, and bearing two pairs of setae; front with several

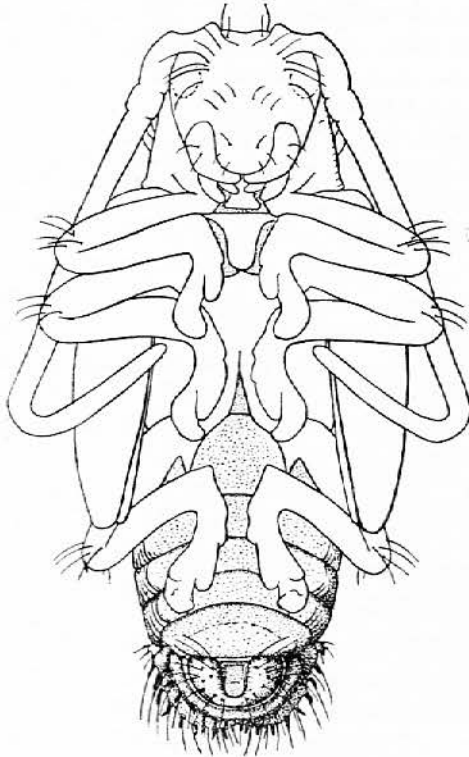


Fig. 290. *Diaxenes dendrobii* Gahan.  
Male pupa. Ventral aspect.

very long setae arising from papillate bases; clypeus with six setae near base, but the transverse impression very feeble. Antennae extending as far as second or third abdominal segment, where they are curved downward to terminate near mid coxae. Eyes feebly convex, glabrous. Mandibles each with two long setae (arising from papillate bases) near middle of outer face. Labrum semicircular, bearing about six setae. *Pronotum* bearing numerous long fine setae arranged more or less in three rows. *Mesonotum* smooth, with four to six shorter setae on each side of scutellum which is slightly protuberant. *Metanotum* smooth, and with eight to twelve setae on each side of scutellar groove. Elytra and wings extending as far as fourth or fifth abdominal segment. *Abdomen* with tergites one to six each with a transverse row of short stout spines near posterior margin. Seventh tergite elongate with sides slightly tapering and bearing a transverse row of much stouter spines near middle, above which are a few smaller ones. Eighth tergite short, transverse, with hind margin slightly rounded, and front margin bearing a row of spines. Ninth segment deeply divided beneath, and bilobed, each lobe bearing several very short conical spines. Sternites four to eight glabrous. *Legs* with about five long fine setae near apex of each femur; mid and hind femora each with a tapering tuberculate process near base; hind femora extending to fourth abdominal segment; tibiae directed posteriorly. *Functional spiracles* present on first six abdominal segments, but a vestigial pair present on segment seven; peritreme round to very broadly oval, very thick, and slightly raised above general level of cuticle.

*Host plants*: *Dendrobium nobile*, *D. wardianum*, and perhaps other Orchids (Xambeu, 1895, 1903; Emden, 1939-1940).

*Biology*. The larva of this species feeds in the stems and pseudobulbs of orchids; usually only one larva is found in each stem. Attacked stems soon become slightly

greyish and wood-like. The pupa, which frequently performs gyratory movements, rests on top of a wad of fibres torn from the inner walls of the stem by the larva. Adults emerge in November, and feed voraciously on the leaves and flowers. *D. phalaenopsidis* Fisher has similar habits (Fisher, 1937; Franssen & Tiggelovend, 1937), and is likely to be imported in the same way.

*Economic importance.* Owing to the high commercial value of exotic orchids, this species is of some economic importance. Fortunately there appears to be no indication that this insect will become acclimatised in orchid houses in this country.

*Material studied.* 1 L, Middlesex, Bush Hill Park Nursery, 12.i.1899, from a pseudobulb of *Dendrobium wardianum* from Burma in coll. B.M.; 2 L, 2 P, France, Paris, x.1894, from *D. nobile*, in coll. B.M.

*References.* Dongé, 1894 (Biol.); Emden, 1939-1940 (L); Fisher, 1937 (Biol.); Franssen & Tiggelovend, 1937 (Biol.); Schwarz, 1904 (Biol.); Xambeu, 1895 (L, P, Biol.), 1903 (Biol.).

#### \*Apodasyini

#### \**Stenidea annulicornis* Brullé

[Imported in ornamental plants from the Canary Is.]

*Mature larva* (fig. 291). Similar to that of *Diaxenes dendrobii*, from which it may be separated by the characters given in the key, p. 81.

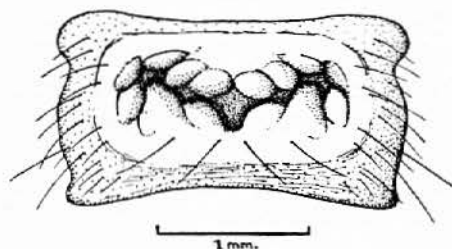


Fig. 291. *Stenidea annulicornis* Brullé. Mature larva. Sixth dorsal abdominal segment.

*Host plant:* *Euphorbia sylvatica canariensis*.

*Material studied.* 1 L, in *Euphorbia* imported from Canary Is., presented by M.G.F. in coll. D.

*References.* Wollaston, 1862 (Biol.).

## COLLECTION AND PRESERVATION

### COLLECTING AND REARING CERAMBYCIDAE

#### Collecting

LITTLE need be said concerning the collecting of adults, since the methods employed, such as beating and sweeping, are those usually adopted for insects in general. The most favourable period of the year for collecting adults is from the beginning of May to the end of August, May and June being the most productive months. Species such as *Phytoecia cylindrica* (Linnaeus) and *Pogonocherus hispidus* (Linnaeus) may be dug out of their pupal cells in the winter months, although if it is intended to breed them, they should be left until spring, by which time they are sexually mature. Most Lepturids may be taken off the flowers of Umbelliferae, *Rosa*, *Rumex* and so forth, especially on hot, sunny, calm days. Traps in the form of jars of cut flower-heads of Umbelliferae may be advantageously placed in clearings of woods to attract them, and this is particularly successful in coniferous woods where there are often few flowering herbaceous plants. In this way such species as *Leptura sanguinolenta* Linnaeus and *Judolia sexmaculata* (Linnaeus) may be taken. Certain species of other subfamilies (e.g. *Callidium violaceum* (Linnaeus), *Aromia moschata* (Linnaeus), *Tetropium gabrieli* Weise, and *Stenostola ferrea* (Schrank)), too, are most in evidence during brilliant sunshine. They may be found flying, or crawling over branches, boles, stumps, fences and so on. On the other hand, many tropical species are nocturnal and may only be obtained by using light traps to attract them. In this country, *Prionus coriarius* (Linnaeus) is seldom to be found in daylight, for it is not until dusk that it starts to ascend tree-stumps in readiness for its nocturnal flight. These species may sometimes be captured at sugaring posts and at light, as is also the case with *Arhopalus fesus* (Mulsant) (Duffy, 1946a, 1946b). Certain plant-feeding Lamiids (e.g. *Agapanthia villosoviridescens* (Degeer) and *Phytoecia cylindrica* (Linnaeus)) may normally only be taken by sweeping or examining their host plants.

