Insect pests of food : The larvae of the Ptinidae associated with stored products / by S.M. Manton; and, The Histeridae associated with stored products, by H.E. Hinton.

Contributors

Great Britain. Ministry of Food.
Manton, S. M. (Sidnie Milana), 1902-1979
Hinton, H. E. (Howard Everest), 1912-1977.

Publication/Creation

London : H.M. Stationery office, 1945.

Persistent URL

https://wellcomecollection.org/works/a9xek3gd

License and attribution

wellcome collection

Wellcome Collection
183 Euston Road
London NW1 2BE UK
T +44 (0)20 7611 8722
E library@wellcomecollection.org
https://wellcomecollection.org

MINISTRY OF FOOD

INSECT PESTS OF FOOD

3. MANTON, S. M.
The Larvae of the Ptinidae associated with Stored Products
(Reprinted from the *Bulletin of Entomological Research*, 35, pp. 341–365)

4. HINTON, H. E.
The Histeridae associated with Stored Products
(Reprinted from the *Bulletin of Entomological Research*, 35, pp. 309–340)

With a Foreword by the
DIRECTOR OF INFESTATION CONTROL

LONDON
HIS MAJESTY'S STATIONERY OFFICE
1945
PRICE 2s. 6d. NET

FOREWORD

These two further papers on the identification of the insect pests of food form numbers 3 and 4 of the series initiated by the publication of an account of the Lepidopterous pests in a previous pamphlet issued by the Ministry in November, 1943.

The key to the larvae of the Ptinidae by Dr. Manton (Mrs. J. P. Harding) is the first comprehensive study to be published of the immature stages of the "spider-beetles" and is the only available means of identifying with certainty the larvae of these beetles, which in all parts of the world are amongst the most serious pests of stored products. It has been possible to include in the key nearly all the Ptinids of economic importance, so that the key will be as useful abroad as in this country. The larvae of the various species of Ptinids are extraordinarily similar in general appearance, and for this reason it has not been possible to construct a key based on characters visible under a hand lens or binocular, but no difficulty should be experienced if microscope slides of the mouth-parts, legs, and spiracles are first made so that these structures can be handled under magnifications of about 500. For rapid identifications, specimens can be mounted in water under a cover-slip.

Dr. Hinton's paper on the Histeridae follows in general outline his previous papers on the Ptinidae and Lathridiidae associated with stored products, both of which were first published in earlier numbers of the *Bulletin of Entomological Research*. The Histerids are beneficial insects in that both the adults and larvae feed on other insect larvae and mites. Broadly speaking, they are rarely if ever of any great importance in keeping down the numbers of small Arthropods that attack stored products. As a rule, they are uncommon in structures, ships, or railway vehicles used to store or transport food. Some species of *Carcinops*, *Dendrophilus* and *Gnathoncus*, however, are sometimes found in considerable numbers in the basements of granaries and mills, particularly in damp and heated grain.

My thanks are due to Mr. N. D. Riley, Keeper of the Department of Entomology, British Museum (Natural History) for placing the facilities of his Department at the disposal of the authors. Acknowledgments are also due to Dr. S. A. Neave, C.M.G., Director of the Imperial Institute of Entomology, who arranged for prompt publication of the papers.

W. McAULEY GRACIE,
Director of Infestation Control.

Ministry of Food,
University College,
Gower Street, W.C.1.

January, 1945.

THE LARVAE OF THE PTINIDAE ASSOCIATED WITH STORED PRODUCTS.

By S. M. Manton, Sc.D.

Fellow of Girton College, Cambridge.

With an Introduction

by H. E. Hinton, Ph.D.

Department of Entomology, British Museum (Natural History).

(Pls. III-IX.)

Introduction.

In recent years much attention has been given by entomologists and others to the beetles of the family Ptinidae because of the serious losses they cause to stored products, particularly cereals. The adults have been revised by Hinton (1941), but no satisfactory key exists to the larvae. Only those of a few species have been described, and these descriptions are not sufficiently detailed to make it possible to identify the species concerned. By means of the keys and illustrations given here it should be possible to name with certainty the larvae of all the more economically important species.

Altogether, fifteen species of Ptinids have been recorded attacking stored products in the British Isles or have been found in building structures where such products are normally kept. Of these, twelve, *viz.*: *Ptinus tectus*, Boield., *P. hirtellus*, Sturm, *P. latro*, F., *P. fur*, L., *P. pusillus*, Sturm, *P. villiger*, Reitt., *P. raptor*, Sturm, *Niptus hololeucus*, Fald., *Trigonogenius globulus*, Sol., *Gibbium psylloides*, Czemp., *Tipnus unicolor*, Piller & Mitt., and *Stethomezium squamosum*, Hinton, are included in the keys given below. An undetermined species, probably of *Ptinus*, which has been found on two separate occasions and is referred to as *P.* sp. indet., is also included. These twelve species include all those of any importance in this country and, with one or two exceptions, all species of any real importance elsewhere in the world. Three species, *Ptinus exulans*, Er., *Eurostus hilleri*, Reitt., and *Mezium affine*, Boield., which have been recorded in Britain as associated with stored products, are not included in the keys as no specimens were available. Of these three, the first has only rarely been introduced and is not yet established, the second has only recently become established here but appears to feed mainly if not entirely on rat and mouse droppings, and the third is sufficiently rare to be of little or no practical importance.

Bred specimens of all of the species included in the keys have been available with the exception of *Ptinus villiger*, which has been included in the keys on larvae found associated with the adults in a sack of flour. Earlier instar larvae of only a few

species have been examined, and the keys are therefore intended only for mature or nearly mature larvae, but it is probable that they will also be useful for identifying first-instar larvae.

In view of the fact that larvae of several other families of the BOSTRYCHOIDEA are sometimes found in warehouses and granaries in the same situations as Ptinid larvae and closely resemble them, the following key appears to be necessary in order to distinguish Ptinid larvae from those of related families.

1. Antenna at least one-third as long as mandible and with three well developed segments or with second and third segments fused together in which case the boundary between the second and third is indicated by a conical sensory appendage. Head partly retracted into prothorax..... 2.
— Antenna much less than one-third as long as mandible and consisting of a single minute segment or sometimes two fused segments. Head not retracted into prothorax..... 3
2. Spiracle of eighth abdominal segment several times as large as spiracles of preceding segments ..... LYCTIDAE
— Spiracle of eighth abdominal segment not distinctly larger than spiracles of preceding segments .....BOSTRYCHIDAE
3. Thoracic spiracle in membranous area between meso- and prothorax but sometimes appearing to be on caudo-lateral part of prothorax. Dorsal surface of abdomen hairy and with transverse bands of spicules.....ANOBIIDAE
— Thoracic spiracle in antero-lateral part of prothorax. Dorsal surface of abdomen hairy but without bands of spicules or stout and short setae or spines ..... PTINIDAE

Explanation of Terms used in the Key.

The inter-specific and inter-generic differences are small, and there is much variation in the larvae here considered. Few useful characters can be seen in whole specimens under a lens or binocular, and preparations of the mouth parts and other organs are necessary for their microscopic examination. A magnification of about 500 should be used. Colour, shape, and size are not of taxonomic value. The characters used in the key are described below, together with their intra-specific variations. Variation in the numbers and disposition of setae on different individuals of a species, and on the two sides of the body of one individual is considerable. The main variations of this type which have been found in the characters used in the key are enumerated.

The single jointed minute antenna (Pl. III, figs. 22-31) shows little marked intra-specific variation. The length of the tactile appendix (terminology used by Böving, 1927) is fairly constant and varies in different species, and reference to the shape of the appendix is made by a statement of the ratio of the length to the width. The greatest intra-specific variation occurs in *Ptinus fur* where the length may be two to almost three times the width.

The labral sensillae are usually constant in number. They can be seen through the epipharynx, and are shown by dotted circles on Pls. IV & V. Only three specimens have been seen with sensillae more or less numerous than other specimens of the same species, these are one of *P. fur* with two instead of three sensillae, the median sensilla being absent, and two of *P. latro*, one lacking a median and a lateral sensilla, and the other lacking a lateral sensilla, the remaining sensillae being in their normal positions. There is considerable bilateral and individual variation in the exact positions of the sensillae, which are only roughly symmetrical.

A pair of Y-shaped sclerites (Pls. IV & V) are present in the labrum, visible from either the labral or epipharyngeal sides. They are variable in shape and in extent, but some of their features are sufficiently constant to be of taxonomic value.

The two arms of the Y may be about equal in width, in length, and in colour, or one may be markedly wider than the other or may be shortened to form a small knob. Bilateral variations are usually not as great as those shown for *Stethomezium squamosum* (Pl. V, fig. 41). In the eight species where the sclerite is roughly similar, the inner arm is usually as wide or almost as wide as the outer arm, but occasionally it is decidedly narrower.

The form and arrangement of setae on the epipharynx (Pls. IV & V) show a similar basal plan in all species examined. The setae can be grouped into sets (see below). In order to facilitate reference to particular setae or sets of setae in the key, a plan showing the positions of the setae is given in the diagram (fig. 1). The numbers and the positions of setae in all sets are subject to considerable variation, and the setae on the two sides are seldom mirror images of each other, yet in spite of this the chaetotaxy of the epipharynx is of taxonomic value. In all figures of the epipharynx the bases of setae inserted on the epipharynx are shown.

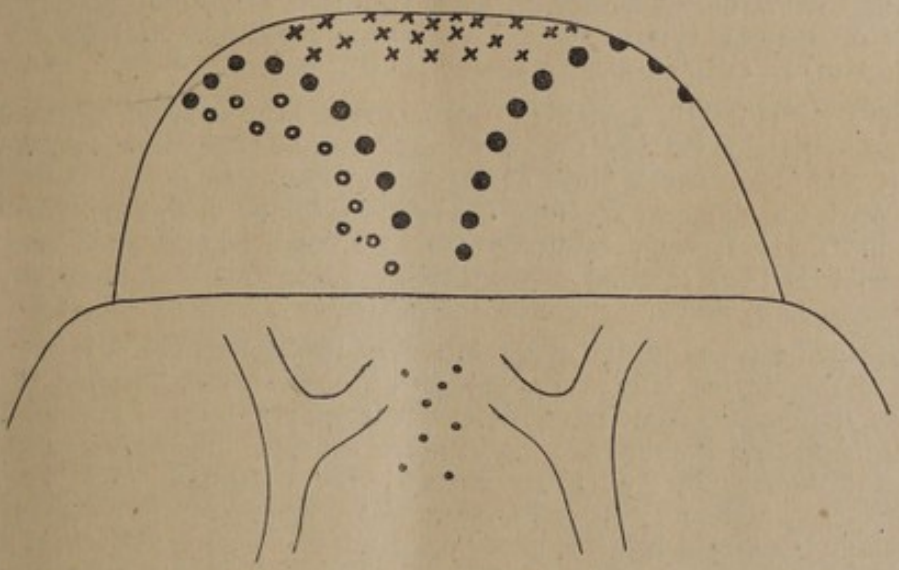


FIG. 1. Plan showing the distribution of sets of setae on the epipharynx; for explanation see text.

The bases of the labral setae are not shown, but the parts of these setae projecting beyond the margin of the epipharynx are figured, as they give an indication of the degree of hairiness of the species.

The main pair of diverging rows of setae are marked by large dots. In some species these comprise a pair of irregular diverging rows of large, often flat, setae lying across the epipharynx. In other species these rows merge more or less evenly into an additional arc of large setae situated near (left side of diagram) or on (right side of diagram) the margin of the epipharynx. The larger and more conspicuous setae of the diverging rows can usually be recognised on each side in all specimens, but the proximal extent of these rows varies, as does their extension on to the lateral margin, where they may either form a continuation of the diverging rows, or an irregular row or group (*e.g.* in *P. fur* the diverging rows usually consist of 4 setae, but sometimes 3 or 5, lying across the epipharynx, and from 1-3 setae on or near the lateral margin; and in *P. pusillus* the diverging rows usually consist of 5 setae, but sometimes 4 or 6, lying across the epipharynx, and from 2-4 setae on or near the lateral margin, in the series of specimens examined).

The irregular transverse rows near the front margin are marked by crosses, and lie between the diverging rows. The numbers of setae here present are not given, although significant, because of the difficulty of determining the point at which these setae merge into those of the labrum which are inserted on the other side.

Setae lateral to the diverging rows are marked by circles. This set may be absent (right side of diagram); it may form on each side a fairly regular row or rows lateral and parallel to the diverging rows; or more numerous setae less orderly in arrangement may lie between the diverging rows and the lateral margins of the epipharynx. This set shows greater bilateral and individual variation than do the diverging rows, and the variations are most conspicuous in species where the setae of this series are few (*e.g.* in *P. pusillus* there may be no setae lateral to the diverging rows on either side, or from 1-6 setae may be present, and the bilateral asymmetry may be as much as 6 setae on one side and 2 on the other; and in *P. fur* one seta of this series is developed occasionally on one or other side in the series of specimens examined).

A basal median group of small setae are marked by small dots. They lie between the inner arms of the Y-shaped sclerites. They may or may not be present, and if present, may or may not merge with the main pair of diverging rows of setae. They show no constancy in exact position or in numbers, and there is little trace of bilateral symmetry. The most conspicuous intra-specific variations noted in the series examined are 1-2 setae in *P. fur* and 3-8 in *P. pusillus*.

The mandible (Pl. III, figs. 1-13) shows little intra-specific or bilateral variation. In some species the tooth on the mesal margin is small, acute, and abruptly projecting, and is situated a little nearer to the apex than to the base; the size of this tooth varies in different species. The general shape of this type of mandible is as shown in Pl. III, figs. 1-7. Alternatively, the tooth on the mesal margin may be obtuse, and it is then situated either midway along this margin or nearer to the apex or to the base, and the shape of the mandible is various (Pl. III, figs. 8-13).

Only the setae situated on the upper surface of the labium (Pl. VI) are used in the key, and in the figures only these are shown. The setae inserted on the lower surface are not figured although visible in the preparations. The limits between the segments of the labium are not visible on the thin-walled upper surface, although conspicuous on the lower surface. A horizontal fold lies across the labium near the junction of the prementum and postmentum, where the distal part of the labium telescopes into the proximal part; the visible degree of telescoping differs slightly in different preparations, and this may affect the apparent position of setae. The following sets of setae are referred to in the key.

A conspicuous pair of strong setae lies near the middle line in all species. These setae may be inserted in or very close to the fold in some species, or some distance proximal or distal to it in others. They appear to be homologous, but it has not been ascertained whether they belong to the prementum or postmentum. In some species these setae are not stronger than others on the prementum (Pl. VI, figs. 54-56), while in other species they are markedly stronger, at least twice as wide as other setae on the prementum (Pl. VI, figs. 45-53). In some species there is a variable number of additional setae irregularly disposed near the main pair (Pl. VI, figs. 48 & 52). The following intra-specific variations have been noted. In the species where the pair of dorsal setae are inserted near the fold across the labium, *e.g.*, *P. fur* and *P. pusillus*, the position of the fold in different preparations may leave the dorsal setae either just anterior or just posterior to the fold, but it is not unlikely that the positions of the setae vary as well as the position of the fold. The setae are not always symmetrically placed, although they are usually of the same size. When additional setae are present, they show very little bilateral symmetry and much individual variation in numbers.

All species show one or more setae forming an irregular lateral row across the base of the prementum. This row may continue laterally to the lower side of the labium, but only those setae inserted on its upper surface are referred to in the key. Their number varies in different species, and small individual and bilateral variations occur.

Distal to the above setae, the larger species may show a few setae which, when sufficiently numerous, form laterally a transverse row at the base of the palp. When only one or two setae are present, they appear to be inserted on the prementum (Pl. VI, figs. 47, 50 & 54), but when three or four occur, as in *Niptus hololeucus* (Pl. VI, fig. 56), the row extends across the basal segment of the palp to its lateral border. The most conspicuous intra-specific variations occur in *P. pusillus* with 0-1 setae, in *P. fur* with 0-2 setae, and in *N. hololeucus* with 3-4 setae in this position.

Paired setae project beyond the anterior margin of the prementum between the palps. They are situated on or near the anterior margin, but their exact positions are variable. Only those setae inserted in the anterior margin of the prementum or on its upper surface are referred to in the key and are shown in the figures; setae which may be inserted here on the lower surface are not considered. When one or two pairs of setae are present they are clearly inserted on the prementum (Pl. VI, figs. 47 & 56), but when more numerous, they spread laterally on to the basal segment of the palp (Pl. VI, fig. 48). Short setules may be present or absent on the upper surfaces of the lateral parts of the prementum and the basal segment of the palp.

The legs (Pls. VII & VIII) show minor intra-specific variations in the shape of the claw, the empodial lobe when present, and in the number and exact positions of the setae, but the form of the claw and the general disposition of setae is common to all three pairs of legs and definite for each species.

The base of the claw bears one large seta situated on the mesal or antero-mesal border in all species. In *Trigonogenius globulus* an additional 1-3 setae are present on the posterior face (Pl. VIII, fig. 62), they are usually nearly as long as the claw, but they may project little beyond the empodial lobe. In all species except *N. hololeucus* an empodial lobe is present on the posterior side of the claw on all legs. In *T. globulus* and *Tipnus unicolor* the lobe is smaller than in other species and variable in extent. The entire margin is sometimes clearly defined, but in some specimens (Pl. VIII, figs. 62 & 65) the edge of the lobe does not appear to extend right across the claw. In the remaining 10 species showing a well defined empodial lobe, the variations in the shape of the latter are sufficient to render the exact shape of the lobe of little taxonomic value (*e.g.*, *P. fur* may appear as in Pl. VII, fig. 57, or the mesal margin of the lobe may be as shown in Pl. VII, fig. 59 for *P. villiger*).

The setae on the tibia show several distinct patterns of distribution. Two setae are situated distally on the upper surface near the claw in all species except *Stethomezium squamosum*, which bears only one seta in this position (Pl. VIII, fig. 63). A group of setae, usually 2-3 in number (Pl. VII, figs. 57 & 59 and Pl. VIII, fig. 61), but more in some species (Pl. VII, figs. 58 & 60), lie on the ventral side about half way along. On the dorsal surface the setae may be absent from the proximal half (Pl. VII, fig. 59) or quarter (Pl. VIII, figs. 57, 58 & 60) or may spread all along (Pl. VIII, figs. 61-64); when absent from the proximal quarter there is either a marked gap between the two dorsal setae near the claw and the rest, which form a band round the middle of the joint (Pl. VII, fig. 57 and Pl. VIII, fig. 65), or the setae spread all along to the two distal dorsal setae (Pl. VII, fig. 60). When setae are present dorsally on the proximal quarter their total number may be few, 5-6 in *S. squamosum* (Pl. VIII, fig. 63), or many, 10-21 (Pl. VIII, figs. 61 & 62). The number and exact positions of the setae on the tibia are very variable, but even in *Trigonogenius globulus*, where the widest range in numbers of setae has been found (11-23), the general disposition of the setae is constant and equally clear whether the numbers are small or large.

The spiracles (Pl. III, figs. 14-21) may be large, medium sized, or small, the length of the mandible being about $1\frac{1}{2}$, $2\text{-}3\frac{1}{2}$, or $5\frac{1}{2}\text{-}6\frac{1}{2}$ × the diameter of the spiracle respectively. The peritreme usually forms a lip projecting upwards and

backwards. The eight pairs of abdominal spiracles are similar in general form, except that the lip on the 7th pair may be the longest and that on the 8th pair is usually shorter than the rest and may be almost absent. The prothoracic spiracles are larger than those on the abdomen and often slightly different in shape. In *Niptus hololeucus* the lip is short and present on some segments only (Pl. III, figs. 14A & B). In *T. globulus* the lip is not much narrower than the spiracle, and the sides of the lip tend to converge (Pl. III, figs. 18A & B). In all other species the lip is long and its sides approximately parallel (Pl. III, figs. 16, 17, 19-21).

Variations in the size of the spiracles and in the form of the lip of the peritreme are so great among specimens of *P. fur* and *P. latro,* that the considerable differences which are apparent between the nine species with medium sized spiracles may not be of reliable taxonomic value; they have not been referred to in the key and are summarised on p. 345. The length of the lip is more variable than its width. In species where the lip is long there is considerable bilateral symmetry between spiracles of a pair, but where the lip is short, as in *Niptus hololeucus* and *P. villiger,* there may be much bilateral variation (*e.g.* in *P. villiger* a lip may be present on one side only of the prothorax, although occurring on both sides of all abdominal segments; and in *N. hololeucus* a small lip, bilaterally unequal in size, may occur on the prothorax, and a small lip may be present on some of the abdominal spiracles, but showing no bilateral symmetry in its presence or in its size, and appearing on different segments in different individuals). In *Trigonogenius globulus* where the lip is relatively wide, the sides of the lip tend to be parallel when the lip is long, but on most segments the sides converge. Parallel sided lips may occasionally be found on different segments in different individuals.

The preanal sclerite and the setae near it show such extensive intra-specific variation that only gross differences can be used in the key. In species where the sclerite is large and U-shaped, the arms may be equal or unequal, and may embrace a variable length of the anal groove (*e.g.*, less than one-third to a half in *P. pusillus* and either more or less than a half in *P. fur*). The inner margin of the sclerite may be either U- or V-shaped and the width of the sclerite is variable in different individuals. In species with a small sclerite, where the arms are short and diverge widely so that they embrace only the extreme end of the anal groove, the sclerite is frequently asymmetrical and the outline various (*e.g., T. globulus* (Pl. IX, figs. 67 & 68), where the arms may be so short as to form a triangular sclerite). The setae near the anus and anal sclerite are arranged in sets, and their abundance appears to be correlated with the degree of hairiness of the body, but there is so much bilateral and individual variation that no satisfactory taxonomic employment of these features has been found.

The degree of hairiness of the body is probably of taxonomic value, but no simple method of evaluating this feature has been devised. The length and abundance of the labral setae are probably correlated with the degree of hairiness of the body and legs; the labral setae projecting beyond the margin of the epipharynx are shown in the figures and record the density and length for each species.

Inter-Generic and Inter-Specific Differences.

The chaetotaxy of the species here considered is correlated to a certain extent with the absolute size of the animals. The smaller species, such as *Tipnus unicolor* and *Stethomezium squamosum,* have fewer and relatively larger setae than the larger ones, such as *P. fur, P. pusillus, Trigonogenius globulus* and *Niptus hololeucus.* Different species of closely similar size also show differences in abundance and size of setae. *P. villiger,* for example, has fewer, shorter setae than *T. globulus, P. pusillus* and *P.* sp. indet., but these differences are not so striking as those between the larger and smaller species.

Many of the inter-generic and inter-specific differences shown by the species here considered have been referred to in the key, and the remainder are noted here. All these characters are illustrated by the figures. In considering the inter-specific differences, the extensive intra-specific variations must be borne in mind.

The length of the tactile appendix of the antenna is about equal to the breadth in *Gibbium psylloides* and in *Niptus hololeucus*; it is about 1½ × the breadth in *Trigonogenius globulus, Stethomezium squamosum, P.* sp. indet. and *P. tectus;* about 2-2½ × the breadth in *Tipnus unicolor, P. pusillus, P. hirtellus, P. latro, P. raptor,* and *P. fur*; and about 3 × the breadth in *P. villiger.*

There are three labral sensillae in all species except *P. hirtellus* and *Niptus hololeucus,* where there are four.

The inner arm of the Y-shaped sclerite in the epipharynx is very much shorter than the outer arm in *Trigonogenius globulus,* and in *P. villiger* it is extremely short and knob-like. In all others the inner arm is almost or quite as long as the outer arm, and, except in *P. tectus, P.* sp. indet. and *Gibbium psylloides* where the inner arm is distinctly wider than the outer arm, the inner arm is either narrower or the same width as the outer arm. In *P. tectus* and *P.* sp. indet. the wide inner arms tend to unite with one another across the middle line (Pl. V, figs. 38 & 42).

Setae on the epipharynx have not been fully described in the key. Their characters in each species can be ascertained by reference to the figures and to the intra-specific variations noted on p. 343. They show fairly easily distinguishable patterns in the genera of which only one species has been seen, although *Trigonogenius globulus* may appear not unlike *P.* sp. indet. Within the genius *Ptinus, P. fur, P. raptor, P. hirtellus* and *P. latro* show almost indistinguishable patterns and *P. villiger* is very close to them, while *P. tectus* differs from the other species as greatly as any of them differ from the other genera.

The mandibles of seven of the eight species of *Ptinus* are very alike. The acutely projecting tooth on the mesal margin is smallest in *P. raptor* and *P. villiger,* largest in *P. latro* and *P.* sp. indet., and intermediate in *P. hirtellus, P. fur,* and *P. pusillus.* The mandibles of *P. tectus* and the other genera have an obtuse tooth on the mesal margin, which is situated nearer to the base in *Tipnus unicolor* and nearer to the apex in *P. tectus, Niptus hololeucus, Trigonogenius globulus, Gibbium psylloides* and *Stethomezium squamosum.*

Setae on the upper side of the labium are not always easy to observe, and the differences between some species are not great. Six species of *Ptinus* differ only slightly: *P. fur* and *P. hirtellus* are alike with 4-5 setae on each side across the base of the prementum, 0-2 setae at the base of the palps, 2 pairs of setae projecting beyond the anterior margin of the prementum between the palps, and a few setules on the basal joint of the palp but none on the prementum. *P. pusillus* and *P. villiger* resemble each other and differ from the above in having 6-7 setae on each side across the base of the prementum, 0-2 setae at the base of the palps, 1-2 pairs of setae projecting beyond the anterior margin of the prementum between the palps, and many setules situated both on the basal joint of the palp and on the lateral parts of the prementum. *P. raptor* and *P. latro* have fewer setules than *P. pusillus* and *P. villiger,* and are intermediate between the above two pairs of species, and are not clearly distinguishable from either. The remaining species are each quite distinct. *Niptus hololeucus* and *Trigonogenius globulus,* like *Stethomezium squamosum,* have the pair of setae near the middle line not markedly stronger than other setae on the prementum and differ in that *N. hololeucus* has 3-4 setae on each side at the base of the palp and setules on the basal segment of the palp only, while *T. globulus* has one seta on each side at the base of the palp and setules on the prementum and on the basal segment of the palp. The other five species are described in the key.

The tarsus is similar in all eight species of *Ptinus* and in *Stethomezium squamosum*, *Gibbium psylloides* and *Tipnus unicolor*, although the empodial lobe is ill-defined in *T. unicolor*. *Trigonogenius globulus* and *Niptus hololeucus* each show a distinct type.

The setae on the tibia are indistinguishable in number and arrangement in *P. fur*, *P. tectus*, *Tipnus unicolor* and *Gibbium psylloides* with 8-13 setae which are absent from the proximal quarter and arranged as in Pl. VII, figs. 57, 58, & Pl. VIII, fig. 65. *P.* sp. indet. is very like these but has more setae (15-21) (Pl. VII, fig. 60). *P. raptor* differs from the above five species in the setae on the dorsal side extending along the whole of the distal two-thirds of the tibia. *P., villiger* and *Stethomezium squamosum* are each distinct from all others as noted in the key. *P. latro*, *P. hirtellus*, and *Niptus hololeucus* are indistinguishable from each other with setae present on the proximal quarter, and numbering 10-15. *P. pusillus* differs only in having more setae (19-20), and *Trigonogenius globulus* may resemble any of these four species, bearing 11-23 setae.

The preanal sclerite is large and U-shaped in *P. fur*, *P. pusillus*, *P. hirtellus*, *P. latro*, *P. raptor*, and *P. villiger*, and small in *P.* sp. indet, and *P. tectus* and the other genera.

The five genera represented by one species each can be readily identified by the following characters: *Niptus hololeucus* by the tarsus, spiracles, epipharynx and labium; *Trigonogenius globulus* by the tarsus, spiracles and labium; *Tipnus unicolor* by the mandible, epipharynx and labium; *Stethomezium squamosum* by the spiracles, epipharynx and labium; and *Gibbium psylloides* by the epipharynx and labium. The genus *Ptinus*, represented by eight species, cannot be diagnosed by any character common to all the species in contrast to the other genera. *P. tectus* may be readily distinguished from the other species by its very distinct mandible and epipharynx and the presence of a small preanal sclerite, and *P. villiger* by its very distinct type of spiracle, Y-shaped sclerite in the labrum, and setae on the tibia. *P. fur*, *P. raptor*, *P. pusillus*, *P. hirtellus* and *P. latro* are closely similar in most features. *P. hirtellus* is easily separable by its four labral sensillae, but is otherwise indistinguishable from *P. latro*, and the others are separable as shown in the key. *P.* sp. indet. resembles *P. tectus* and differs from the other species of *Ptinus* in many characters, *viz.*, the small preanal sclerite, the length of the antenna, the shape of the Y-shaped sclerite in the labrum, the presence of additional setae near the strong pair near the middle line on the upper side of the labium, and in having more than two pairs of setae projecting beyond the anterior margin of the prementum, but the two species are very unlike in the mandible, the epipharynx, the labral setae, and in size.

In the adult beetles, Hinton (1941) has noted that *P. tectus* may be readily distinguished from other species of the genus, that *P. fur* and *P. pusillus* are closely related, and that *P. hirtellus* is very close to *P. latro*. Thus as far as larval material has been examined, the species which appear to be closely or distantly related in the adult state show the same relationships in the late larval phase.

Characters common to the Ptinid Larvae referred to in the Key.

Böving (1927) has commented on the classification of families connected with the ANOBIIDAE and on the relationship of the PTINIDAE to the ANOBIIDAE, and he characterises the larvae of the tribes and genera of the latter. The characters common to the Ptinid larvae considered in this key are given below so that a ready comparison may be made between them and the larvae of related groups.

Labrum hairy. Epipharynx with a pair of diverging rows of spine-like setae about 5-10 in number, with irregular transverse rows near the front margin between the diverging rows comprising 5 or more setae, and sometimes with additional setae lateral to the diverging rows. No median or paramedian chitinous marks. A pair of Y-shaped sclerites present in the labrum, visible from either labral or epipharyngeal sides. Mandible with one apical tooth and one tooth about

half way along the mesal margin. Maxillary mala simple, but with inner and outer parts differentiated; the inner part bears one large chitinous process, 2 large spines and other setae, and the outer part bears many stout spines and other setae. Labium with prementum forming no projection distally between the palps. One pair of strong setae present near the middle line on the upper side near the junction of the prementum and and mentum. Tibia with long hairs more or less evenly distributed, no short spines. Body covered with long soft hairs. Preanal sclerite present.

KEY TO MATURE OR NEARLY MATURE LARVAE OF THE PTINIDAE.

1. Preanal sclerite large, U-shaped, reaching to about the middle of the anal groove (Pl. IX, fig. 66) 2
— Preanal sclerite small, variable in size and shape, the arms of the triangular or slightly U-shaped sclerite too short to embrace more than the extreme end of the anal groove (Pl. IX, figs. 67 & 68).....7
2. Labrum with 4 sub-basal sensillae (Pl. IV, fig. 32).....*Ptinus hirtellus*, Sturm
— Labrum with 3 sub-basal sensillae (Pls. IV & V).....3
3. Width of the first abdominal spiracle (Pl. III, fig. 15) is about 6 × that of its lip; spiracles large, length of mandible being about 1·5 × the longest diameter of the first abdominal spiracle. The inner arm of the Y-shaped sclerite in the labrum very much shorter than the outer arm, knob-shaped (Pl. IV, fig. 33). Tibia with setae absent from the proximal half of the upper surface, and bearing about 7-8 setae (Pl. VII, fig. 59).
.....*Ptinus villiger*, Reitt.
— Width of the first abdominal spiracle (Pl. III, figs. 16, 17 & 20) is about 2-3½ × that of its lip; spiracles medium sized, length of mandible being 2-3½ × the longest diameter of the first abdominal spiracle. The inner arm of the Y-shaped sclerite in the labrum (Pl. IV, figs. 34-37) as long or almost as long as the outer arm. Tibia with setae present on the proximal half of the upper surface (Pl. VII, figs. 57 & 60; Pl. VIII, fig. 61) 4
4. Tibia with setae absent from the proximal quarter of the upper surface (Pl. VII, figs. 57 & 60) 5
— Tibia with setae present on the proximal quarter of the upper surface (Pl. VIII, fig. 61) 6
5. Tibia with setae extending dorsally along the whole of the distal two-thirds or three-quarters, total number about 21-23 (Pl. VII, fig. 60). Tooth on the mesal margin of the mandible (Pl. III, fig. 6) slightly smaller and projecting markedly less than in *P. fur*.....*Ptinus raptor*, Sturm
— Tibia with setae forming a band round the middle which is separated by a gap from two dorsal setae near the distal end, total number 8-13 (Pl. VII, fig. 57). Tooth on the mesal margin of the mandible (Pl. III, fig. 3) slightly larger than in *P. raptor* and projecting acutely.....*Ptinus fur*, L.
6. Tibia with about 19-20 setae. The epipharynx (Pl. IV, fig. 35) with the main pair of diverging rows of setae numbering about 7-9 and sharper than in *P. latro*; with the setae lateral to the diverging rows numbering 0-6 and tending to form one subsidiary row parallel to the diverging rows; with a basal median group of 3-8 small setae; and with the setae composing the irregular transverse rows near the front margin, between the diverging rows, tapering and sharp and more numerous than in *P. latro*.
.....*Ptinus pusillus*, Sturm
— Tibia with about 12-13 setae. The epipharynx (Pl. IV, fig. 36) with the main pair of diverging rows or setae numbering about 7 and blunter than in *P. pusillus*; with setae lateral to the diverging rows usually absent; with the basal median group usually represented by one seta; and with the

setae composing the irregular transverse rows near the front margin, between the diverging rows, blunter and fewer than in *P. pusillus*.
.....*Ptinus latro*, F.

7. Claw of tarsus (Pl. VIII, fig. 64) without empodial lobe. Labrum with 4 sub-basal sensillae (Pl. V, fig. 44). Epipharynx with the main pair of diverging rows of setae each bearing a large flat pointed seta situated proximal to a large flat seta with a very blunt extremity. Spiracles (Pl. III, figs. 14 A & B) with a short lip on the peritreme on some segments and no lip on others; width of the first abdominal spiracle is about $4\frac{1}{2}$ × that of its lip when the lip is present; spiracles medium sized. Upper side of labium (Pl. VI, fig. 56) with a transverse row of 3-5 setae at the base of the palp .....*Niptus hololeucus*, Fald.

— Claw of tarsus with an empodial lobe (Pl. VII, figs. 58-60; Pl. VIII, figs. 61-63 & 65). Labrum with 3 sub-basal sensillae (Pl. IV, figs. 33-37; Pl. V, figs. 38-43). Epipharynx not as above. Spiracles with a long lip on the peritreme on most segments other than the eighth abdominal segment (as in Pl. III, figs. 16-21); the width of the first abdominal spiracle is $1\frac{1}{2}$ × that of its lip, when the lip has parallel sides.....8

8. Claw of tarsus (Pl. VIII, fig. 62) bearing a few (1-3) setae on the posterior side in addition to the seta on the antero-mesal border. The lip on the peritreme of the spiracles (Pl. III, figs. 18 A & B) on most segments is wider towards the base, and the sides tend to converge instead of being parallel on many segments. The inner arm of the Y-shaped sclerites in the labrum (Pl. V, fig. 43) is considerably shorter than the outer arm.
.....*Trigonogenius globulus*, Sol.

— Claw of tarsus (Pl. VII, figs. 57-60; Pl. VIII, figs. 61 & 63-65) bearing no setae on the posterior side in addition to the seta on the mesal or antero-mesal border. The lip on the peritreme of the spiracles (as in Pl. III, figs. 16, 17 & 19-21) has approximately parallel sides and is not markedly wider near its base. The arms of the Y-shaped sclerites in the labrum (Pl. V, figs. 38-42) are approximately equal in length 9

9. Distal margin of the epipharynx (Pl. V, fig. 39) distinctly concave in the middle line. The upper surface of the labium (Pl. VI, fig. 53) with one pair of strong setae near the middle line, at least twice as wide as other setae on the prementum, and about 1-2 additional setae; with about 3 setae on each side across the base of the prementum; and with a few setules on the basal segment of the palp and prementum.
..... *Gibbium psylloides*, Czemp.

— Distal margin of the epipharynx (Pl. V. figs. 38 & 40-42) convex or straight in the middle line. Labium not as above.....10

10. Epipharynx (Pl. V, figs. 40 & 41) small, less than 130 μ wide at the transverse fold; with the setae of the diverging rows numbering about 5; and with setae lateral to the diverging rows absent. The upper side of the labium (Pl. VI, figs. 51 & 55) bearing no strong setae near and in addition to the pair near the middle line.....11

— Epipharynx (Pl. V, figs. 38 & 42) larger, more than 160 μ wide; with the setae of the diverging rows numbering more than 5; and with setae lateral to the diverging rows present. The upper side of the labium (Pl. VI, figs. 48 & 52) bearing several strong setae near and in addition to the pair near the middle line 12

11. Claw of tarsus (Pl. VIII, fig. 65) with a small empodial lobe which may be ill-defined; the base of the brown part of the claw not markedly expanded on the mesal side. Setae on the tibia absent from the proximal quarter of the dorsal surface, and about 9-10 in number. The two proximal pairs of setae on the diverging rows on the epipharynx (Pl. V, fig. 40) are almost the same distance apart. Mandible (Pl. III, fig. 11) wide, the

length being about 1·2 × the width; the tooth on the mesal margin obtuse, its point being nearer to the base than to the apex of the mandible. Tactile appendix of antenna (Pl. III, fig. 28) almost twice as long as wide. The upper side of the labium (Pl. VI, fig. 51) bearing one pair of strong setae near the middle line, at least twice as wide as other setae on the prementum; and with a few setules on the prementum and basal segment of the palp. Spiracles medium sized, the length of the mandible being about 3 × the diameter of the first abdominal spiracle .....*Tipnus unicolor*, Piller & Mitt.