The collector who wishes to obtain larvae or pupae must be prepared to spend often many hours of strenuous work, and should be equipped with a trowel, hammer, chisel and saw, with which to expose and reduce stumps and roots to sufficiently small pieces. It is only occasionally that infested wood is sufficiently rotten to make work easy. In the case of root-feeding species such as *Prionus coriarius* (Linnaeus) and *Judolia cerambyciformis* (Schrank), trees which have been recently dug up or blown down should be chosen whenever possible, as much time is thus saved in digging. The writer (1946c, 1949b) has had most success during the winter months, when the discovery of the characteristic larval depredations is much easier because of the absence of foliage and undergrowth. Suspected sections of roots, twigs, etc. were brought back for a more thorough examination; the larvae or pupae were removed, sorted under a

microscope (to ensure there were no mixed colonies), and then replaced in their original galleries whenever possible. When a year or so later the adults emerged, efforts were made to induce pairing and oviposition so that material in every stage of the life-history could be preserved for subsequent description. These measures were not always successful the first time, and in some cases numerous attempts had to be made before there was sufficiently close approach between the actual conditions and the natural requirements of the larvae. Whenever a pupa was found, careful search was made for the larval exuvia, for by rearing the adult from the pupa a reliable identification of the larval skin is obtained. This procedure is of paramount importance so far as the identification of entire larvae is concerned.

### Rearing

Since Cerambycid larvae are so varied in their habits, little can be said regarding the many different methods of rearing them: all that can be done is to give general suggestions, and to draw attention to special points. The whole essence of rearing any larvae under laboratory conditions is, of course, to reproduce as closely as possible the actual conditions under which they normally exist; hence the importance of critical observation in the field. The chief drawback to rearing them is the duration of the larval period, which may be three or more years in many cases. A very important point to observe is the nature and condition of the infested wood or plant tissue. Breeding experiments recently undertaken have clearly indicated that the successful development of Cerambycid larvae depends to a far greater extent on the nature and condition of the wood (i.e. thickness of bark, presence of sap, stage of deterioration, etc.) than on the species of tree concerned. Many species show a decided preference for a particular part of the tree, such as the roots and twigs. The determination of these factors sometimes delayed the successful rearing of a species for several years. When a colony was collected, it was ascertained as accurately as possible how recently the tree had died, the stage of deterioration, and what degree of humidity was desirable. For example, species which normally infest standing boles naturally require drier conditions than those which feed in fallen branches or roots. Generally speaking, it is better to have the wood too moist rather than too dry: moreover, it is fatal to give larvae dry, rotten wood when they have been living in sound wood.

Two fatal conditions are drought and mould, and constant inspection is necessary if these are to be avoided. Wood should be moistened and examined for signs of mould periodically. The maintenance of good ventilation is the surest way of inhibiting mildews; non-porous containers should never be exposed to sunlight, as this causes excessive condensation. Ford's discovery (1947) that the growth of mould in closed vessels may be inhibited by sprinkling the surface with a 5 per cent aqueous solution of common salt (NaCl) has been applied to good effect.

Whenever the identity of a living larva is to be ascertained by rearing the adult, the necessity of individual rearing must be stressed. Disregard for this fact has in the past created great confusion and many erroneous statements. Soon after pupation has taken place, the exuvia must be secured and carefully preserved before the adult ecloses and starts to emerge.

A convenient method of rearing half- to full-grown larvae is to saw off a section of an infested root or stump (the larger the better), and also a similar section of wood which has not been so severely attacked. These should be rested side by side and in close contact on top of a tray filled with light sandy soil. They should then be covered with small-mesh wire netting, and placed in a shady spot in the garden where they should be watered periodically. Should the larvae exhaust their original food-supply before pupating, they will readily bore into the other section (Duffy, 1946a).

When it is inconvenient or impossible to obtain a section of the actual wood in which the larva happens to be feeding, a similar section of the same host in the same condition must be obtained. The larva may then safely be introduced into its new quarters by first excavating with a knife or gimlet a cavity through the bark, partly filling it with frass from the original gallery, and inserting the larva head-first. The entrance hole should then be covered over with a piece of bark kept in place with elastic bands or transparent, adhesive tape.

The successful rearing of adults from half- to full-grown larvae is a simple matter in comparison with rearing from the egg stage because of the extreme delicacy and consequent high mortality of first- and early-instar larvae, which are so susceptible to moulds and desiccation. After nearly ten years' experiment with various methods of rearing, the writer has succeeded in developing a technique, which although relatively simple, has produced most satisfactory results. Whenever a larva, and even its host or habitat was unknown, as was the case of *Stenocorus meridianus* (Linnaeus) and *Judolia cerambyciformis* (Schrank) for example, it was only by rearing *ab ovo* that its biology and immature morphology became known. The technique consisted of the following stages of procedure:

(i) Captive adults were placed in a large roomy breeding-cage with glass front and perforated zinc sides, the bottom of which was filled to a depth of about two to three inches with sandy soil. Sections of the host plant, when known, were partly embedded in the soil, either horizontally or vertically, but usually both. If the nature of the wood preferred by the larva concerned was unknown, then sections of wood in varying degrees of decay and from various parts of the tree (i.e. twigs, roots, etc.) were supplied, careful watch being made to see which proved the most attractive to ovipositing adults. When even the host-plant was unknown, then as wide a range of hosts as possible, both deciduous and coniferous, were provided. Most species were to a certain degree polyphagous, so with judicious selection the number was not great. In addition, food was supplied for the adults in the form of flower-heads or drops of sweetened water applied to the bark with a pipette.

(ii) A day or so after oviposition had been seen to take place, the selected wood was taken out, and the eggs carefully removed and transferred by means of a dissecting needle or moistened camel-hair brush to a piece of filter paper, and placed in a covered Petri dish. The latter has the advantage in that the humidity is easily controlled, and daily observation is possible without having to remove the cover. Whenever eggs show a tendency towards shrivelling the filter paper was slightly moistened with saline water. If moulds formed, they were removed by gently brushing the eggs with a camel-hair brush.

(iii) As soon as the first-stage larvae were observed to be crawling actively over the filter paper, they were one by one transferred with a moistened camel-hair brush to a fresh section of wood of the same kind and in the same condition as that on which the eggs were laid. Suitable accommodation was made by making a few incisions under the bark in a longitudinal direction at the top end of the log, which was kept in a vertical position in a jar containing saline water, and placed away from the sunlight. A day or two later, as soon as the larvae had commenced to form their galleries, the log was removed, inverted, and inserted to a depth of at least half its length in an unglazed flower-pot filled with sandy soil, at the bottom of which was a layer of crushed brick to provide satisfactory drainage. The flower-pot was kept out of doors during the summer months, and watered occasionally (about every two or three weeks) with saline water. Every month or so the wood was pulled out, and the bark carefully removed in small pieces until a larva was exposed, so that the progress of larval development could be ascertained.

(iv) As soon as a larva showed signs of pupation (which sometimes took place in the soil), the flower-pot was covered with a piece of strong gauze secured to its rim with a length of elastic, and placed in a sunny aspect to hasten the emergence of adults.