— Claw of tarsus (Pl. VIII, fig. 63) with a large clearly defined empodial lobe; the base of the brown part of the claw markedly expanded on the mesal side distal to the seta. Tibia with setae present on the proximal quarter of the dorsal surface and numbering about 5-6. The basal pair of setae of the diverging rows on the epipharynx (Pl. V, fig. 41) separated by a distance of half that which separates the next pair of setae. Mandible (Pl. III, fig. 9) narrower than in *Tipnus unicolor*, length being about 1½ × the width; tooth on the mesal margin obtuse, its point being nearer to the apex than to the base of the mandible; the apex of the mandible more curved than in *T. unicolor*. Tactile appendix of the antenna slightly longer than wide (Pl. III, fig. 30). The upper side of the labium (Pl. VI, fig. 55) bearing one pair of setae near the middle line which are not stronger than other setae on the prementum; no setules present on the prementum or on the basal segment of the palp. Spiracles (Pl. III, fig. 19) small, the length of the mandible being about 6½ × the diameter of the first abdominal spiracle.....*Stethomezium squamosum*, Hinton

12. Few setae on the epipharynx (Pl. V, fig. 38); the setae on the diverging rows are all distal to the Y-shaped sclerites; no median group of setae present between the inner arms of the Y-shaped sclerites; and there are a few setae lateral to the diverging rows. Mandible (Pl. III, fig. 8) wide, the length being about 1·2 × the width; the tooth on the mesal margin obtuse. The upper side of the labium (Pl. VI, fig. 48) with 1-2 setae on each side across the base of the prementum; with about 4 pairs of setae projecting beyond the anterior margin of the prementum between the palps. Tibia with about 11 setae. Fewer setae on the labrum and round the anus than in *Ptinus* sp. indet. .....*Ptinus tectus*, Boield.

— Many setae on the epipharynx (Pl. V, fig. 42); the diverging rows of setae are not separable from a median basal group of small setae between the inner arms of the Y-shaped sclerites; many setae lateral to the diverging rows are present. Mandible (Pl. III, fig. 1) narrower than in *P. tectus*, the length being about 1·4 × the width; the tooth on the mesal margin acute. The upper side of the labium (Pl. VI, fig. 52) with about 3-5 setae on each side across the base of the prementum; and with about 5-7 pairs of setae projecting beyond the anterior margin of the prementum between the palps. Tibia (Pl. VII, fig. 58) with about 15-21 setae. Many setae on the labrum and round the anus .....*Ptinus* sp. indet.

Acknowledgment.

The material used in the preparation of this key has been provided by Dr. H. E. Hinton who has bred the larvae. I should like to thank Dr. Hinton for suggesting the problem and for his assistance with technique and literature.

References.

Böving, A. G. (1927). The larva of *Nevermannia dorcatomoides* Fisher with comments on the classification of the Anobiidae according to their larvae (Coleoptera: Anobiidae).—Proc. ent. Soc. Wash., **29**, pp. 51-62, 1 pl.

Hinton, H. E. (1941). The Ptinidae of economic importance.—Bull. ent. Res., **31**, pp. 331-381, 59 figs.

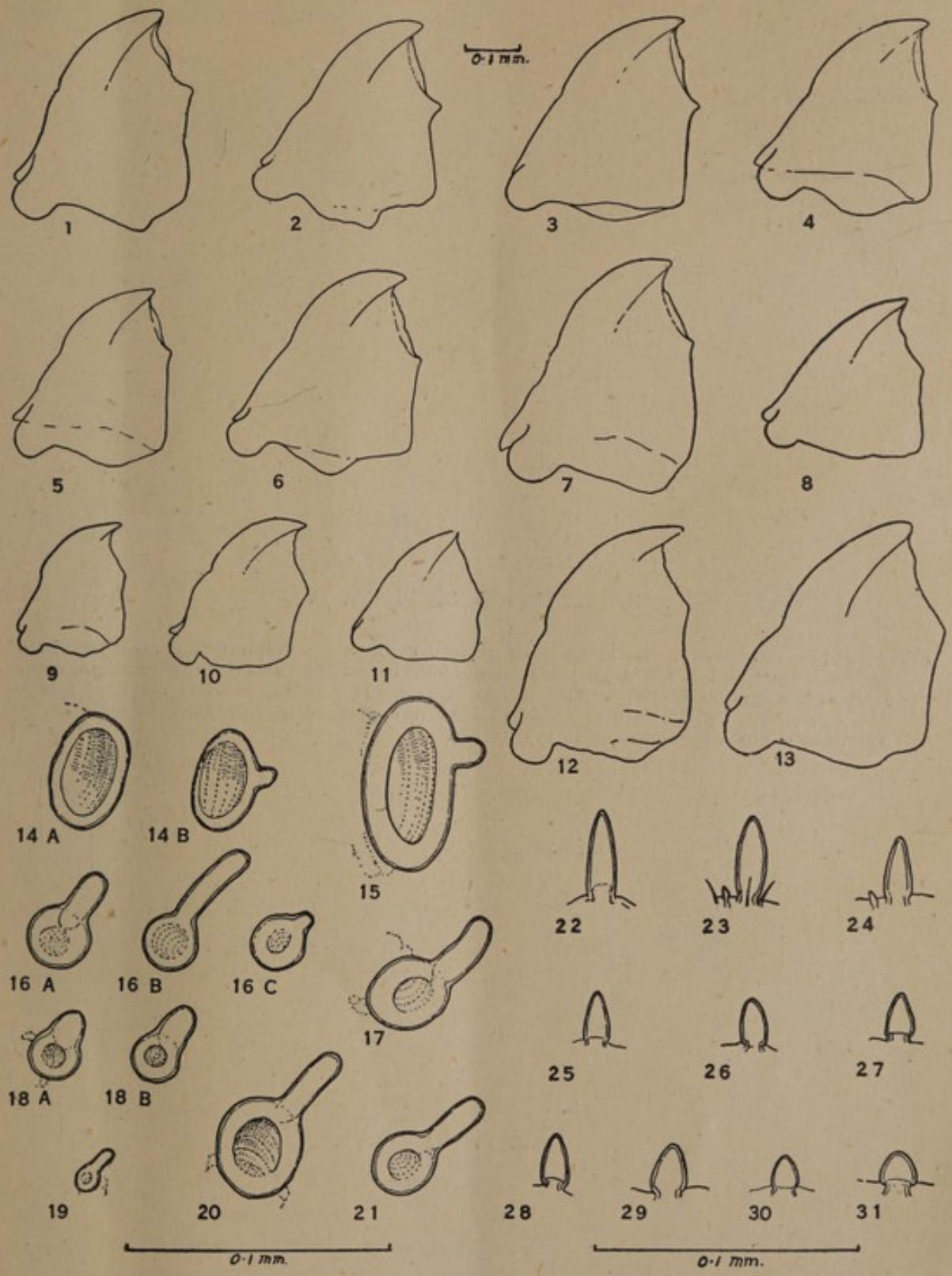
EXPLANATION OF PLATE III.

FIGS. 1–13.—Mandibles: (1) *Ptinus* sp. indet. (2) *P. latro*. (3) *P. fur*. (4) *P. pusillus*. (5) *P. hirtellus*. (6) *P. raptor*. (7) *P. villiger*. (8) *P. tectus*. (9) *Stethomezium squamosum*. (10) *Gibbium psylloides*. (11) *Tipnus unicolor*. (12) *Niptus hololeucus*. (13) *Trigonogenius globulus*.

FIGS. 14–21.—Peritreme of Spiracles: (14 A, B) First and third abdominal spiracles of *Niptus hololeucus*. (15) First abdominal spiracle of *Ptinus villiger*. (16 A–C) First, seventh and eighth abdominal spiracles of *P. latro*. (17) First abdominal spiracle of *P. fur*. (18 A, B) First and third abdominal spiracles of *Trigonogenius globulus*. (19) First abdominal spiracle of *Stethomezium squamosum*. (20) First abdominal spiracle of *P. pusillus*. (21) First abdominal spiracle of *P. hirtellus*.

FIGS. 22–31.—Tactile Appendix of Antenna: (22) *P. villiger*. (23) *P. fur* (*P. raptor* may be like this or like fig. 25). (24) *P. pusillus*. (25) *P. hirtellus* (*P. latro* is very like this). (26) *P.* sp. indet. (27) *P. tectus*. (28) *Tipnus unicolor*. (29) *Trigonogenius globulus*. (30) *Stethomezium squamosum* (*Gibbium psylloides* is very like this). (31) *Niptus hololeucus*.

Bull. Ent. Research. Vol. 35. Plate III.

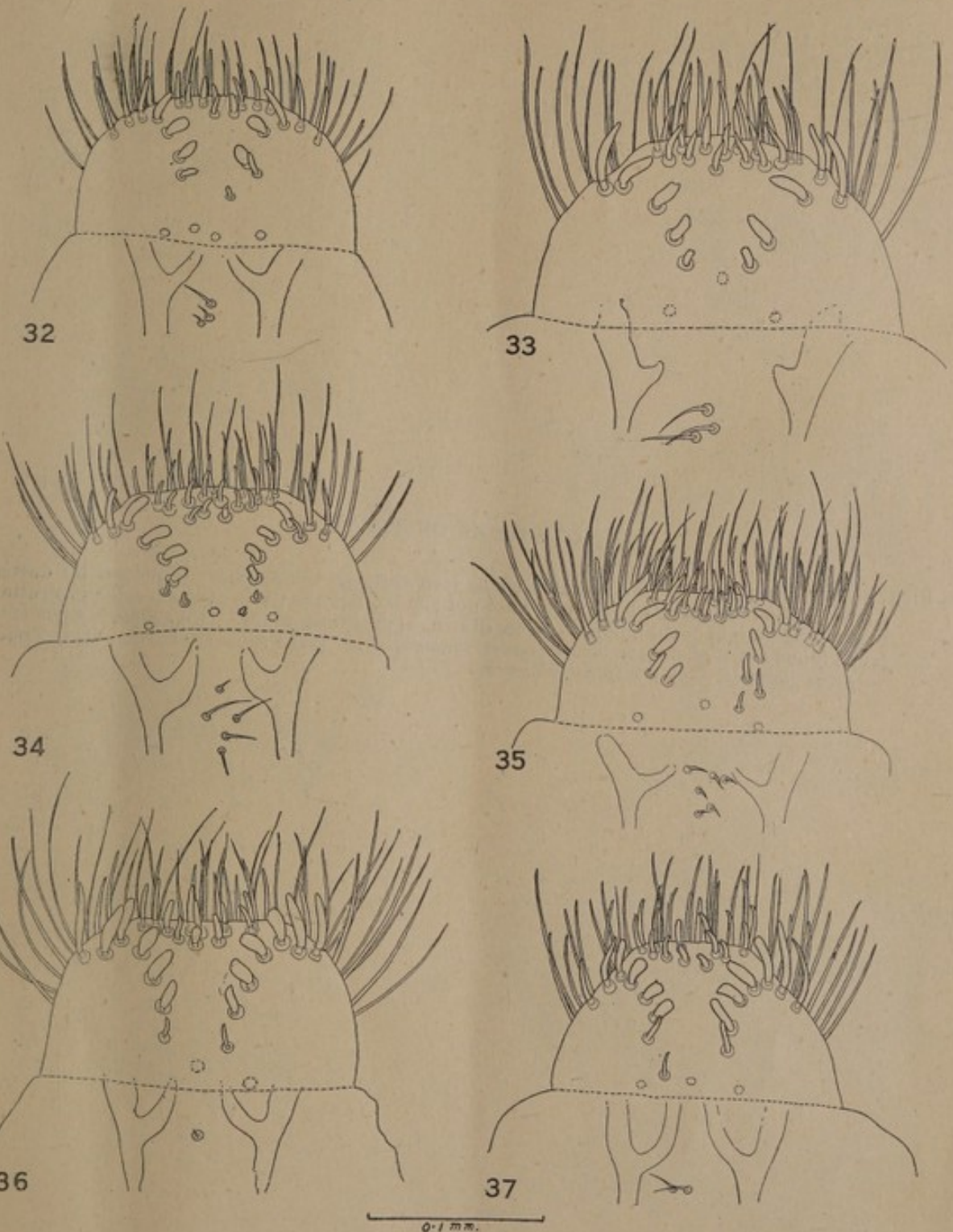


EXPLANATION OF PLATE IV.

FIGS. 32–37.—Epipharynx, with labral sensillae seen through the epipharynx shown by dotted circles. The bases of the labral setae are not shown, but the parts of these setae projecting beyond the margin of the epipharynx are drawn. (32) *Ptinus hirtellus*. (33) *P. villiger*. (34) *P. raptor*. (35) *P. pusillus*. (36) *P. latro* (the absence of one lateral sensilla in this specimen is probably abnormal). (37) *P. fur*.

Bull. Ent. Research. Vol. 35.

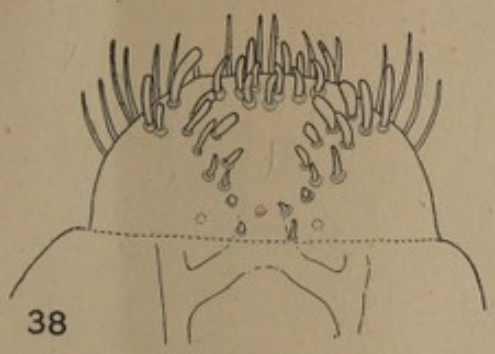
Plate IV.

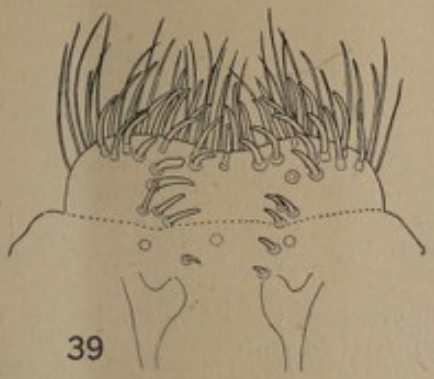


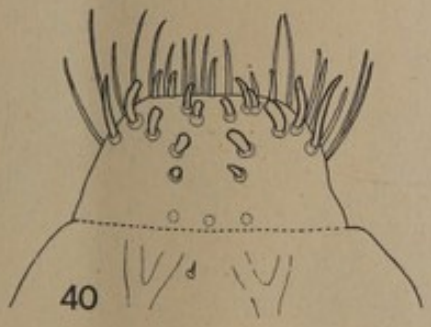
EXPLANATION OF PLATE V.

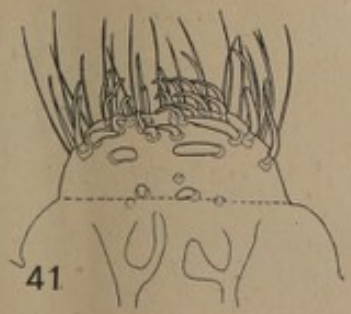
FIGS 38–44.—Epipharynx, with labral sensillae seen through the epipharynx shown by dotted circles. The bases of the labral setae are not shown, but the parts of these setae projecting beyond the margin of the epipharynx are drawn. (38) *Ptinus tectus*. (39) *Gibbium psylloides*. (40) *Tipnus unicolor*. (41) *Stethomezium squamosum*. (42) *Ptinus* sp. indet. (43) *Trigonogenius globulus*. (44) *Niptus hololeucus*.

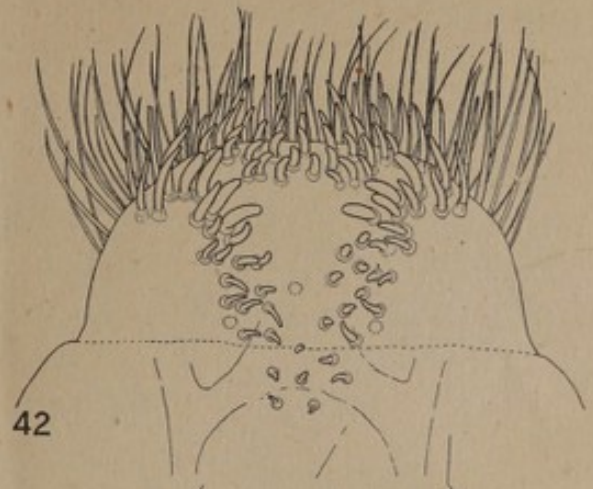
Bull. Ent. Research. Vol. 35. Plate V.

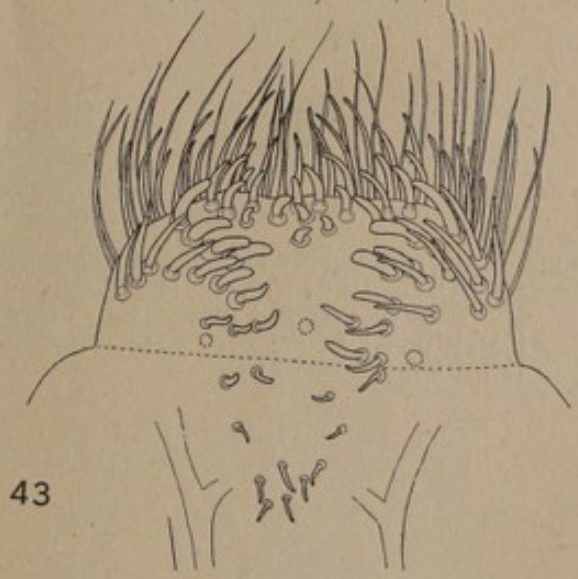

38

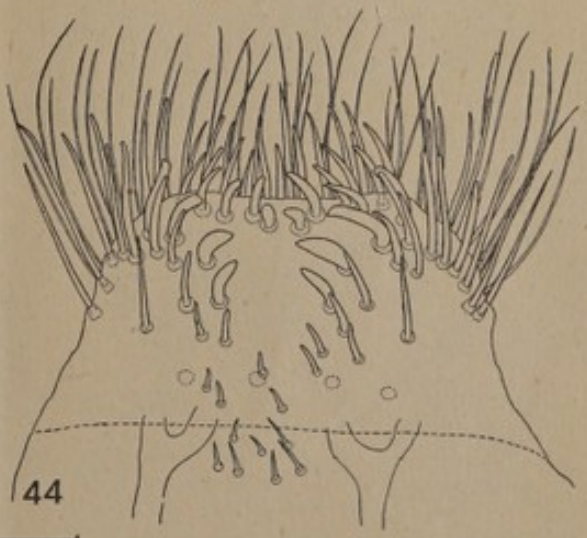

39


40


41


42


43

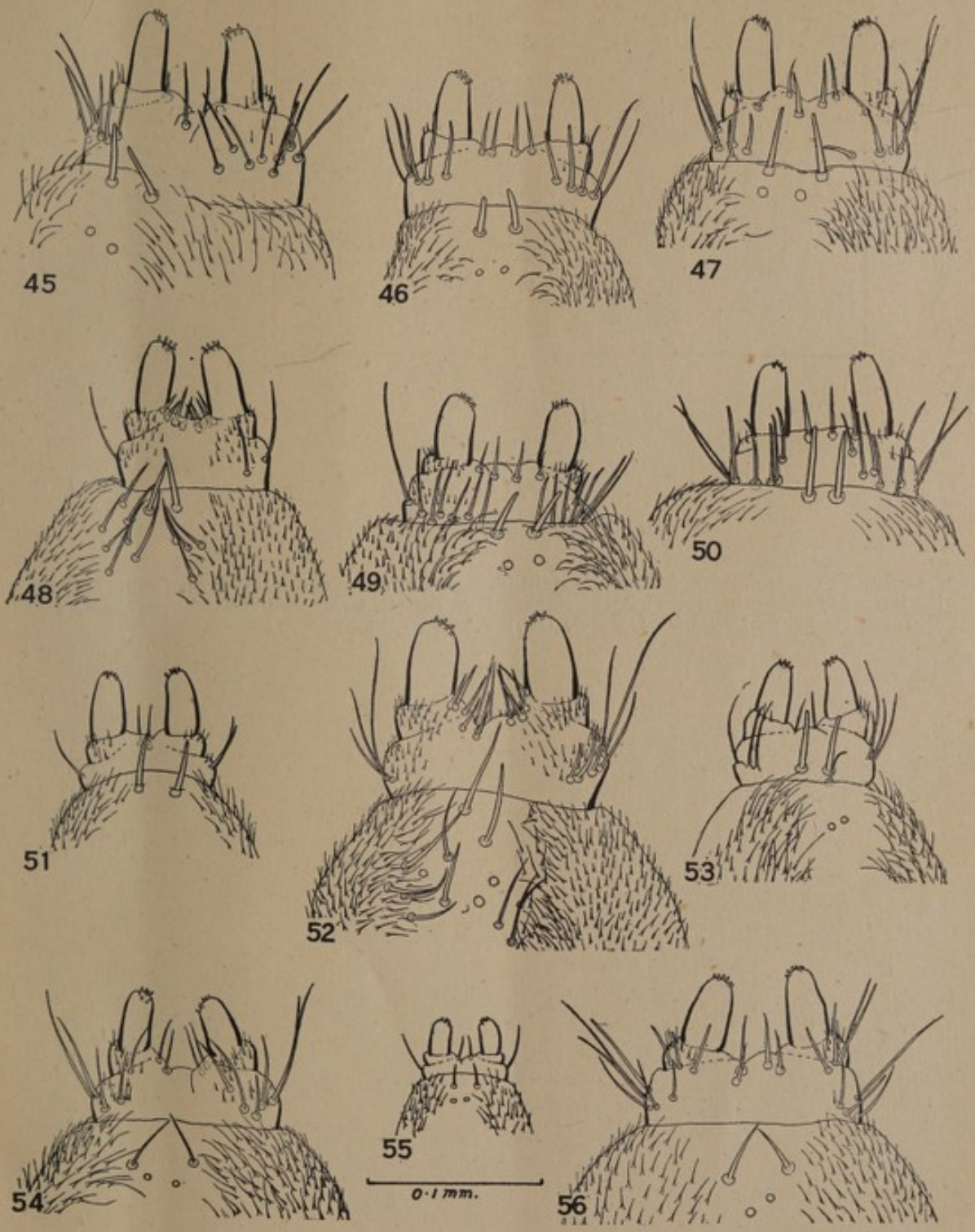

44

0·1 mm.

EXPLANATION OF PLATE VI.

FIGS. 45–56.—The upper Side of the Labium, the setae inserted on the lower surface are not shown: (45) *Ptinus latro*. (46) *P. hirtellus*. (47) *P. fur*. (48) *P. tectus*. (49) *P. pusillus* (*P. villiger* is very like this). (50) *P. raptor*. (51) *Tipnus unicolor*. (52) *Ptinus* sp. indet. (53) *Gibbium psylloides*. (54) *Trigonogenius globulus*. (55) *Stethomezium squamosum*. (56) *Niptus hololeucus*.

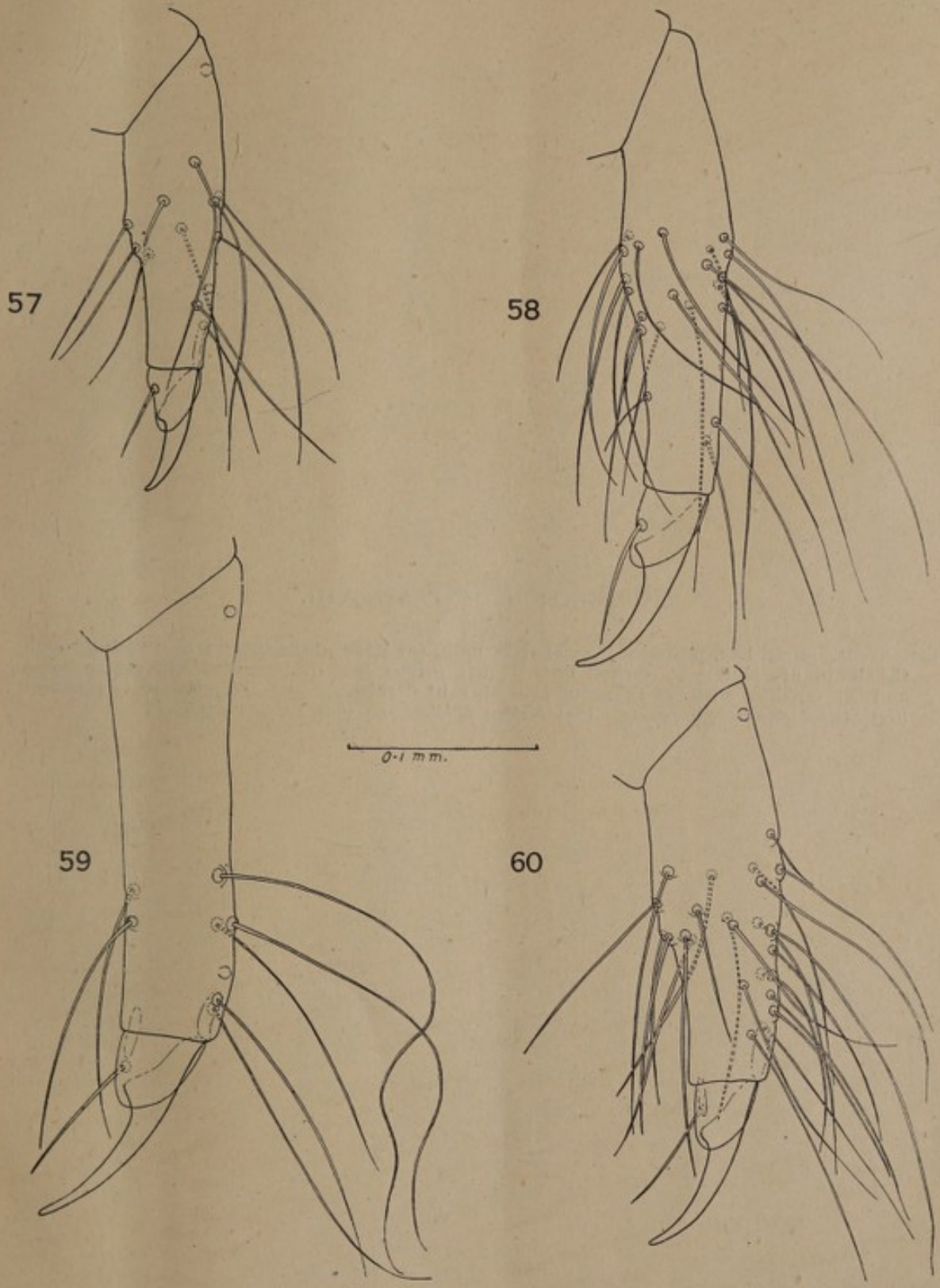
Bull. Ent. Research. Vol. 35. Plate VI.



EXPLANATION OF PLATE VII.

FIGS. 57–60.—First Leg, posterior view of right limb, the setae on the anterior side, seen through the limb, are shown by dotted lines: (57) *Ptinus fur* (*P. tectus* and *Gibbium psylloides* are also like this). (58) *Ptinus* sp. indet. (59) *P. villiger*. (60) *P. raptor*.

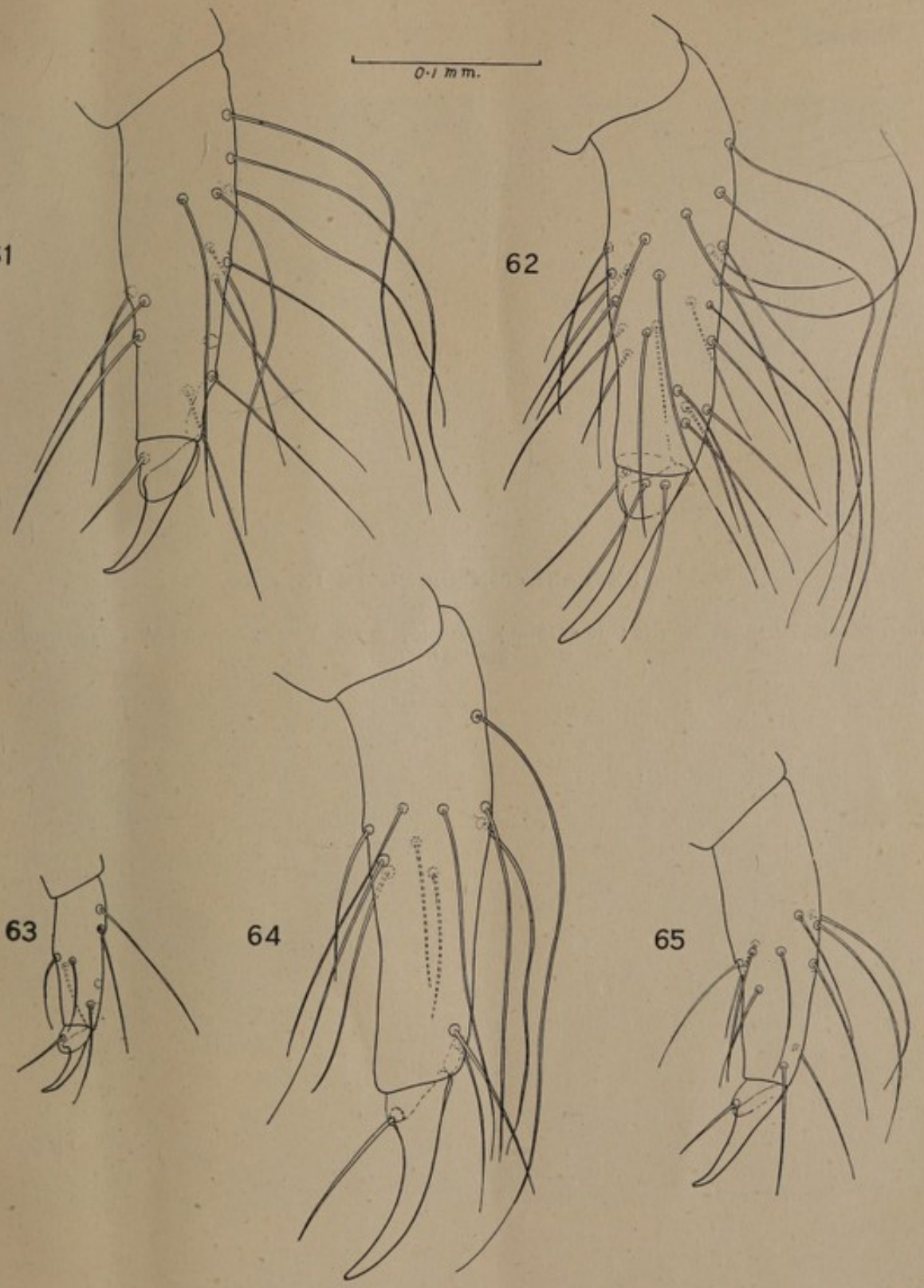
Bull. Ent. Research. Vol. 35. Plate VII.



EXPLANATION OF PLATE VIII.

FIGS. 61–65.—First Leg, posterior view of right limb, the setae on the anterior side, seen through the limb, are shown by dotted lines: (61) *Ptinus latro* (*P. pusillus* with 19-20 setae and *P. hirtellus* with 12-15 setae are also like this). (62) *Trigonogenius globulus*. (63) *Stethomezium squamosum*. (64) *Niptus hololeucus*. (65) *Tipnus unicolor*.

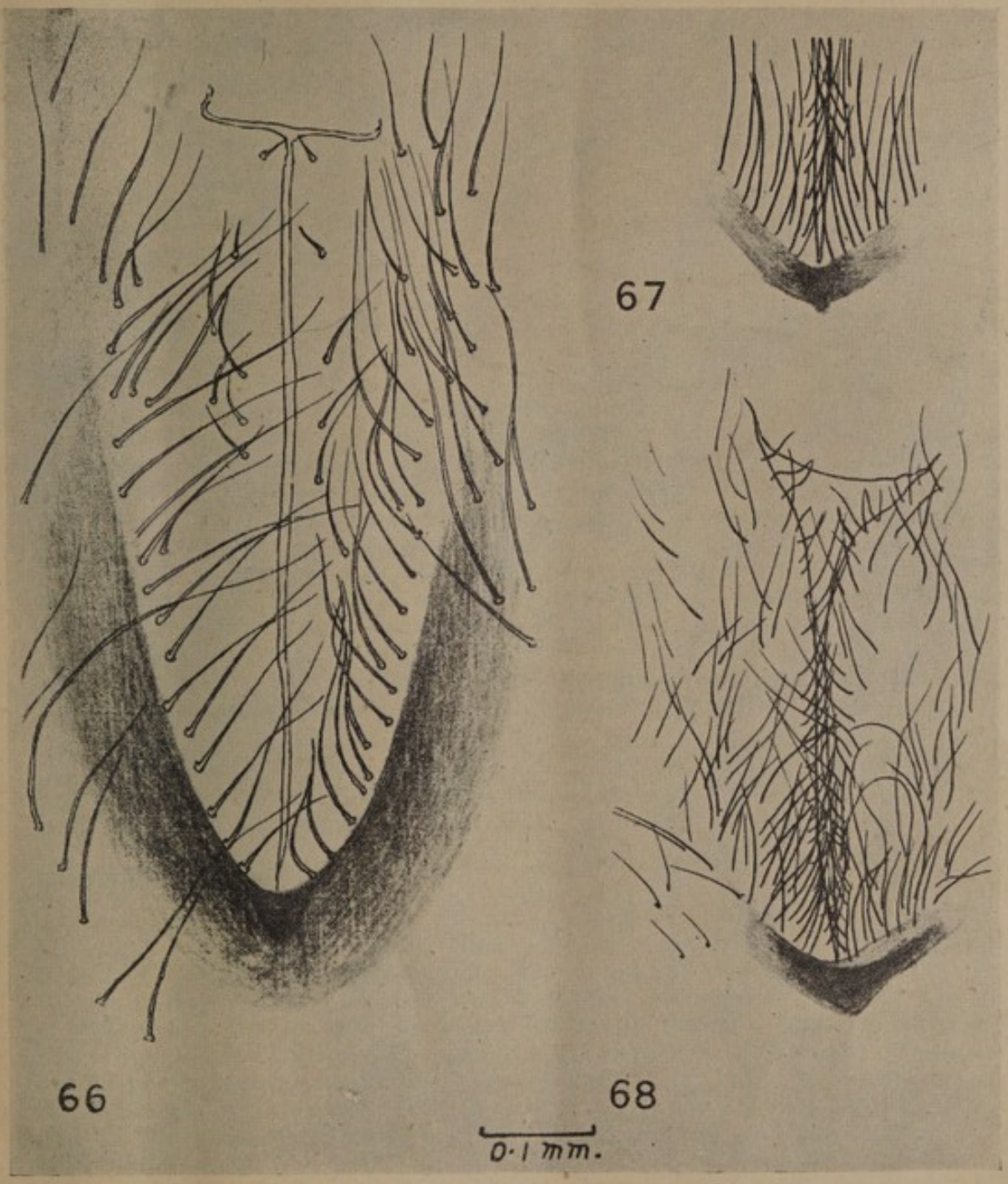
Bull. Ent. Research. Vol. 35. Plate VIII.



EXPLANATION OF PLATE IX.

FIGS. 66–68.—Preanal Sclerite: (66) *Ptinus fur*. (67 & 68) Two Specimens of *Trigonogenius globulus*.

Bull. Ent. Research. Vol. 35. Plate IX.



THE HISTERIDAE ASSOCIATED WITH STORED PRODUCTS.(*)

By H. E. Hinton, Ph.D.

Department of Entomology, British Museum (Natural History).

Introduction.

Fourteen species of the family Histeridae have been found in various parts of the world in stored food or in warehouses and other building structures used to store dry animal or vegetable products. Of these, the four that have not yet been found in the British Isles are: *Teretriosoma americanum* (Lec.), *Hypocacculus metallescens* (Er.), *Saprinus semipunctatus* (F.), and *Carcinops mayeti*, Mars. Keys and full descriptions are given for ten species, but four others, which appear to be more or less accidentally associated with stored products, are only included in the keys. Under the headings of the ten more important species will be found summaries of their distribution and habits. The synonymy given for the various species has been in the main restricted to names current in the economic and biological literature. An attempt has been made to define the family both as regards adults and larvae and to give a summary of the biology and ecology of the whole family.

The three drawings of the whole insects were done by Mr. A. Smith. All other figures were drawn by me with the aid of a *camera lucida*, and lines next to figures refer to a length of 0·20 mm. unless otherwise indicated. The adults were described under a magnification of × 75.

Characters of the Family.

Adults.

About 3,200 species of Histerids have been described, and these are now placed in 10 subfamilies and about 200 genera. Most of the species are 1-10 mm. long, but a few are considerably larger, and one, *Oxysternus maximus* (L.), attains a length of 30 mm. The body is always compact and usually oval and strongly convex but is sometimes cylindrical and sometimes strongly flattened. The cuticle is hard and heavily sclerotised and is usually strongly shining and black or reddish brown, but in a number of the Saprininae the cuticle may have a strong metallic brassy, blue, or blue-green lustre and a few have conspicuous red or yellow markings on the elytra.

The head can be almost entirely retracted into the prothorax and is usually hypognathous, but in the Hololeptinae and Trypanaeinae it is prognathous. A

(*) The two previous papers in this series are :—"The Ptinidae of economic Importance."—Bull. ent. Res., **31**, 1941, pp. 331–381, 59 figs., and "The Lathridiidae of economic Importance."—*Ibid.*, **32**, 1941, pp. 191–247, 67 figs.

groove which receives the antennal scape is present on the ventral sides in front of the eye. The antennae have a long and often very thickened and dilated basal segment or scape, a 6- or 7-segmented funicle which forms a distinct angle with the scape so that the antennae are elbowed (geniculate), and a large solid club which sometimes has transverse sutures distinctly marking the boundaries of the three segments of which it is formed. The mandibles are large, stout, and often strongly projecting. The maxilla has a densely setose galea and lacinia and a 4-segmented palp. The labial palpi are 3-segmented. The prothorax always fits very closely on the base of the elytra, and on its ventral surface antennal cavities are present on the sternum or hypomeron. The elytra are truncate behind and do not cover the propygidium or pygidium except in some ABRAEINAE. The hind wings are usually well developed, and the venation is of the Staphylinid type, *i.e.*, the median and cubitus do not form a loop in the distal part of the wing. The mesosternum is short and broad and there is frequently no dividing suture between it and the large metasternum. The mesosternal episternum is very large and frequently extends between the bases of the prothorax and elytra so that it is visible from above. The abdomen has five free and externally visible sternites, and the first of these appears to consist of the sternal elements of the second and third segments. There are seven external abdominal tergites of which the sixth (propygidium) and seventh (pygidium) are very rarely covered by the elytra, and the seventh is nearly always very large and more or less vertically inclined. The legs are more or less flattened and can be closely retracted against the body. The coxae are all widely separated, the hind pair being particularly widely separated. The anterior coxae are strongly transverse, and their cavities are open behind. The tarsal formula is 5-5-5 except in the genera *Aeletes* and *Acritus* where it is 5-5-4.