The above technique has proved more successful than any other. Desiccation, and the invasion of moulds were eliminated, with the result that mortality was surprisingly low. This technique, however, is not applicable in the case of species such as *Aromia moschata* (Linnaeus) and *Oberea oculata* (Linnaeus), which require living, healthy or only slightly decayed wood. For species such as these, a section of wood containing larvae should be stood up in a shallow, unglazed earthenware pot containing saline water, and placed at the bottom of a glass cylinder. Providing the cylinder has been placed in a sunless, well-ventilated position, the wood should require no attention for at least a month, by which time replacement usually becomes necessary owing to the drying-out of the sap.

The most satisfactory and convenient method of rearing herbaceous-plant feeders such as *Phytoecia cylindrica* (Linnaeus) and *Agapanthia villosoviridescens* (Degeer) is to grow the appropriate plant in a flower-pot. When adults are available, they should be placed on the plant, which has first been "sleeved" with gauze or muslin. No further attention would be necessary beyond the occasional watering.

If it is desired to rear larvae which have been imported in timber from tropical or subtropical regions, some form of incubator breeding-cage is necessary. A very satisfactory cage of this type is that designed and tested by M. G. Fraser, who has succeeded in rearing such species as *Elaphidion nanum* Fabricius, *Plocaederus viridipennis* Hope and *Cordylomera suturalis* Chevrolat. Fraser (1949b) has given the following specifications:

"The main body of the cage (fig. 292) consisted of a cupboard about 2 ft. 10 in. high by 1 ft. 10 in. wide by 1 ft. 6 in. deep. The doors were removed and replaced in the first instance with glass. Later this was itself replaced with "plaster-board". Two slatted shelves were fitted at appropriate heights. A rectangle about 1 ft. 6 in. by 10 in. was cut out of the bottom of the cupboard to receive a shallow baking tin (price 1s. 4d.) which holds a saturated solution of common salt. This was

covered by a sheet of perforated zinc to prevent straying insects from falling into the solution.

"A hole was cut in the plywood back of the cupboard to such a size that an ordinary cocoa tin fitted tightly therein. The tin was pushed into the hole so that the bottom was towards the front of the cage. It is desirable to drill a small hole in the bottom of the tin so that one may readily observe whether or not the light inside is burning. The lid of the tin was cut in such a way that an ordinary electric light

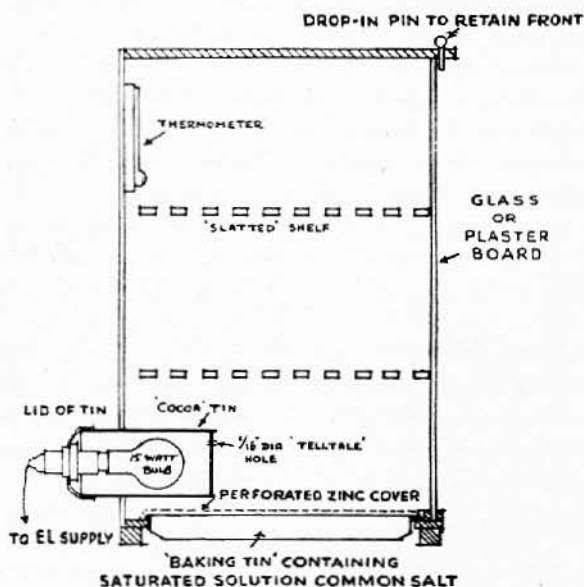


Fig. 292. A cheap incubator breeding cage. (Fraser, 1949b)

holder could be fitted through it. This was then wired up and connected to the electric supply, a 15 watt bulb (preferably carbon filament) was inserted and the lid replaced on the tin. A small thermometer was fixed as high as possible inside the cage.

"After switching on the current, the temperature must be adjusted to suit the requirements; this is done by closing the cage and leaving it for a period of an hour or more, after which the temperature can be regulated by pushing the cocoa tin heater-element further in to raise the temperature, or by pulling it further out if the temperature is too high. In practice it was found that a temperature of about 75° to 80° F. was ample for tropical Cermabycidae. Owing to the large size of the cage, however, it was not easy to maintain this temperature during the summer of 1948 as long as the cage was fitted with a plain glass front; it was, indeed, necessary to cover the glass with a blanket at night. With a plaster-board front, however, a temperature of 90° F. can be maintained even in winter.

"Obviously the cage is crude and capable of much improvement and elaboration. The provision of a thermostatically controlled switch, for instance, might well prove,

in the long run, to be a positive economy; but it should be borne in mind that, if plugged into the household circuit, such a switch is apt to annoy other occupants of the house by interfering with the radio programmes as it clicks on and off. The cage proved to be quite effective as described, and was constructed and completed for a total outlay of 7s. 6d."

During the course of rearing, a number of larvae will probably be found to be parasitised. They should not be thrown away, but placed in a separate tin lined with filter paper. The resulting parasite imagines, together with their preserved larvae, and the identity of the host, should be sent to an authority on the group, as material and information of this kind are badly needed. Finally, every rearing cage or container should bear a label with a number which refers to the full data of the specimens concerned; microscope-slide labels are suitable for this purpose.

### THE PRESERVATION AND STORAGE OF IMMATURE STAGES

CERAMBYCID larvae and pupae as compared with those of Lepidoptera, for example, are not particularly colourful, and this, together with the fact that the majority are rather small, renders them unsuitable for general exhibition purposes. But those of some of the larger species, if well preserved, make useful and attractive additions to beetle collections and add greatly to their general interest; moreover, if sections of galleries and pupal cells are included, life-history series can be prepared demonstrating diversity in various groups of this important family.

For this purpose, larvae of an inch or more in length are best prepared by the method generally adopted for "blowing" lepidopterous larvae, i.e. by enlarging the anus, pressing out the abdominal contents, and inflating with hot air until rigid. If in addition they are then filled with suitably tinted, melted wax and allowed to "set", they then present a very life-like appearance, providing care is taken not to inflate them beyond their normal dimensions. Very large larvae, such as those of *Prionus* and *Ergates* species, cannot be "blown" satisfactorily as they turn black in the drying process, presumably owing to their thick integument and high fat content.

Another method of dry preservation is as follows. Immerse the larva for one week (or two if very large) in 95 per cent alcohol. It should then be completely dehydrated by immersion for one to three weeks (according to size) in absolute alcohol, which should be changed weekly if necessary. This should be followed by immersion for approximately twelve hours in mixtures of one part xylol to two parts absolute alcohol; two parts xylol to one part absolute alcohol; and then pure xylol. Finally the larva should be allowed to dry off before it is mounted on card in the same way as a beetle. Pupae may be prepared in the same manner.