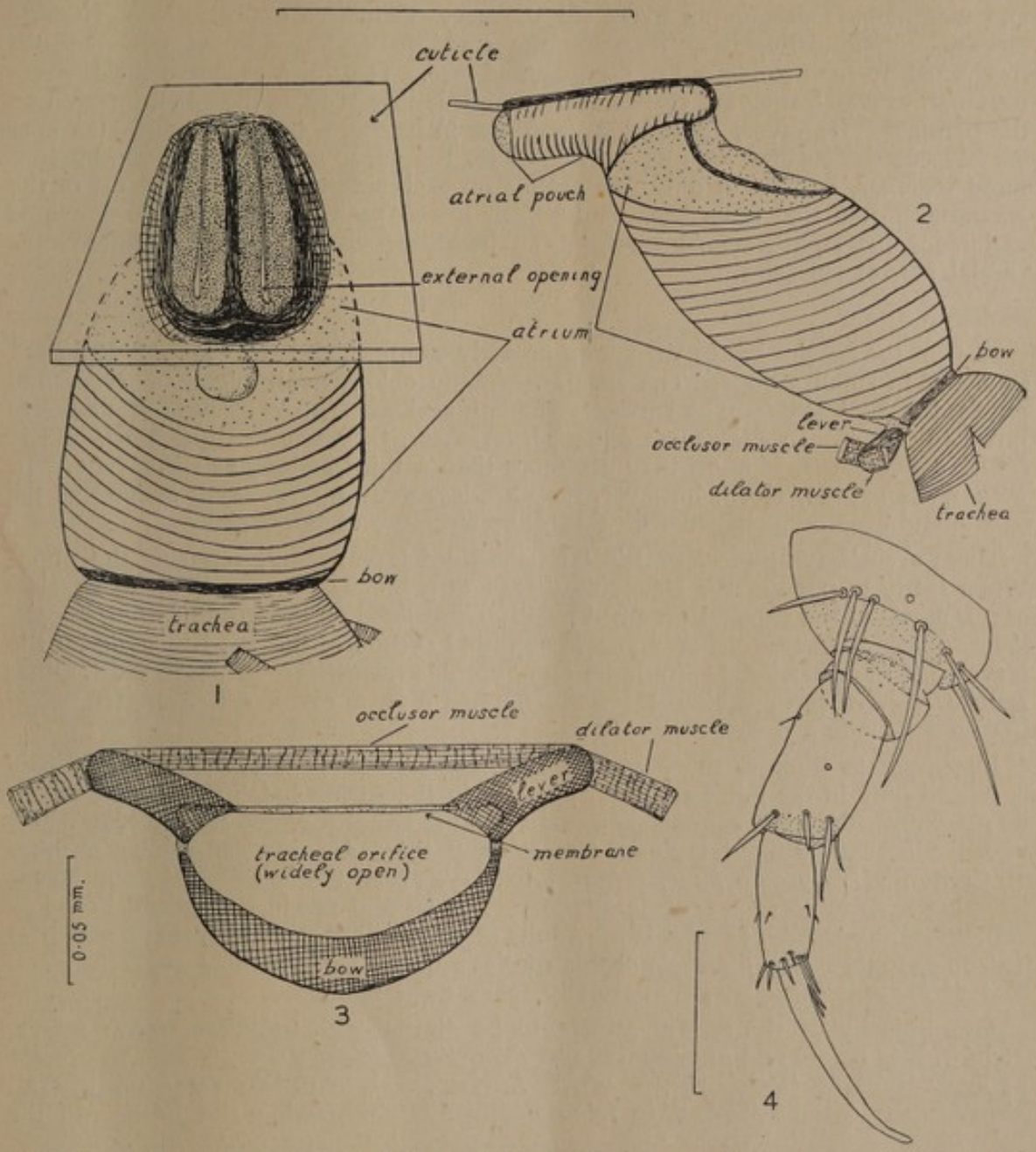
The Histerids associated with stored products may be distinguished from all other beetles found in similar situations by possessing the following combination of characters: Antennae elbowed and with a large and solid club; prothorax with ventral or antero-ventral antennal cavities; elytra shortened so that two apical abdominal tergites are exposed; and abdomen with a large and more or less vertically inclined pygidium and five externally visible sternites. The hard, compact, and convex body with a strongly shining black or reddish brown cuticle adds greatly to the distinctive appearance of the members of this family.

Larvae.

The larvae are usually narrow and subparallel and elliptical in cross section. The cuticle is whitish but the head and thoracic tergites are generally brownish and well sclerotised. The thoracic sternites are also often sclerotised.

The head is prognathous with exserted mouth-parts. It may be broader than long as in *Hister* or distinctly longer than broad as in *Carcinops*. The labral, clypeal, and frontal sclerites are always fused together, and in second and third instar larvae the coronal and frontal sutures are usually altogether absent. The middle anterior margin of the head is always distinctly toothed, and on antero-lateral side there is usually a fringe of long setae which often arise from a feebly sclerotised area. The 3-segmented antennae are inserted above the basis of the mandibles and are always shorter than the head. There are two or three sensory cones on or near the apex of the second segment. Ocelli are often absent but some (*Hister, Dendrophilus, Epierus*) have a single ocellus on each side of the head. The mandibles are large, sickle-shaped, and usually have one or two prominent teeth on the middle of the cutting edge though teeth are absent in the TERETRIINAE. Near the base of each mandible there is apparently always a thick brush of long setae which are often secondarily spinose apically. The maxilla has the cardo and stipes fused together to form a sub-cylindrical segment. The cylindrical galea is inserted on the palpiger (usually

counted as the first segment of the palp) and has a long apical seta. All trace of the lacinia appears to be lost. The palp—including the palpiger—is usually 4-segmented but may be 5-segmented (TERETRIINAE). The labium is without a ligula and the palpi are 2- or (TERETRIINAE) 3-segmented.



FIGS. 1–4.—*Hister cadaverinus*, Hoffm., third-instar larva. (1) Eighth abdominal spiracle. (2) Lateral view of same. (3) Closing mechanism of eighth abdominal spiracle. (4) Anterior face of right front leg.

The abdomen is 10-segmented. The tenth segment is short, tubular, and serves as a proleg. The ninth bears a pair of 2-segmented, rarely 1-segmented, urogomphi which may be heavily sclerotised (*Hister*) or nearly membranous (*Dendrophilus*). Urogomphi are known to be absent in some termitophilous forms. The first eight tergites and sternites sometimes, *e.g. Hister*, have transverse series of small, acute, well-sclerotised tubercles. In some termitophilous forms there are fleshy, conical

protuberances on the first eight pleurites and sternites. The spiracles are biforous.(*) The legs are short and 5-segmented with short and widely separated coxae. The single claw is sometimes longer than the tibio-tarsal segment.

The whitish and parallel-sided body and prognathous head with protruding mouth-parts and prominent, curved mandibles together with the 10-segmented abdomen and 2-segmented urogomphi make for the very distinctive appearance of Histerid larvae. Superficially, they resemble the CARABIDAE, but may at once be distinguished by their 5- instead of 6-segmented legs. They also resemble the HYDROPHILIDAE to which they are closely related and like them have the galea inserted on the palpiger. However, Histerid larvae differ in having a brush of long setae near the base of the cutting edge of the mandible, the cardo and stipes of the maxilla fused together, and no or only one ocellus on each side of the head. Most of the HYDROPHILIDAE that have been found with stored products have an 8-segmented abdomen, the eighth segment forming a breathing chamber which contains the caudal pair of spiracles.

Biology.

Most of the species lay in the spring or early summer, and the eggs are deposited singly or in small groups. The eggs are usually oblong-oval, slightly curved, and rounded at both ends. The surface is smooth and whitish. The eggs of some are unusually large. In *Platysoma punctigerum*, Lec., they are nearly a third, and in *Hister cadaverinus*, Hoffm., they are more than a third as long as the female. In *Plegaderus nitidus*, Horn, however, they are less than one-twentieth as long as the female and are acorn-shaped with a cap-like structure at the broad end.

There are always three larval instars, the third larval moult releasing the pupa. When ready to pupate, the larvae may fashion a pupal " cocoon " which consists of fragments of the substratum glued together and lined on the inside with a smooth layer. According to Reichardt (1941), a pupal cocoon of this kind is made by the larva of *Hister unicolor*, L., in dung, and *Saprinus tenuistrius*, Mars., in sand. Other species, *e.g. Abraeus globosus* (Hoffm.), pupate in a round cell in rotten wood but do not make a cocoon.

In temperate climates there is, as a rule, one generation a year, and the winter is passed only in the adult stage. Eggs laid in the spring hatch into larvae which do not pupate until late summer or autumn, and the adults, which emerge after a few weeks, hibernate without laying. Occasionally there are two generations a year. In California *Platysoma punctigerum*, Lec., lays about the end of May, and larvae hatching from these eggs become adults by August and produce a second brood in September and October; and it is the adults of this second generation that overwinter (Struble, 1930). The life-cycle of this species requires seven to nine weeks, whereas that of *Placsius javanus*, Er., normally takes eight months.

The majority of the species appear to be diurnal although *Exaesiopus torrus*, Rchdt., flies before and after sunset and *Teretrius acaciae*, Reitt., is known to come to light at night (Reichardt, 1941). A characteristic peculiarity of nearly all HISTERIDAE is their instinct to feign death by withdrawing the head into the

(*) The prothoracic and abdominal spiracles are similar in structure. The primary atrial aperture is completely closed, at any rate between moults. Each spiracle (fig. 11) has two functional external openings each of which consists of a narrow, dorsal, median slit along the long axis of the atrial chamber or pouch. These openings are clearly visible in well stained specimens of *Hister cadaverinus*, Hoffm., but their use has also been verified experimentally by submerging living larvae in water. If the atrial chamber of these larvae is gently squeezed, a bubble of air will be given off from the slit. The spiracles have no external openings in the position described by Steinke (1919) and Böving & Craighead (1931). It is worth noting that in his description of biforous spiracles (HYDROPHILIDAE, DRYOPIDAE, LAMPYRIDAE, etc.) Steinke (*op. cit.*) has consistently failed to note the true functional openings, and he has described the outer scar of the preceding spiracle as the external opening. The spiracles of the LAMPYRIDAE, DRYOPIDAE, etc., are similar in origin to the dorsal spiracles of Dipterous larvae.

prothorax and closely retracting the legs beneath the body when touched or alarmed in any way. Most adult HISTERIDAE run rather slowly, but some of the long-legged myrmecophilous HAETERIINAE are said to be able to run very quickly. None is known to produce sound, and stridulatory organs are unknown in the family.

The habits and life-histories of only a few Histerids are known in detail. However, something is known of the food of a considerable number, and it is probably safe to say that both as larvae and adults they are an exclusively carnivorous group. Their food consists of small Arthropods, chiefly mites and larvae of insects. Species of *Dendrophilus* and *Saprinus* kept in the laboratory would feed on raw and cooked meat, and it therefore seems likely that many of the species found in carrion may occasionally feed on the carrion itself though their normal food in carrion is fly and beetle larvae.

While most Histerids will probably prey on many kinds of mites and insects, a considerable number are restricted to one or only a few hosts either through the nature of their habitat or because they exercise a certain amount of selection. This host specificity is particularly evident amongst a large number of myrmecophilous species. Many of these ant-loving forms are restricted to the nests of one genus or even one species of ant. The Indo-Malayan *Plaesius javanus*, Er., preys on the larvae of weevils of the genera *Sphenophorus* and *Cosmopolites* and has been found useful in controlling the depredations of these weevils. *P. javanus* has been introduced into Queensland, Jamaica, and Trinidad to help to control the banana weevil borer, *Cosmopolites sordidus*, Chevr. *Pachylister chinensis* (Quens.) has been introduced into Fiji from Java to help to control the common housefly. Another species, *Oxysternus maximus* (L.) has been found useful in the control of the palm weevil, *Rhynchophorus palmarum* (L.). Two species prey on Chrysomelid larvae, *Saprinus virescens* (Payk.) on *Phaedon armoraciae* (L.) on watercress, and *Hister helluo*, Truqui, on *Agelastica alni* (L.) on alder. Both of these species hunt the Chrysomelid larvae on the leaves of the plants mentioned, a very unusual habit in the family. Other species which apparently have a preference for particular larvae are; *Hister holubi*, Schm., on *Tinaea vastella*, Zell., in horns and hoofs, and *Platysoma punctigerum*, Lec., on *Dendroctonus brevicomis*, Lec., in the bark of yellow pine.

From the point of view of the type of habitat occupied, the HISTERIDAE may be placed in five main groups: (1) saprophiles, (2) inhabitants of bird and animal nests, (3) troglobionts, (4) inhabitants of the burrows of wood-boring beetles, and (5) myrmecophiles and termitophiles. This ecological grouping has been discussed in some detail by Reichardt (1941). The saprophiles or inhabitants of dung, carrion, and decaying vegetable matter are the most numerous group in the family. They are nearly all broadly oval, strongly convex, short-legged species, and the most obvious adaptation to their mode of life is the hard, polished, and hairless cuticle to which liquid or semi-liquid decaying matter does not easily adhere. Those that are found in carrion are usually attracted to it in the fifth or ammoniacal stage of decomposition, that is, in a stage when there is usually no lack of fly or beetle larvae.

The inhabitants of bird and animal nests are a small group which do not show any obvious morphological modifications for their mode of life except perhaps in a slight lengthening of the antennae and hind tarsi and a slight enlargement of the eyes. Of the five species common in warehouses and granaries in Britain, probably four (2 *Gnathoncus*, 2 *Dendrophilus*) live out-of-doors normally in bird and animal nests.

A few have been found in caves but most of these are either accidental entrants or have only recently become cave-dwellers. One species, however, *Spelaeacritus anophthalmus*, Jeannel, is a true troglodyte and exhibits the typical morphological modifications found in cavernicolous beetles. Its antennae and legs are long, its

head is nearly prognathous, eyes and hind wings are absent, and its elytra are fused together.

A large number of species in several unrelated sub-families regularly prey on the eggs, larvae, pupae, and, sometimes, adults of xylophagous beetles (Lyctids, Bostrychids, Anobiids, Ciids, Cerambycids, Scolytids, Platypodids). In this group of HISTERIDAE specialisation in the shape of the body has proceeded in two strikingly different directions. Those that live under loose bark of dead or dying trees are flattened, often very noticeably so, and more or less parallel-sided. Those that live in the burrows in the wood are narrow and cylindrical in shape. A few of the cylindrical forms belonging to the TERETRIINAE are predators of Lyctids and Bostrychids which attack the woodwork of warehouses.

The myrmecophiles form a large proportion of the HISTERIDAE, but comparatively few termitophiles are known. Amongst the myrmecophiles, every type of relationship from actively persecuted lodgers to well cared for guests (symphyles) is known. The adults and larvae of all species, however, feed chiefly on the eggs, larvae, or pupae of the ants. Some of the symphyles have on some part of the body clusters of golden-yellow hairs (trichomes) at the basis of which open glands which secrete substances much sought after by the ants. One species, *Eucurtia comata* (Blackb.), which lives with the Australian ant, *Ectatomma metallicum*, has on the elytra longer trichomes than any other myrmecophilous or termitophilous insect known. The larvae of some termitophilous Histerids are physogastric, *e.g.* the South African, *Monoplius pinguis*, Lewis, has specialised membranous areas on the abdomen from which exude secretions much liked by the termites.

Practically nothing is known of the natural enemies of Histerids. Their larvae are undoubtedly eaten by a number of different insects, and mites are commonly found attached to the adults, particularly to the propygidium and pygidium. Adults have been found in the stomachs of rooks and the Eastern Nightingale.

Economic Importance of Species associated with Stored Products.

Because of their exclusively predacious habits, the Histerids must be regarded as beneficial insects, but the amount of good that they do as predators of mite and insect pests is probably rarely if ever of any real importance. Most of the species breed only where the local relative humidities are high, and species of *Dendrophilus*, *Carcinops*, and *Gnathoncus* have usually only been found in large numbers in warehouses and mills where the local relative humidities were of the order of 90-95 per cent.

Five species, *viz.*: *Carcinops quattuordecimstriata* (Steph.), *Dendrophilus punctatus* (Hbst.), *D. xavieri*, Mars., *Gnathoncus nanus* (Scriba) and *G. nannetensis*, Mars., are relatively common indoors in Britain, and of these *C. quattuordecimstriata*, *D. punctatus*, and *G. nanus* have occasionally been found in considerable numbers, particularly in damp and heated waste grain.

Four species have been included in the keys but have not been described in the text for the reasons given below.

Teretrius picipes (F.) and *Teretriosoma americanum* (Lec.), like all members of the subfamily TERETRIINAE, normally inhabit the galleries of wood-boring beetles. Both are known to be predators of some of the Lyctids and Bostrychids that frequently attack building structures, and they may therefore occasionally be found indoors. *T. picipes* has been recorded with *Lyctus brunneus* (Steph.) by Fowler (1889); with *Sinoxylon sexdentatum* (Oliv.) by Ganglbauer (1899); and with *Lyctus linearis* (Goeze) by Bickhardt (1916). *T. americanum* has been recorded with *Lyctus planicollis*, Lec. (Reichardt, 1941).

Hister cadaverinus, Hoffm., and *H. merdarius*, Hoffm., have been found on several occasions during 1942-44 in Britain in mills and warehouses under dead rats and cats where they probably fed on maggots. Their status in relation to stored products is not yet clear, but *H. cadaverinus*, at least, is probably only a stray. The latter is very common out-of-doors in carrion, dung, compost-heaps, and accumulations of rotting vegetation. *H. merdarius* is found in similar situations but is rarer, and it has also often been found in the nests of various birds and owls and in pigeon-cotes.

Key to Adults.