The above methods are, of course, quite unsuitable if one wishes to form a collection of immature stages with a view to studying their taxonomy. For this purpose it is unfortunately common practice merely to kill and store specimens in alcohol, with the result that they become so contracted and discoloured that reliable description or even comparison is scarcely possible in many cases; moreover, the difficulty of dissection is greatly increased owing to the excessive hardness of the tissues. In order to avoid such hardening, and to retain the original form and colour

of the specimen, it should first be killed by immersion in Pampel's Fluid (Imms, 1939), which may be made up as follows:

|                                       |          |
|---------------------------------------|----------|
| Glacial acetic acid . . . . .         | 4 parts  |
| Distilled water . . . . .             | 30 parts |
| Formaldehyde . . . . .                | 6 parts  |
| Ethyl alcohol (95 per cent) . . . . . | 15 parts |

Specimens should be left in this fluid for at least one to three weeks according to size before transferring to 75 or 80 per cent alcohol<sup>1</sup> for permanent storage. Some workers prefer to store specimens permanently in Pampel's Fluid, but the writer considers this unnecessary; moreover, it is far more pleasant to work with spirit material than with that which has been stored in Pampel's Fluid owing to the absence of unpleasant fumes from the acetic acid and formaldehyde.

Even the immersion in Pampel's Fluid does not prevent a certain amount of discoloration, and although this does not seriously affect taxonomic study, it does detract from the life-like appearance, should the material be required for exhibition, demonstration or photographic purposes. If such a condition is required, the writer (1950) has found the following treatment to be the most satisfactory. First make a small incision in the side of the abdomen of the larva or pupa with a surgical needle or similar instrument, and immerse the specimen in a test-tube of weak alcohol (30-50 per cent), to which have been added two or three drops of glacial acetic acid. Then heat the tube carefully, maintaining a temperature of just below boiling-point for ten to twenty minutes according to size; and then transfer to Pampel's Fluid for the period already stated.

Before starting to form a systematic collection of immature stages, a supply of small tubes should be obtained. The writer has always used tubes of a standard length of 3 in., and ranging in diameter from  $\frac{3}{8}$  to 1 in. Tubes 3 by 1 in. proved to be the most useful size, and allowed adequate space for the data label to be entirely visible. Various large larvae such as those of *Prionus* and *Ergates* are best placed in small glass jars such as surgeon's rounds. If round-bottomed tubes are used, a slab of wood, in which has been drilled a series of holes to accommodate them in a vertical position, is very useful, and greatly facilitates sorting and comparison.

Labels for the tubes are best cut out in strips from sheets of a fairly tough rag paper, as many papers soften and readily tear when soaked in spirit. Waterproof indian ink or a B pencil should be used for writing out the labels; care should be taken to allow the former to become thoroughly dry before immersion. All essential data such as the name, locality, date, host-plant and collector should, of course, be recorded on each label. If it is intended to form a really extensive collection, tubes of individual species may more readily be picked out if a small round label bearing a serial number (which refers to a systematic card index) has been inserted face-downward in the bottom of the tube, where it is kept in place by a small wad of tissue paper. When the specimens and data label have been inserted in the tube, the latter

<sup>1</sup> Pure alcohol (ethyl alcohol) is very expensive, whereas industrial alcohol (methylated spirit) is equally suitable, and much cheaper. Application for its purchase should first be made to the local Surveyor of Customs and Excise.

should be topped up with alcohol, and plugged with a saturated wad of crumpled tissue paper or cotton wool; the former is preferable, since there is less risk of appendages and processes of specimens becoming entangled with it. Corks should on no account be used because they soon deteriorate and cause excessive discoloration. Care should be taken to see that all air-bubbles are excluded.

It is the writer's practice, whenever possible, to include in the tube an adult specimen along with its immature stages: this not only facilitates the rapid recognition of the identity of the tube's contents, but also serves to prevent the misplacement of tubes during routine examination. Great care should also be taken always to include any larval exuvia which may be found in pupal cells. Sections of thin glass tubing, plugged at both ends, are ideal for this purpose; they should be inserted in a standard tube along with the other stages.

When thus prepared, the tube should be inverted, and placed in a jar about one-third full of 80 per cent alcohol, the bottom having first been covered with a layer of cotton wool to obviate breakage of tubes. Practically any wide-mouthed, glass-stoppered jar is suitable for the purpose, but shouldered jars should be avoided owing to the difficulty of removing and replacing tubes. When a number of tubes has accumulated, a separate jar, appropriately labelled, may be allocated to each subfamily. If it is desired to segregate the tubes of a jar into smaller divisions such as tribes, four separate compartments may be made simply by inserting a cross comprising two rectangular plates of celluloid, as advocated by van Emden (1942).

A satisfactory method of restoring larvae which have accidentally become desiccated is that recommended by Emden (*loc. cit.*); they should be soaked for one to two days in a 1-2 per cent solution of caustic potash, and then gradually transferred to 40, 70, and finally 80 per cent alcohol.

Finally a word concerning the dispatching of living specimens by post. Larvae are extremely susceptible to bruising, and care should be taken to prevent them from being unduly shaken in transit; moreover, they are very prone to injury, and kill one another when in close contact. The most satisfactory method is to send a section of the infested timber with the larvae and pupae *in situ*; if the section is of living or moist wood, and likely to be more than one day in the post, it is advisable to seal the ends of the section with paraffin wax to retain the sap or moisture. If this is not possible, then the larvae should be sent each in a separate glass tube only slightly larger than the specimen itself, and packed at one or both ends with slightly moistened sawdust or frass, so that the specimen does not slide up and down the tube. If tubes are not available at the time, larvae may be placed in a tin full of moistened moss, providing they are kept separated as much as possible; this method is useless so far as pupae are concerned, and only results in the adults failing to eclose satisfactorily, if at all. If a pupa cannot be dispatched in its original pupal cell, it is best placed in a glass tube lined with filter paper, and of a diameter only slightly exceeding that of the pupa; the tube should be plugged at both ends with crumpled tissue paper so that the pupa does not move about. Living adults required for oviposition should be sent in a perforated tin, containing a supply of suitable food (e.g. flower-heads, leaves): this procedure also reduces the likelihood of the specimens dying from desiccation.

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In the following list, the abbreviations of names of journals comply, whenever possible, with those cited in the "World List". Several of the journals concerned, however, have been started since its publication, and in such cases the abbreviations have been made to agree with it as closely as possible.