1. Body cylindrical. Basal segment of antenna inserted in a socket which cuts into the lateral margin of the front. Mandibles small. Mesosternal disk with anterior middle produced into an emargination of the prosternal process. Teretriinae 2

— Body oval to nearly round. Basal segment of antenna inserted under the lateral margin of the front, the socket not cutting into the margin. Mandibles large. Mesosternal disk with anterior middle not produced but emarginate or nearly truncate..... 3

2. Prosternum with distinct median longitudinal striae. Length, 1·7-2·4 mm. Palaearctic..... *Teretrius picipes* (Fabricius, 1792)

— Prosternum without median longitudinal striae or carinae. Length, 1·5-2·0 mm. Eastern United States..... *Teretriosoma americanum* (Leconte, 1859)

3. Prosternum with anterior part not or only very slightly bent ventrally and anterior margin usually truncate. Antennal club not divided into three parts by transverse sutures. Saprininae..... 4

— Prosternum with anterior third to one-half strongly bent ventrally, the process thus formed being often separated by a suture from caudal part; anterior margin strongly rounded and produced forwards. Antennal club with distinct transverse sutures 9

4. Head without lateral or frontal striae, only rarely with short and poorly developed supra-orbital striae. Elytron with three striae, including outer marginal, on vertical side. *Gnathoncus*..... 5

— Head with well developed lateral striae and sometimes with a distinct frontal stria. Elytron with not more than two striae, including outer marginal, on vertical side..... 7

5. Front tibia (fig. 32) with outer margin only feebly emarginate between spines. Abdomen without coarse punctures on first and fifth tergites, but fifth tergite with a single very large puncture on each side near spiracle. Male with anterior margin of tenth abdominal tergite (fig.36) truncate and caudal margin deeply, triangularly emarginate; genitalia (fig. 42) with dorsal channel more than half as long as parameres and with ventral basal margin of basal piece and parameres (fig. 45) truncate. Length, 1·8-3·0 mm. Europe..... *Gnathoncus punctator*, Reitter (1896)

— Front tibia (fig. 31) with outer margin deeply emarginate between spines. Abdomen with many coarse punctures on anterior half of first and fifth tergites. Male with anterior margin of tenth abdominal tergite (fig. 37) broadly, arcuately emarginate and caudal margin truncate or nearly so; genitalia (fig. 43) with dorsal channel much less than half as long as parameres and with ventral basal margin of basal piece and parameres (fig. 44) deeply emarginate at middle..... 6

6. Pygidium with punctures of basal half distinctly transverse and oblong or obovate. Male with apex of eighth abdominal sternite (fig. 35) pointed. Length, 1·5-3·0 mm. Palaearctic Region, Africa, Formosa.
.....*Gnathoncus nanus* (Scriba, 1790)

— Pygidium with punctures of basal half round. Male with apex of eighth abdominal sternite (fig. 38) broadly rounded. Length, 2·4-3·8 mm. Palaearctic Region.....*Gnathoncus nannetensis* (Marseul, 1862)

7. Length, 1·8-2·5 mm. Head with a well developed frontal stria. Antennal club with ventral side not depressed. Prosternum with median carinae converging anteriorly and ending some distance from anterior margin. Elytron without an apical stria; sutural stria complete and joined to third; third to sixth striae extending to apical third or fourth. Cuticle nearly always with a strong bronze or brassy lustre. Mediterranean Region, Caucasus, Turkestan.
.....*Hypocacculus metallescens* (Erichson, 1834)

— Length, 4-10 mm. Head with or without a frontal stria. Antennal club with two or more large depressions on ventral surface. Prosternum with median carinae diverging anteriorly and extending to anterior margin. Elytron with a complete and distinct apical stria; sutural stria usually absent on basal region; third to sixth striae not or scarcely extending to apical two-fifths. Cuticle black or with a strong blue-green lustre, rarely with a feeble brassy lustre.....8

8. Head without a frontal stria, *i. e.* lateral striae very widely interrupted across front. Cuticle black, rarely with a slight brassy lustre. Elytron with third stria as long as fourth. Prosternum with lateral carina joined to median at a point only slightly nearer to anterior margin than to coxal cavity; median carinae strongly diverging anteriorly. Hypomeron glabrous. Meso-metasternal sutural line coarsely and closely crenate. Male with a fringe of long, slender, curved setae on four basal segments of middle tarsi. Length, 4-7 mm. Palaearctic Region, N. India.
.....*Saprinus semistriatus* (Scriba, 1790)

— Head with a complete or very nearly complete frontal stria. Cuticle nearly always with a distinct blue or blue-green metallic lustre. Elytron with third stria very much shorter than fourth and only present apically. Prosternum with lateral carina joined to median at a point about three times as far from coxal cavity as from anterior margin; median carinae only moderately diverging anteriorly. Hypomeron with long, erect setae. Meso-metasternal sutural line not crenate. Male without a fringe of long, slender, curved setae on four basal segments of middle tarsi. Length, 5-10 mm. Mediterranean Region, S. Europe, Iran, Caucasus, Turkestan.....*Saprinus semipunctatus* (Fabricius, 1792)

9. Prothorax with cavity for the reception of the antennal club ventral and on the middle of the hypomeron, the cavity being broad and not sharply circumscribed. Anterior margin of prosternum on each side with a narrow and very deep emargination which receives the antennal funicle. DENDROPHILINAE 10

— Prothorax with cavity for the reception of the antennal club anterior, open in front, and more or less completely closed beneath by the sides of the prosternum, the cavity being deep and sharply circumscribed. Anterior margin of prosternum not emarginate. (The two species included here are 5·5 mm. or more long and both have two striae on each side of the pronotum parallel to the lateral margin.) HISTERINAE.....13

10. Front tibia with inner margin straight or very nearly straight. *Dendrophilus*. 11

— Front tibia with inner margin distinctly curved. *Carcinops*.....12

11. Elytra with first and second striae absent, the second being only occasionally represented behind middle of disk by a row of punctures; dorsal half between suture and second stria with most punctures about two-thirds as large as apical punctures and separated by two to four diameters, the surface between them being microreticulate. Length, 2·6-4·0 mm. Europe, N. America.....*Dendrophilus punctatus* (Herbst, 1792)

— Elytra with first and second striae usually distinct, sometimes with first obsolete or absent except at base; basal half between suture and second stria with punctures abruptly finer and much sparser than those of apical half, being about a fourth as coarse and usually separated by five to ten diameters and the surface between them is smooth and highly polished. Length, 2·5-3·7 mm. Japan, N. America, England. .....*Dendrophilus xavieri*, Marseul (1873)

12. Length, 1·6-2·7 mm. Elytron without a short stria between first and second striae. Propygidium nearly as long as pygidium; surface with fine and coarse punctures intermixed. Metasternal disk with inner lateral stria extending obliquely outwards and ending at a point considerably lateral and anterior to mesal margin of hind coxa. Abdomen with two striae on each side of disk of first sternite; extreme side of first sternite with a single stria near lateral margin. Male with clypeus not concave and frontal stria complete; male genitalia (fig. 53) with parameres only about one-fourth as long as basal piece. Cosmopolitan. .....*Carcinops quattuordecimstriata* (Stephens, 1832)

— Length, 1·4 mm. Elytron with a short supplementary stria on apical half between first and second striae. Propygidium less than half as long as pygidium; surface with fine punctures only. Metasternal disk with inner lateral stria nearly straight and ending at a point mesal to mesal margin of hind coxa. Abdomen with a single stria on each side of disk of first sternite; extreme side of first sternite with two parallel striae near lateral margin. Male with clypeus (and part of front of head?) strongly and broadly concave and frontal stria absent; male genitalia (fig. 54) with parameres more than half as long as basal piece. Egypt, Arabia.....*Carcinops mayeti*, Marseul (1870)

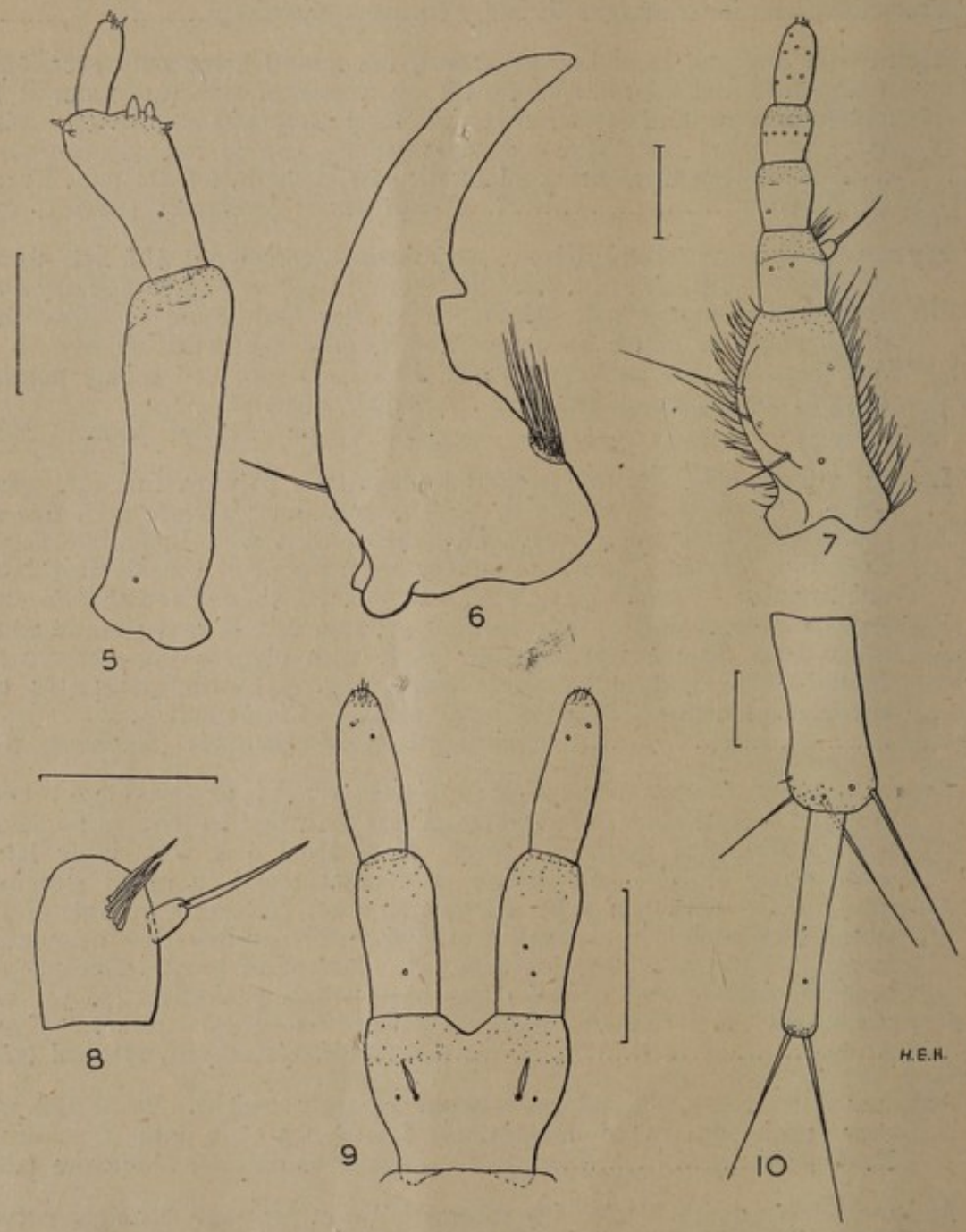
13. Antennal club reddish with sutures between segments straight. Front tibia with four teeth on outer margin. Length, 5·5-7·0 mm. Europe, N. America.....*Hister merdarius*, Hoffmann (1803)

— Antennal club greyish black with sutures between segments strongly curved. Front tibia with five or six teeth on outer margin. Length, 5·5-9·0 mm. Europe, Asia, Japan.....*Hister cadaverinus*, Hoffmann (1803)

Key to Larvae.

This key is based on third-instar larvae but will probably serve equally well for distinguishing between species represented by first- or second-instar larvae. First- and second-instar larvae of both *Hister cadaverinus*, Hoffm., and *Carcinops quattuordecimstriata* (Steph.) have been examined and found to differ only slightly

from third-instar larvae, the chief difference being that the coronal and frontal sutures of the early stages are very distinct instead of absent or externally invisible.

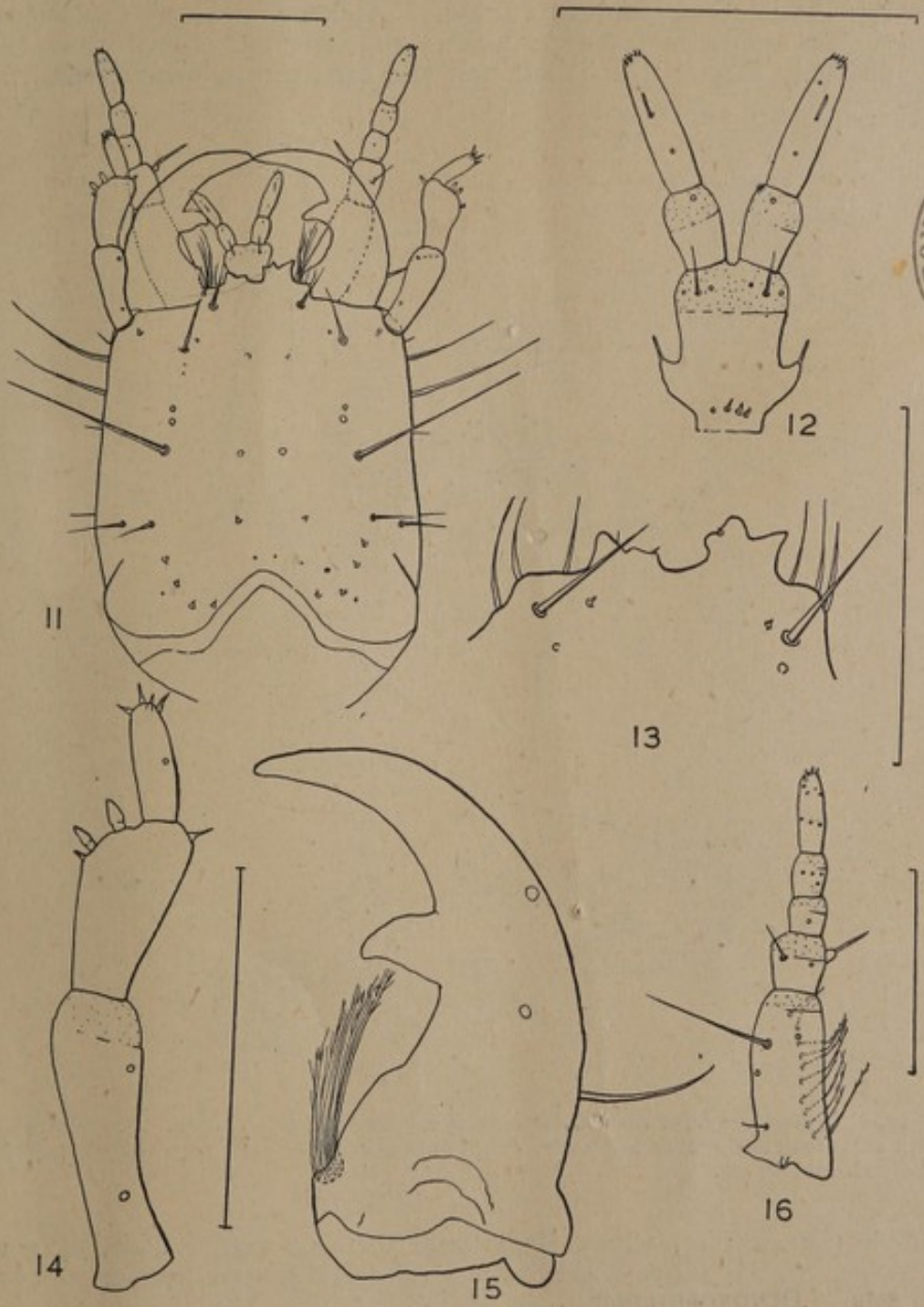


FIGS. 5–10.—*Hister cadaverinus* Hoffm., third-instar larva. (5) Dorsal view of left antenna. (6) Ventral view of right mandible. (7) Ventral view of right maxilla. (8) Inner or dorsal view of left palpiger. (9) Ventral view of labium. (10) Dorsal view of urogomphus.

One species, *Teretrius picipes* (F.), and one genus, *Saprinus*, have been included in the key on the basis of characters given by Böving & Craighead (1931), but larvae of all other species dealt with have been examined by me. The larva of *Hister merdarius*, Hoffm., has been described by Paykull (1811, Monogr. Hist.: 22, pl. 1, f. 1) but not in sufficient detail to enable me to distinguish it satisfactorily from *H. cadaverinus*.

1. Maxillary palpi 5-segmented including palpiger and labial palpi 3-segmented, the apical segment of both the maxillary and labial palpi being much smaller than the preceding. Mandible without a tooth on cutting edge. TERETRIINAE.....*Teretrius picipes* (F.)

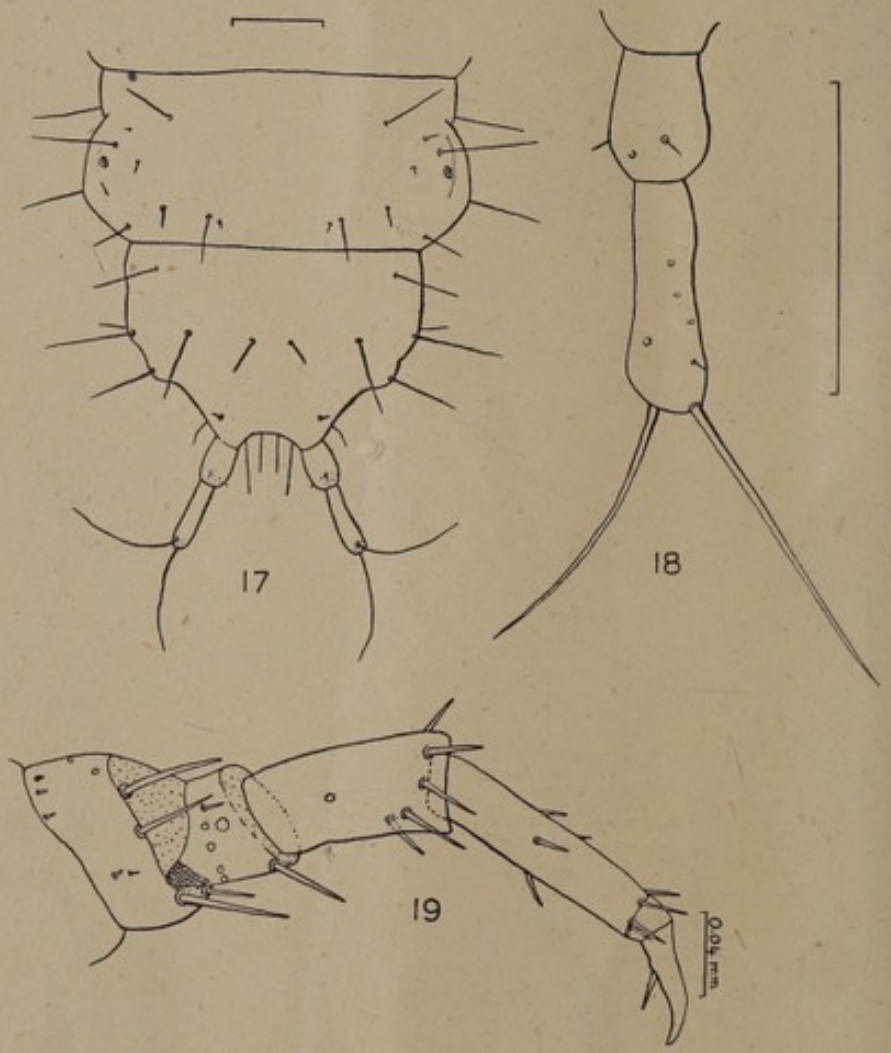
— Maxillary palpi (figs. 7, 16) 4-segmented including palpiger; labial palpi (figs. 9, 12) 2-segmented. Mandible (figs. 15, 27) with at least one large tooth on cutting edge.....2



FIGS. 11–16.—*Carcinops quattuordecimstriata* (Steph.), second-instar larva. (11) Dorsal view of head. (12) Dorsal or inner view of labium. (13) Enlarged dorsal view of anterior margin of head. (14) Dorsal view of left antenna. (15) Dorsal view of right mandible. (16) Ventral view of right maxilla.

2. Pronotum with a well-marked longitudinal furrow on each side half way between median line and lateral margin. Abdomen with transverse rows of very short but distinct spines on first eight tergites and sternites. Tarsal claws (fig. 4) distinctly longer than tibio-tarsus and without setae. (Head distinctly broader than long and with a single ocellar lens on each side. Prementum (fig. 9) without a lateral sub-basal setose process. Urogomphi well sclerotised. Mature larva 15 mm. or more long.)
.....*Hister cadaverinus*, Hoffm.

— Pronotum without longitudinal furrows. Abdomen without transverse rows of short spines on first eight tergites and sternites. Tarsal claws (fig. 19) distinctly shorter than tibio-tarsus and each with a ventral seta.....3



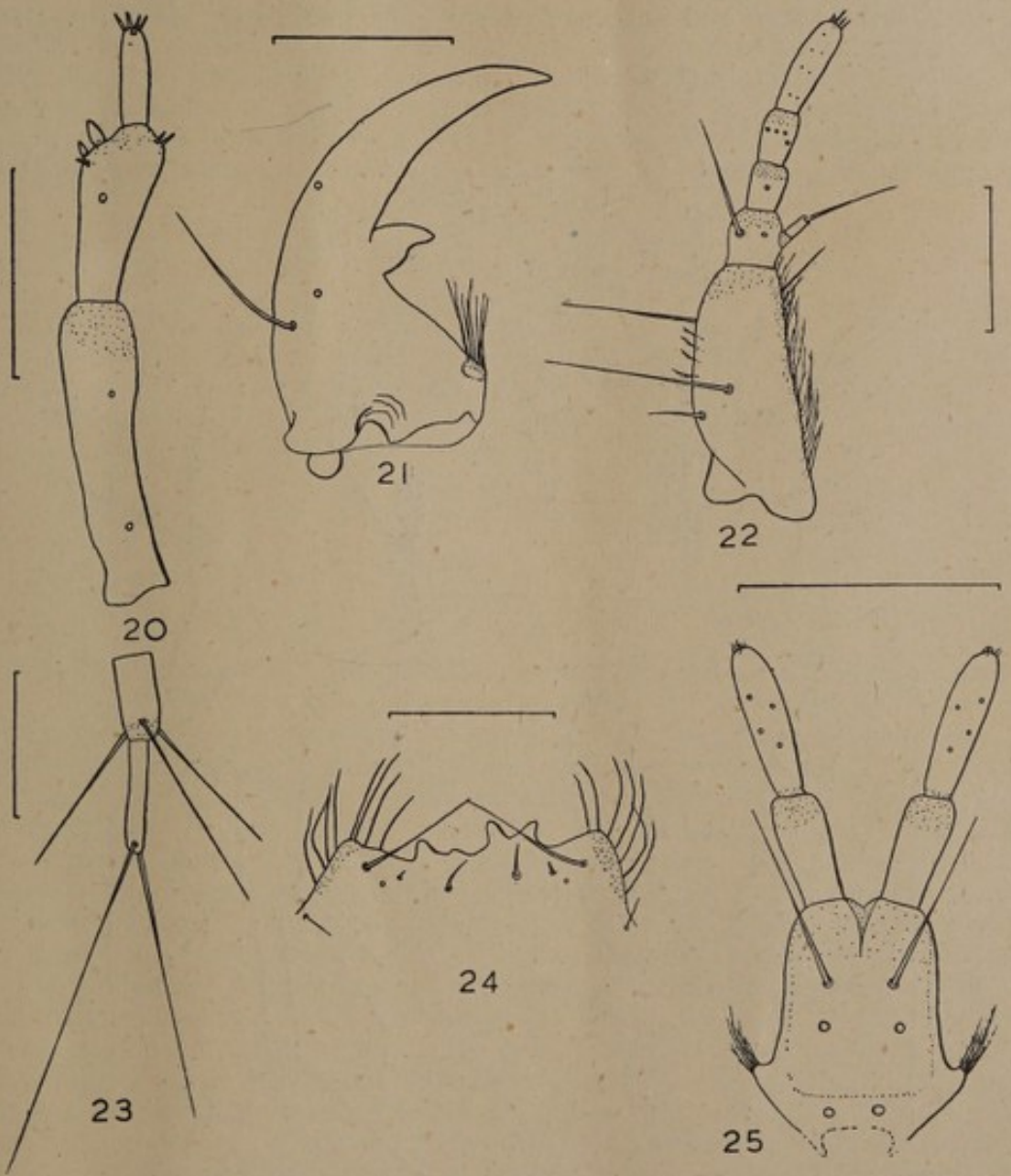
FIGS. 17–19.—*Carcinops quattuordecimstriata* (Steph.), second-instar larva. (17) Dorsal view of eighth and ninth abdominal segments. (18) Inner dorsal view of urogomphus. (19) Anterior face of left middle leg.

3. Mandible (figs. 15, 21) with a single large tooth on cutting edge. Prementum (figs. 12, 25) on each side with a sub-basal process bearing one or more seta. DENDROPHILINAE.....4

— Mandible with two large teeth on cutting edge or (fig. 27) with one large tooth and a small, obtusely rounded tooth. Prementum (fig. 28) without a lateral sub-basal setose process. SAPRININAE.....5

4. Head (fig. 11) distinctly longer than broad; anterior middle margin with 3 + 3 teeth and anterior angle with only three long marginal setae (fig. 13); ocelli apparently absent; prementum (fig. 12) with a single seta on sub-basal lateral process. Urogomphus (fig. 18) with setae near apex of first segment very short, about a tenth as long as apical setae of second segment.....*Carcinops quattuordecimstriata* (Steph.)

— Head no longer than broad; anterior middle margin with 2 + 2 teeth and anterior angle with seven or eight long marginal setae (fig. 24); ocelli represented on each side by a single poorly developed cuticular lens; prementum (fig. 25) with a brush of setae on sub-basal lateral process. Urogomphus (fig. 23) with setae near apex of first segment nearly as long as apical setae of second segment.....*Dendrophilus punctatus* (Herbst)



FIGS. 20–25.—*Dendrophilus punctatus* (Herbst). (20) Left dorsal view of antenna of second-instar larva. (21) Left dorsal view of mandible of same. (22) Ventral view of right maxilla of third-instar larva. (23) Dorsal view of left urogomphus of second-instar larva. (24) Dorsal view of anterior margin of head of third-instar larva. (25) Ventral view of labium of second-instar larva.

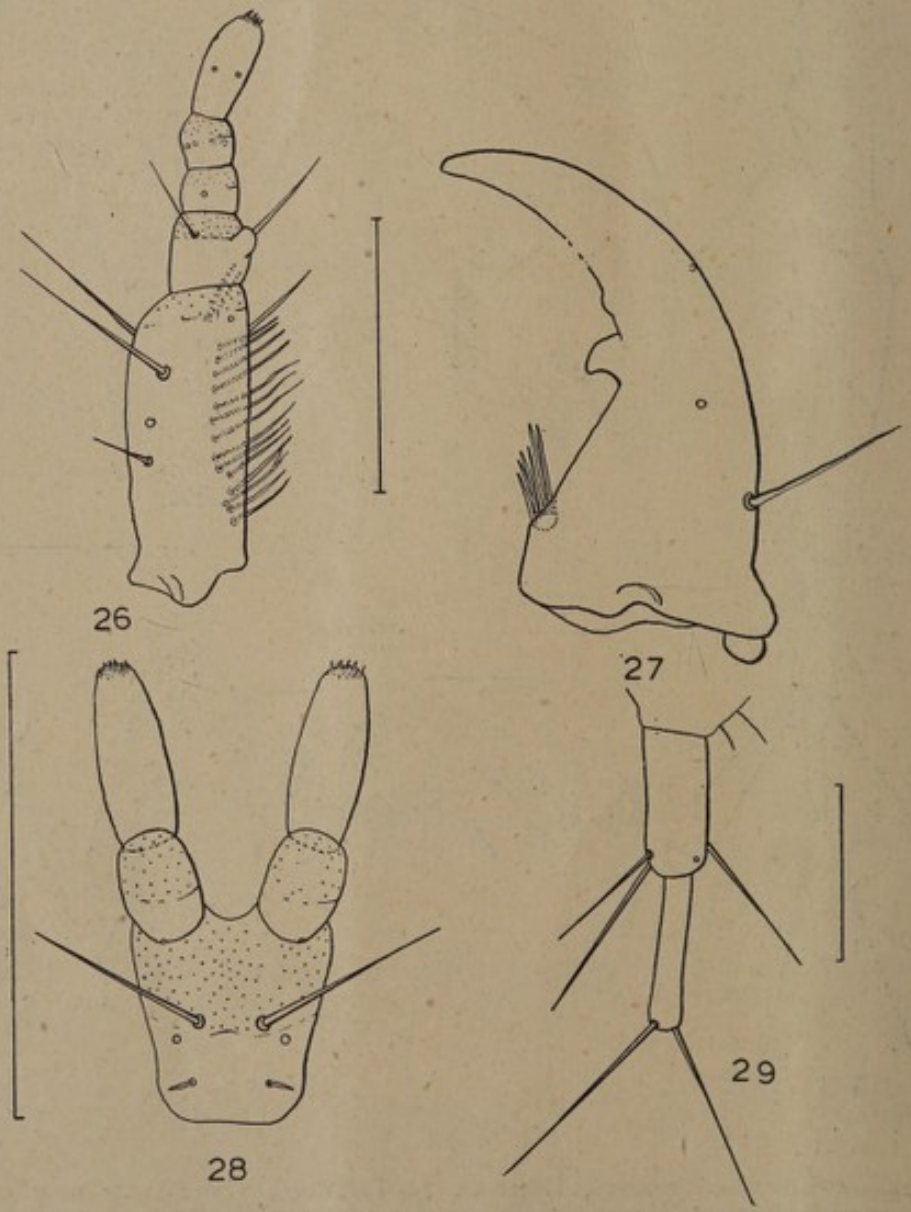
5. Mandible (fig. 27) with outer surface smooth; cutting edge with one large tooth plus one small and obtusely rounded tooth (Setae of abdomen very dark brown to nearly black).....*Gnathoncus nanus* (Scriba)

— Mandible with outer surface irregularly sinuate near apex; cutting edge with anterior tooth nearly as long as posterior.....*Saprinus* spp.

Gnathoncus nanus (Scriba) (figs. 31, 35, 39).

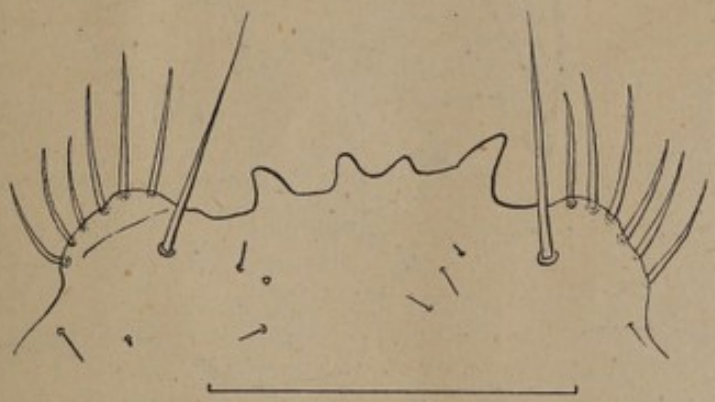
1790. *Hister nanus,* Scriba, J. Lieb. Ent., **1,** p. 73, pl. v. f. 7, 7a, 7b.
1792. *Hister rotundatus,* Kugelann, in Schneider, N. Mag. Lieb. Ent., **3,** p. 304.
1798. *Hister punctatus,* Paykull, Fauna Suec., **1,** p. 49.
1862. *Gnathoncus punctulatus,* Thomson, Skand. Col., **4,** p. 242.

♂: Length, 1·5-3·0 mm.; breadth, 1·2-2·0 mm. Body obovate to very broadly oval in outline and strongly convex. Cuticle strongly shining and black or very dark rufo-piceous; legs and antennae except club moderately dark rufo-piceous;



FIGS. 26–29.—*Gnathoncus nanus* (Scriba), third-instar larva. (26) Ventral view of right maxilla. (27) Dorsal view of right mandible. (28) Ventral view of labium. (29) Inner dorsal view of left urogomphus.

antennal club paler reddish and densely clothed with fine testaceous hairs. *Head* with marginal striae absent, but occasionally with a shallow, indistinct supra-orbital stria. Punctures on middle round, shallow, indistinctly umbellicate (mag. × 100), slightly coarser than facets of eyes, and separated by one and a half to three diameters. Clypeus with punctures slightly denser. Surface between punctures smooth or with an occasional microscopic puncture. *Pronotum* with apical stria complete and lateral stria on each side extending very nearly to base. Surface of middle of disk with round or oval, occasionally umbellicate punctures about as coarse as those of head and usually separated by two to four diameters; towards sides punctures become coarser and denser so that a short distance from lateral margin they are half again to twice as coarse as those of middle of disk, slightly deeper, and are separated by half of one to two diameters; immediately before lateral margin the punctures are nearly as fine as those of middle of disk; base with a single or double, usually rather indistinct, transverse row of punctures which are nearly as coarse as those of sides. Surface between punctures smooth and with an occasional microscopic puncture. *Elytra* with apical stria extending to suture but often fine, shallow, and rather indistinct. Sutural stria confined to basal region or extending to slightly beyond middle, but if long often represented more by a row of punctures than by a distinct impressed line; beyond basal third slightly diverging from suture towards apex and near base also diverging from suture.

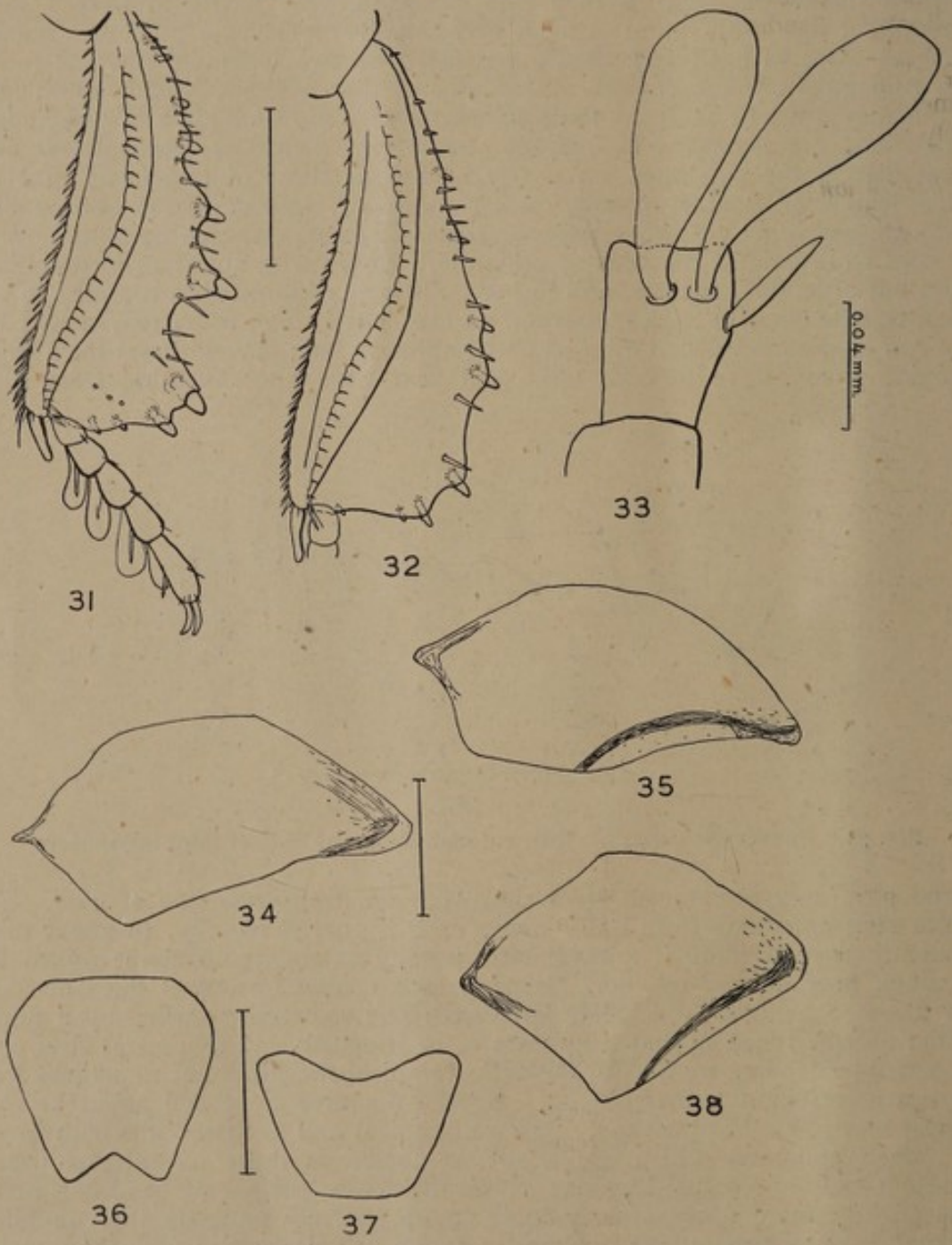


30

FIG. 30. *Gnathoncus nanus* (Scriba), anterior margin of head of third-instar larva.

Second stria only represented by a short, curved, transverse line at base. Third to fifth stria extending from base, where each is curved mesally, to about middle or slightly beyond middle. Sixth stria usually extending to about apical third but much finer beyond middle. Humeral stria confined to basal third or fourth, very finely to moderately coarsely impressed, and sometimes crossed by a number of fine, oblique rugae so that it appears to be irregular. Subhumeral stria coarse and usually extending from basal two-fifths to apical two-fifths but sometimes longer and nearly reaching humeral stria. Strial punctures close and about as coarse as those along base of pronotum. Surface of apical half or three-fifths with broadly oval, deep punctures which are about as coarse as those of extreme base of pronotum and are separated by one to two diameters; surface of basal half or two-fifths slightly more finely and distinctly more sparsely punctate than middle of pronotal disk; extreme apex of elytra (in region of apical stria) with the punctures finer than elsewhere on apical region and with surface between punctures finely, lightly, and longitudinally rugose or nearly smooth. Surface between all discal elytral punctures smooth or nearly so. *Propygidium* with punctures of caudal half round or transversely oval, as large as those before apical elytral stria, and seldom separated by as much as one diameter. Surface between punctures with a lightly impressed but distinct series of fine and irregularly transverse lines which

are often reticulate, these lines being more heavily impressed on basal half which is also more finely and much more sparsely punctate. *Pygidium* with basal punctures as coarse or coarser than caudal ones of propygidium, slightly sparser, and subquadrate or semi-elliptical but always with nearly all distinctly transverse; on apex these punctures are sparser and much finer; the coarse pygidial punctures often have a central microscopic puncture, *i.e.*, they are often umbellicate.