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PLATES

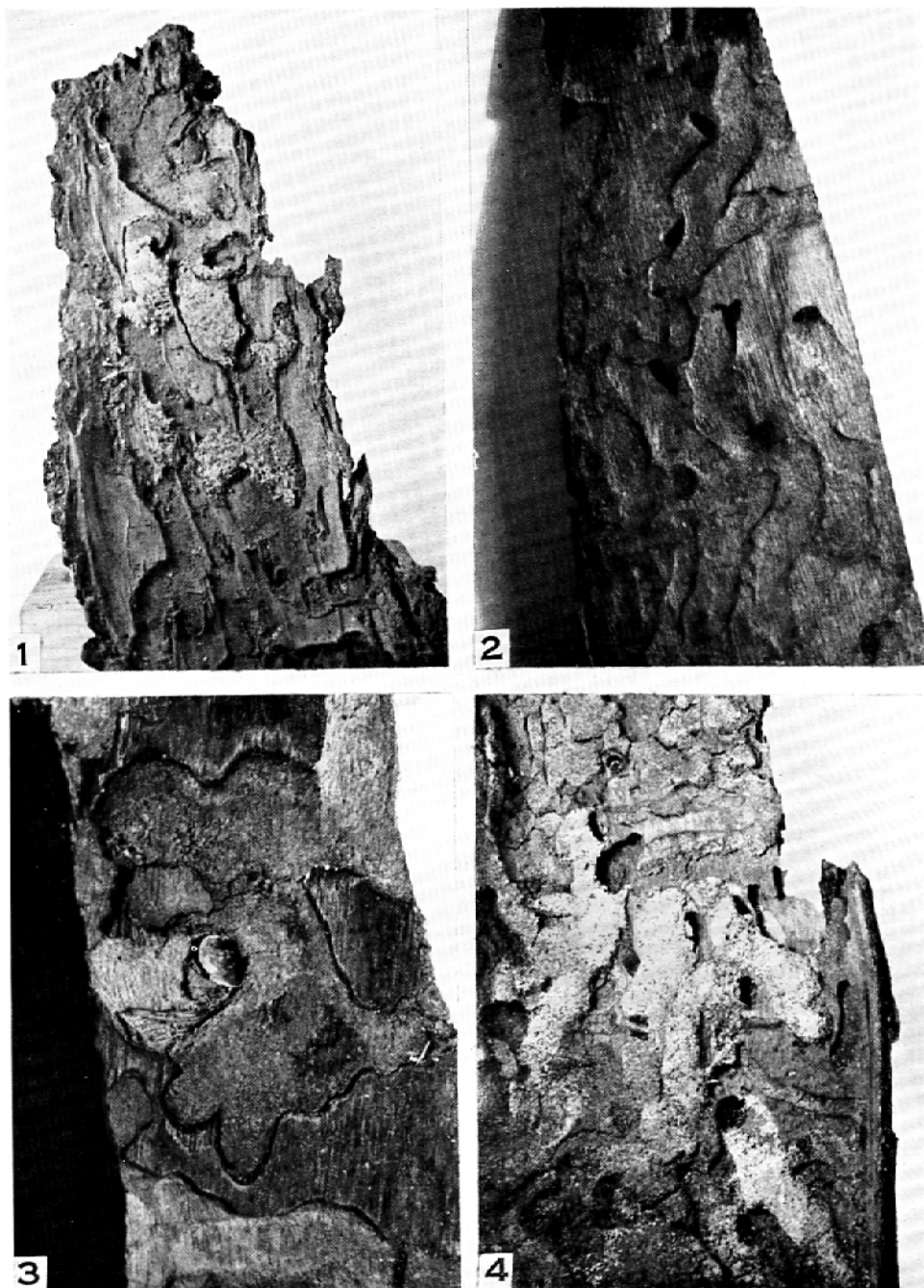


Fig. 1. *Tetropium gabrieli* Weise. Subcortical larval galleries.

Fig. 2. *Elaphidion nanum* Fabricius. Subcortical larval galleries.

Fig. 3. *Plocaederus viridipennis* Hope. Subcortical larval gallery and calcareous cocoon.

Fig. 4. *Callidium violaceum* (Linnaeus). Subcortical larval galleries.

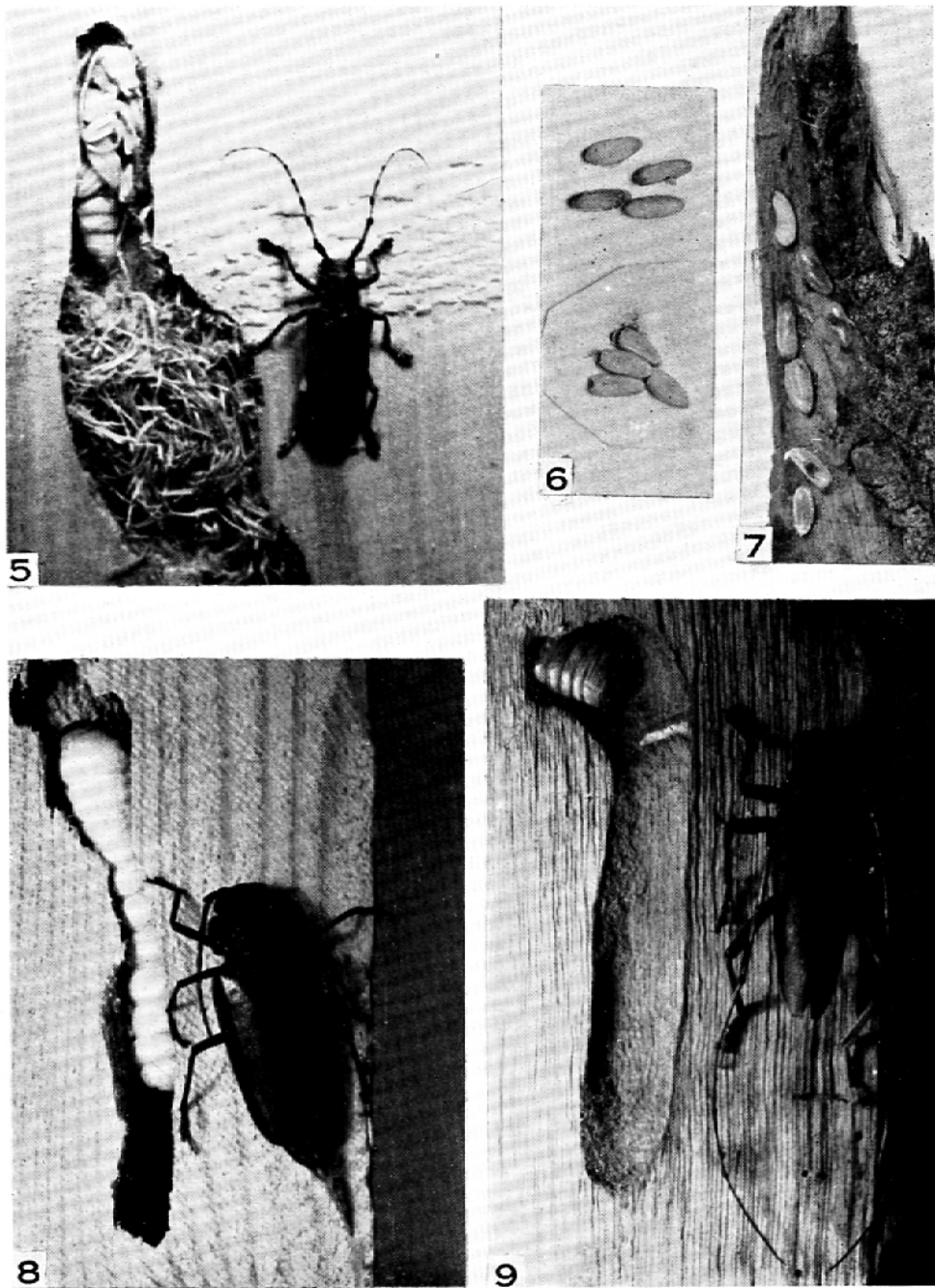


Fig. 5. *Saperda carcharias* (Linnaeus). Pupal cell, pupa and adult.

Fig. 6. *Prionus coriarius* (Linnaeus). Eggs.

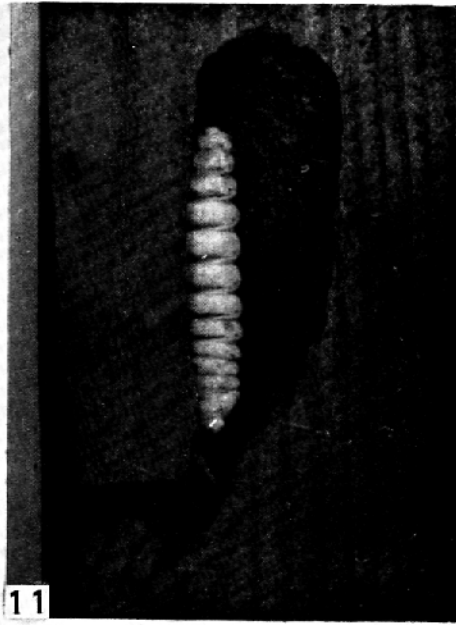
Fig. 7. *Aromia moschata* (Linnaeus). Eggs.

Fig. 8. *Ergates faber* Linnaeus. Larval gallery, larva and adult.

Fig. 9. *Cerambyx cerdo* (Linnaeus). Pupal cell, larva and adult.



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Fig. 10. *Monochamus galloprovincialis* (Olivier) Pupal cell, pupa and adult.

Fig. 11. *Ergates spiculatus* Fabricius. Pupal cell and larva in *Pinus*.

Figs. 12 and 13. *Hylotrupes bajulus* (Linnaeus). Sections of attic timber heavily infested.

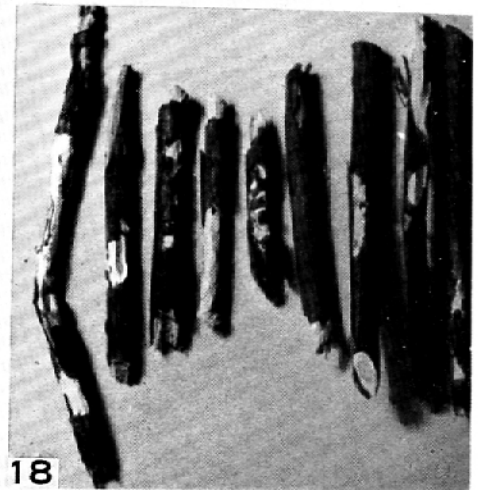
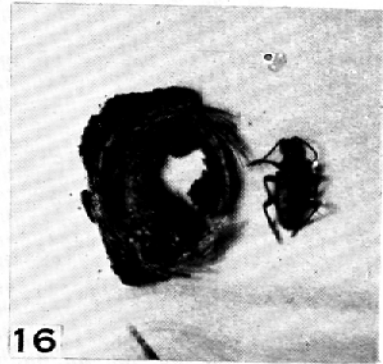
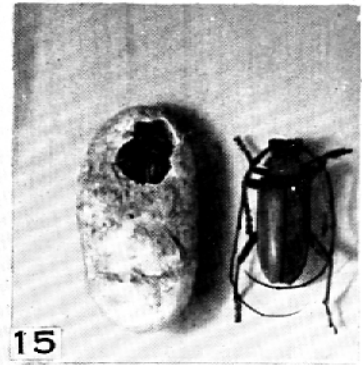


Fig. 14. *Prionus coriarius* (Linnaeus). Pupal cell and pupa.  
Fig. 15. *Plocaederus basalis* Gahan. Pupal cocoon and adult.  
Fig. 16. *Rhagium inquisitor* (Linnaeus). Pupal cell and adult.  
Fig. 17. *Prionus coriarius* (Linnaeus). Larva in decaying root of *Quercus*.  
Fig. 18. *Gracilia minuta* (Fabricius). Infested wickerwork.

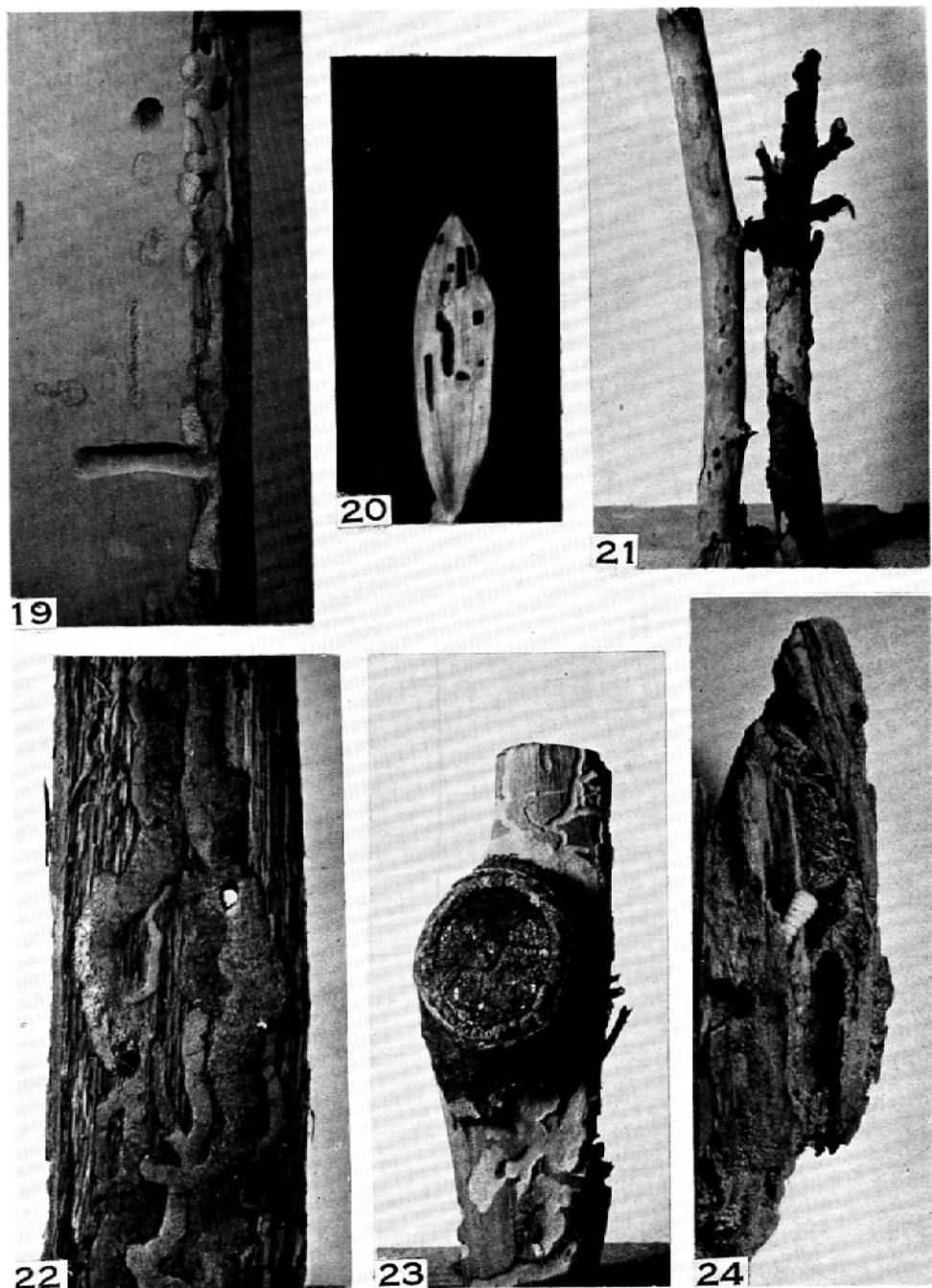


Fig. 19. *Cyllene acuta* Germar. Larval galleries.

Fig. 20. *Chreonoma* sp. Orchid leaf nibbled by adult.

Fig. 21. *Pogonocherus hispidus* (Linnaeus). Emergence holes in twigs of *Pyrus*.

Fig. 22. *Plagionotus arcuatus* (Linnaeus). Subcortical larval galleries in *Quercus*.

Fig. 23. *Clytus arietis* (Linnaeus). Subcortical larval galleries.

Fig. 24. *Arhopalus fesus* (Mulsant). Larva and pupal cell in infested root of *Pinus*.

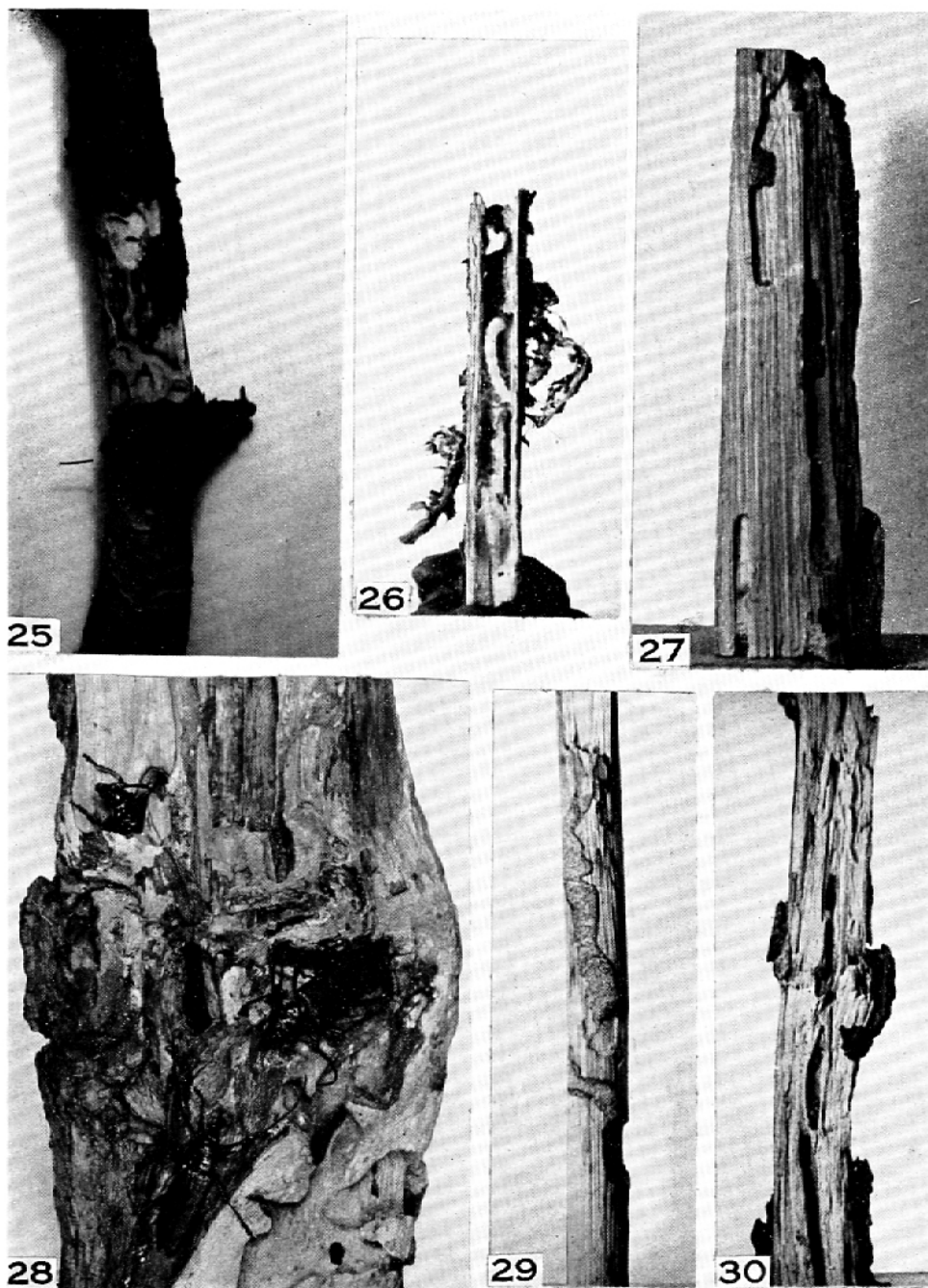


Fig. 25. *Molorchus minor* (Linnaeus). Subcortical larval galleries.

Fig. 26. *Agapanthia villosiviridescens* (Degeer). Larva and pupa in stem of *Carduus*.

Fig. 27. *Phymatodes testaceus* (Linnaeus). Pupal cells.

Fig. 28. *Aromia moschata* (Linnaeus). Adults emerging from infested trunk of *Salix*.

Fig. 29. *Leiopus nebulosus* (Linnaeus). Subcortical larval galleries.

Fig. 30. *Stenostola ferrea* (Schrank). Larval galleries in *Tilia*.

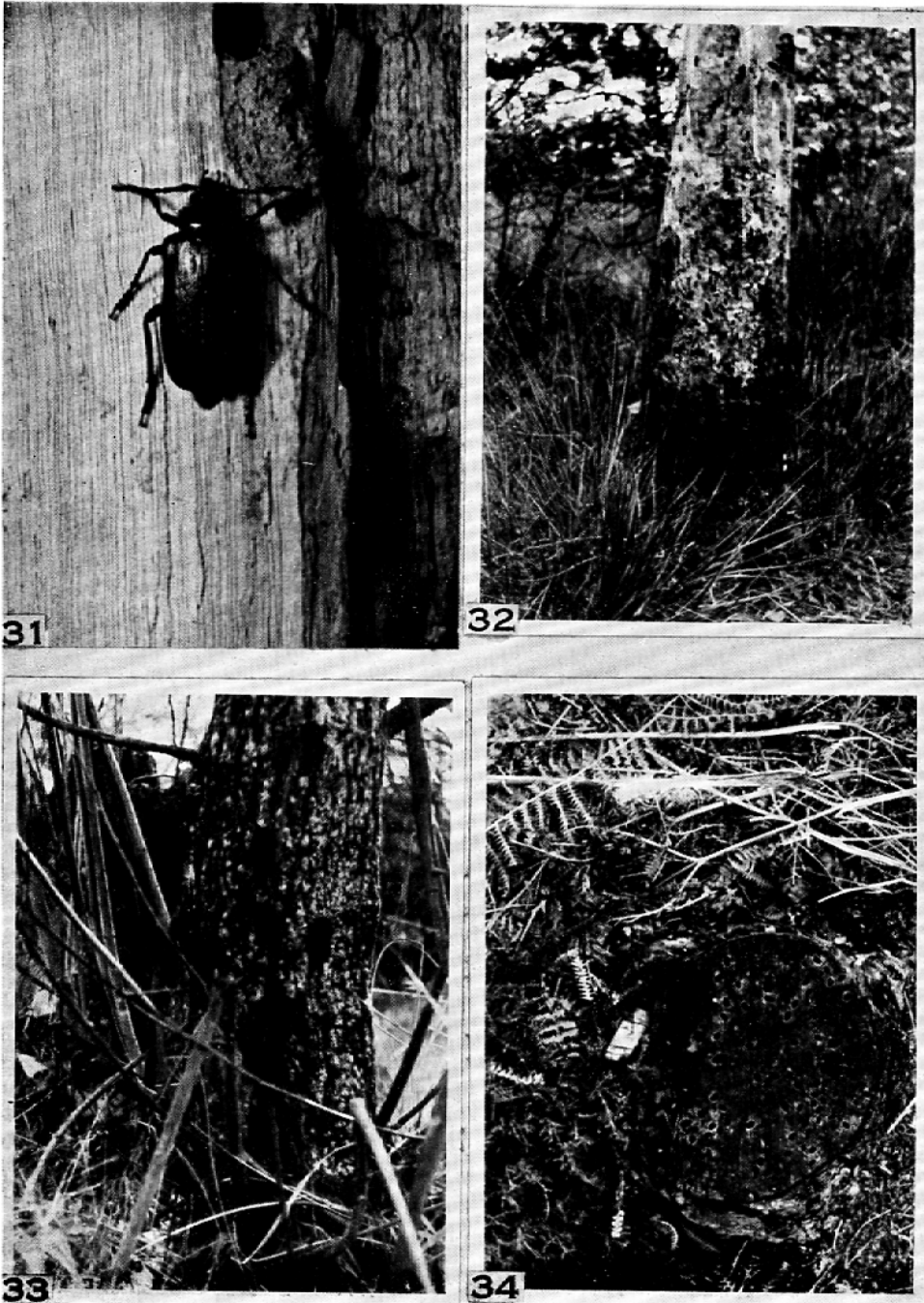


Fig. 31. *Prionus coriarius* (Linnaeus). Adult on stump.

Fig. 32. *Asemum striatum* (Linnaeus). Infested bole of *Pinus*.

Fig. 33. *Aromia moschata* (Linnaeus). Emergence holes in *Salix*.

Fig. 34. *Asemum striatum* (Linnaeus). Emergence holes in stump of *Pinus*.

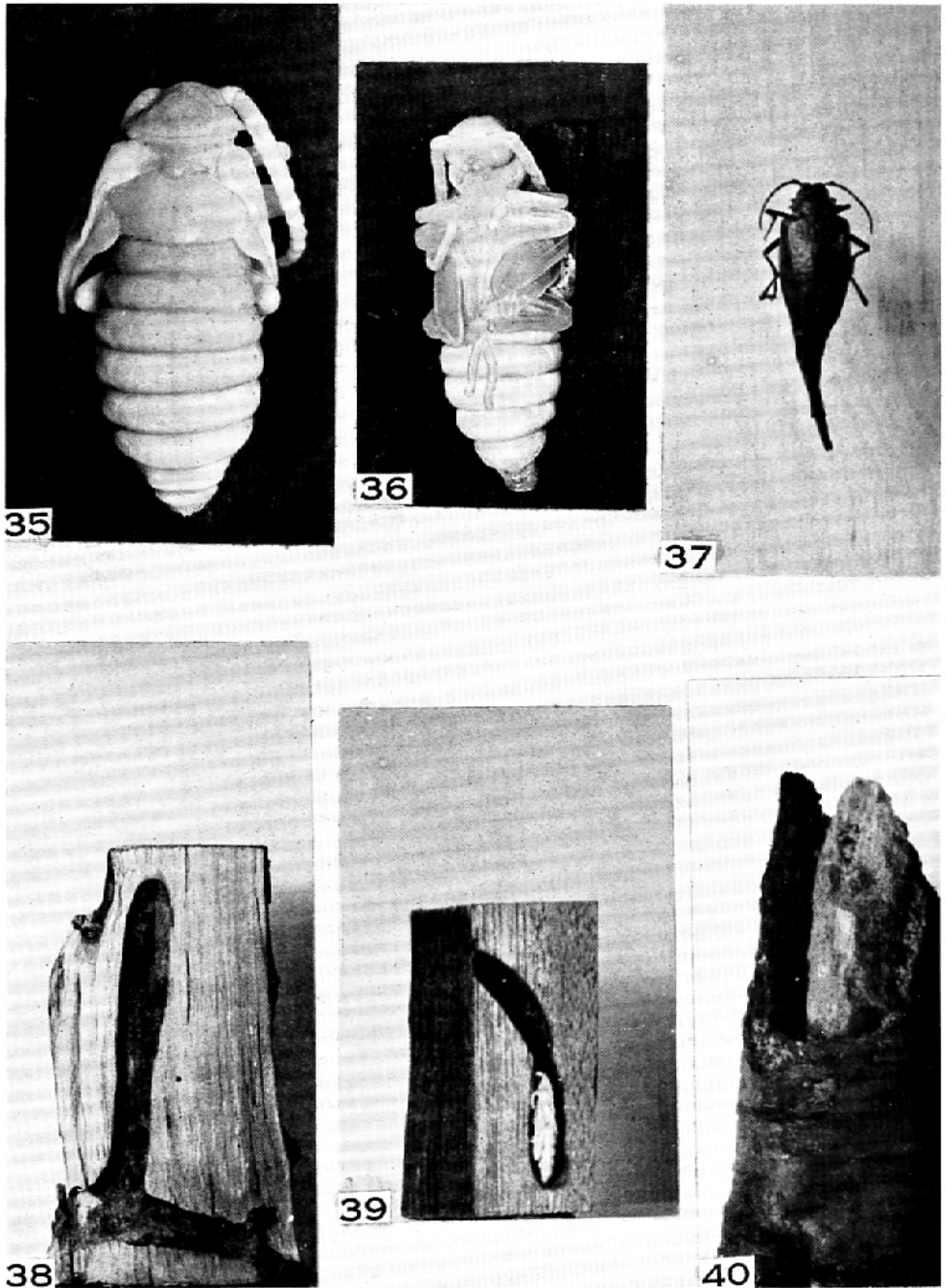


Fig. 35. *Prionus coriarius* (Linnaeus). Pupa. Dorsal aspect.

Fig. 36. *Arhopalus fesus* (Mulsant). Pupa. Ventral aspect.

Fig. 37. *Prionus brachypterus* Gebl. Adult, showing length of ovipositor.

Fig. 38. *Aromia moschata* (Linnaeus). Larval gallery in *Salix*.

Fig. 39. *Cordylomera* sp. Pupal cell and pupa.

Fig. 40. *Prionus coriarius* (Linnaeus). Root of *Quercus* excavated by larva.