FIGS. 31–38. *Gnathoncus* spp. (31) Front tibia of *G. nanus* (Scriba). (32) Same of *G. punctator* Reitt. (33) Ventral view of third segment of front tarsus of ♂ of *G. nannetensis* (Mars.). There is often only one flat seta on segments one to four, but there are sometimes two setae on first segment and only one on the second to fourth inclusive. (34) Eighth abdominal sternite of male of *G. punctator*. (35) Same of *G. nanus*. (36) Tenth abdominal tergite of male of *G. punctator*. (37) Same of *G. nannetensis*. (38) Eighth abdominal sternite of male of *G. nannetensis*.

Surface between punctures smooth or nearly so. *Prosternum* with median carinae joined or nearly joined anteriorly; lateral carinae prominent and joining median carinae at a point slightly nearer to front coxal cavity than to anterior margin. Mesosternal disk with complete and coarse apical and lateral striae; near caudal margin with a coarsely crenate line which, except at sides, is slightly anterior to meso-metasternal sutural line; surface coarsely and sparsely punctate. Metasternal disk flat to feebly concave and surface coarsely and sparsely punctate; lateral discal stria extending caudally and outwards nearly to hind coxa.

♀: Externally similar to male but without large, broad, flat setae on four basal segments of front tarsi and with the metasternal disk feebly convex instead of flat or feebly concave.

Distribution: Palaearctic Region, Africa, Formosa.

Habits: Donisthorpe (1897) records it in a London granary; Gerhard (1909) in a pigeon-cote in Germany; Joy (1909) in a starling's nest in Britain; Auzat (1917) in France in hen-houses, birds' nests, and carrion, especially dead birds; Donisthorpe (1939) in Windsor Forest on bones and in a crow's nest; and Reichardt (1941) records it in the U.S.S.R. on carrion, especially dead birds, occasionally in dung and rotting vegetation, frequently in hen-houses, dove-cotes, and old nests of squirrels, hoopoes, owls, starlings, ravens, etc.

During 1942-44 specimens were found in granaries at Burnham, Bucks and N. Belfast, warehouses at Norwich and London, and large numbers in waste grain in the basement of a London flour mill.

Gnathoncus nannetensis (Marseul) (figs. 33, 37-38, 40, 43-44).

1803. *Hister rotundatus* (var. a), Hoffmann, Ent. Hefte, **1**, p. 87, pl. 1, f. 10.
1862. *Saprinus nannetensis*, Marseul, Ann. Soc. ent. Fr., (4) **2**, p. 499, pl. 13, f. 2.

♂: Length, 2·4-3·8 mm.; breadth, 1·6-2·4 mm. Very similar to *G. nanus* but differs in having the pygidial punctures round and never transverse instead of distinctly transverse, and in having the apex of the eighth abdominal sternite (fig. 38), which is lateral, broadly rounded instead of moderately pointed, this sternite being a little longer than broad in *G. nannetensis* and nearly twice as long as broad in *G. nanus*. *G. nannetensis* is on the average a distinctly larger species; the sutural elytral stria is more often confined to the basal region; the extreme apex of the elytra is frequently much more coarsely and longitudinally rugose than in any specimens of *G. nanus* seen; the surface between the pygidial punctures is often distinctly but very finely alutaceous, whereas in *G. nanus* the surface between the pygidial punctures is very rarely alutaceous; and the prosternal striae often end anteriorly in a deep pit.

♀: Differs from the male in not having broad, flat, ventral setae on the four basal segments of the front tarsi and in having the metasternal disk convex instead of flat or feebly concave.

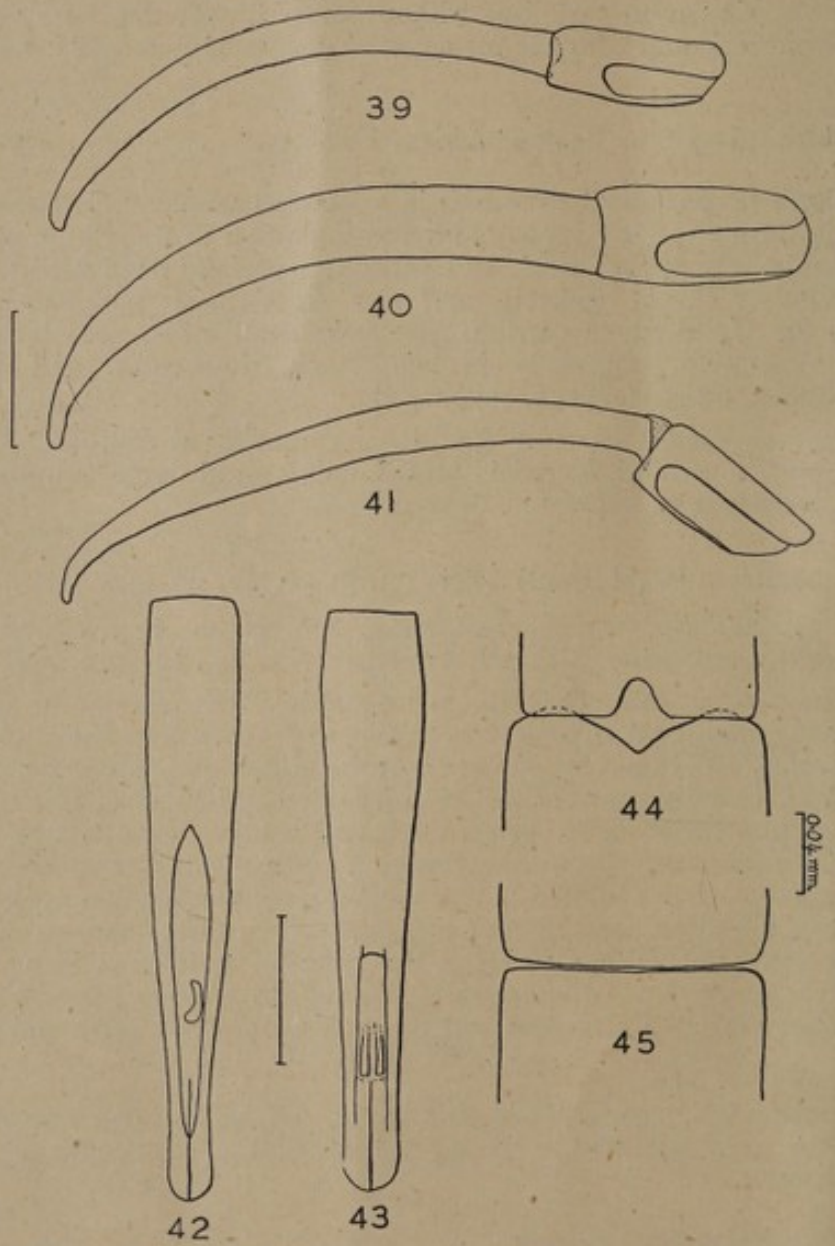
Distribution: Palaearctic Region.

Habits: Walker (1916b) records it in a granary at Cothill, Berks; Auzat (1917) in France in hen-houses, birds' nests, and carrion, especially dead birds; Donisthorpe (1939) in Windsor Forest in a bird's nest, on old bones, and in a dead bird. According to Reichardt (1941) its habits are similar to those of *G. nanus* (Scriba). It is found in carrion, especially dead birds, and more rarely in dung and rotting vegetation. It is common in hen-houses, dove-cotes, old nests of squirrels and in nests of such birds as hoopoes, owls, starlings, and ravens.

Gnathoncus punctator, Reitter (figs. 32, 34, 36, 41-42, 45).

1896. *Gnathoncus punctator,* Reitter, Ent. Nachr., **22,** p. 307.
1907. *Gnathoncus nidicola,* Joy, Ent. Rec., **19,** p. 134, pl. 6, f. 2.
1918. *Gnathoncus nidicola* var. *auzati,* Pic, Echange, **34,** p. 9.

♂: Length, 1·8-3·0 mm.; breadth, 1·6-2·2 mm. Very similar to *G. nanus* and *G. nannetensis* from both of which it differs as follows: (1) the outer margin of the front tibiae is much less deeply emarginate (*cf.* figs. 32 and 31); (2) the first



FIGS. 39–45. Male genitalia of *Gnathoncus* spp. (39) Lateral view of *G. nanus* (Scriba). (40) Same of *G. nannetensis* (Mars.). (41) Same of *G. punctator,* Reitt. (42) Dorsal view of *G. punctator.* (43) Same of *G. nannetensis.* (44) Ventral view of base of parameres and basal piece of *G. nannetensis.* (45) Same of *G. punctator.*

abdominal tergite has no coarse punctures instead of an anterior belt of very coarse punctures; (3) the fifth abdominal tergite has only a single large puncture on each side near spiracle instead of a complete, transverse, anterior belt of coarse, close

punctures; (4) the tenth abdominal tergite is truncate at base and deeply, triangularly emarginate at apex (fig. 36), whereas in *G. nanus* and *G. nannetensis* (fig. 37) the base of this tergite is broadly, arcuately emarginate and its apex is truncate or nearly so; (5) the male genitalia have the parameres much less curved (*cf.* figs. 41 and 40); (6) the dorsal channel occupies much more than half instead of much less than half of the length of the parameres (*cf.* figs. 42 and 43); and (7) the ventral base of both the parameres and the basal piece is truncate instead of deeply emarginate at middle (*cf.* figs. 45 and 44). In addition to the differences listed above, the punctures of the pygidium are somewhat different, being much less transverse than in *G. nanus* and more strongly umbellicate than in *G. nannetensis*. Many of the umbellicate punctures are half-moon shaped with the caudal middle part open and joined to the raised centre, and the surface between the punctures is nearly always distinctly microreticulate. The sutural stria is confined to the extreme basal region in all specimens seen. The apex of the elytra is usually more strongly rugose than in *G. nannetensis*, and the coarse punctures often extend to the base of the elytra in the interval between the fifth and sixth striae.

♀: Differs from male in having the metasternal disk feebly convex instead of feebly concave in anterior half and in not having the large, flat, ventral setae of the four basal segments of the front tarsi.

Distribution: Europe, Caucasus, Turkmen.

Habits: In Britain it has been found in the nests of various kinds of birds and on one occasion in straw in a shed (Joy, 1907, 1909). Auzat (1917) records it in hen-houses and in birds' nests in France. Donisthorpe (1939) records it in Windsor Forest under a dead pigeon, on bones, and abundant in birds' nests. According to Reichardt (1941) it is found in the U.S.S.R. almost exclusively in birds' nests and only rarely in hen-houses. I have seen a few specimens which were found in March, 1942, in a granary in Gloucester.

Hypocacculus metallescens (Erichson) (fig. 46).

1834. *Saprinus metallescens*, Erichson, in Klug, Jahrb. Insectenk., **1**, p. 192.
1867. *Saprinus geminatus*, Wollaston, Col. Hesperid., p. 86.
1876. *Saprinus arachidarum*, Marseul, Abeille, Paris, **16**, p. 39.

♂: Length, 1·8-2·5 mm.; breadth, 1·3-1·7 mm. Body broadly oval and strongly convex. Cuticle very strongly shining and black or nearly so with a strong bronze or brassy lustre, but a few specimens—probably only those recently emerged—are dark rufo-piceous and lack the metallic lustre; antennae dark rufo-piceous with club rufo-testaceous; legs dark reddish brown. *Head* with frontal stria arcuate and complete across front; stria complete at base but on sides sometimes interrupted on supra-orbital region. Surface with punctures slightly coarser than facets of eyes and rather evenly distributed, being separated by one to two diameters; surface between punctures smooth or nearly so. Clypeus punctate like head but near anterior margin more densely so. Labrum with a broad, transverse impression. Pronotum with marginal stria of apex and sides complete and at front angles much further from edge than elsewhere. Surface of disk with punctures as fine as those of head but separated by three to five or more diameters; on each side about two-thirds of distance to lateral margin these punctures become abruptly coarser and denser so that a short distance before lateral margin they are about four or five times as coarse and are separated by one-fourth to three-fourths (on apical half) of a diameter or (basal half) one or two diameters; on a belt adjacent to lateral margin they are nearly as fine as on middle of disk but are denser; base with two rather regular rows of punctures which are nearly as coarse as those of sublateral apical belt; middle of base with three transverse rows of coarse punctures;

surface between pronotal punctures everywhere smooth or nearly so. *Elytra* punctate and striate as shown in fig. 46. *Propygidium* one-third as long as pygidium and caudal half with round or slightly oval punctures which are as coarse and dense as those near apex of elytra; surface between punctures very finely, transversely alutaceous. *Pygidium* with round or very slightly transversely oval punctures which are as coarse as those of caudal half of propygidium, are occasionally umbellicate, and are usually separated by one to nearly two diameters; on apex these punctures are slightly sparser and distinctly finer; surface between

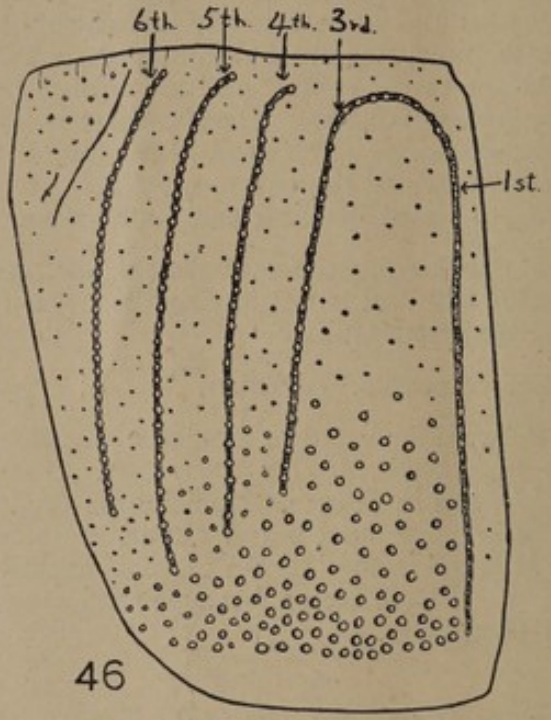


FIG. 46. Elytra of *Hypocacculus metallescens* (Er.).

punctures scarcely noticeably, transversely microreticulate but on apical half the surface is smooth or nearly so. *Prosternum* with median striae (or carinae) widely separated on apex of process and strongly converging anteriorly but nearly parallel on anterior half where they end some distance from anterior margin; carinae in front of anterior coxae more prominent than median prosternal carinae, to which they are not joined, and joined together to form a straight line along anterior margin. Mesosternal disk with anterior margin nearly truncate; thickly margined at apex and sides; surface with round, moderately coarse punctures which are separated by one to three diameters and are only slightly sparser on middle. Metasternum with lateral stria extending caudally and outwards nearly to hind coxa: disk very sparsely and finely punctate but with a few coarser and denser punctures at sides, and on each side before hind coxa with a small area which is as coarsely and densely punctate as propygidium. Abdomen with lateral discal stria of first sternite extending from base to near caudal margin in an arcuate curve.

♀: Externally similar to male.

Distribution: Mediterranean Region, Caucasus, Turkestan.

Habits: It has been found in France in stored ground-nuts (Marseul, 1876) and in Egypt in small numbers in bran (Willcocks, 1925) and in warehouses in débris under mats, in mills, and in flour (Zacher, 1940). According to Reichardt (1941), it is found out of doors in dung.

Saprinus semistriatus (Scriba) (fig. 47).

1790. *Hister semistriatus*, Scriba, J. Leib. Ent., **1**, p. 72.
1798. *Hister semipunctatus*, Paykull, Fauna Suec., **1**, p. 45.
1801. *Hister nitidulus*, Fabricius, Syst. Eleuth., **1**, p. 85.

♂: Length, 4-7 mm.; breadth, 3·0-4·5 mm. Body broadly oval and strongly convex. Cuticle very strongly shining and black but occasionally with a scarcely noticeable brassy lustre; tarsi and funicle of antenna dark rufo-piceous. *Head* with marginal stria well developed but absent on middle two-thirds of front. Surface on each side above eye with a large area set with round to oval punctures which are about four times as coarse as facets of eyes and are separated by less than one to one diameter; clypeus slightly more finely and sparsely punctate and middle of front with punctures one-half as coarse and separated by two to four diameters;

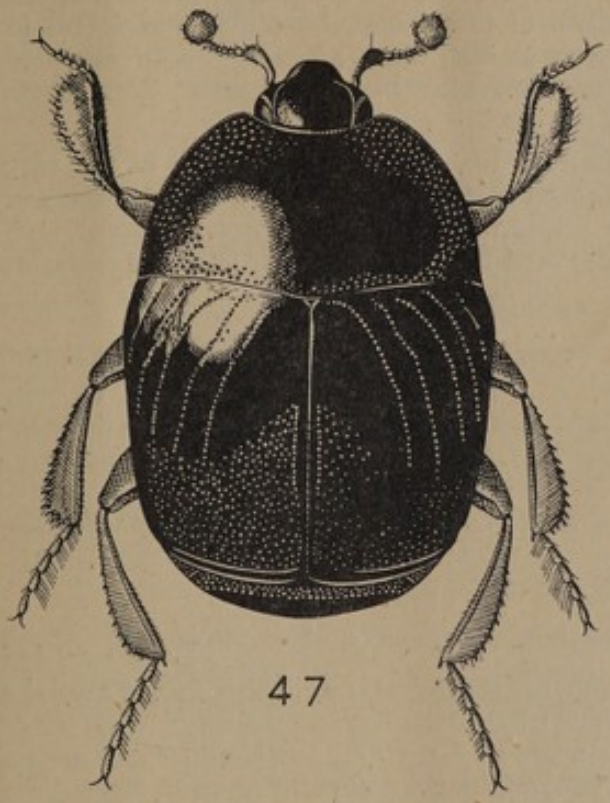


FIG. 47. *Saprinus semistriatus* (Scriba).

surface between punctures with very sparse, microscopic punctures. *Pronotum* with apical and lateral striae coarse and complete. Surface of most of disk with two sizes of microscopic punctures separated by about four to ten diameters; on each side near lateral margin with a broad belt of very dense punctures which are often twice as coarse as supra-orbital punctures of head, this belt extending slightly mesally near apex as shown in fig. 47; base with a narrow belt of similar coarse and dense punctures. *Elytra* with apical stria complete, distinct, and joined to sutural which is absent on basal third or two-fifths and is sometimes broadly interrupted or indistinct on much of apical two-thirds; third to sixth striae as shown in fig. 47; these dorsal striae vary considerably and may be broadly interrupted at one or more points, the fourth and fifth are usually not joined at base, and the third and fourth may run into each other on basal fourth or fifth of elytra. Strial punctures are coarse, dense, deep, and more or less round. Apical two-fifths of elytra (fig. 47) is punctate like striae with the punctures usually separated by one to three diameters; basal three-fifths microscopically and very sparsely punctate;

intervals between fifth and sixth striae often coarsely punctate nearly to base and often with numerous oblique, deeply impressed lines. *Propygidium* on caudal one-half or two-thirds with punctures very slightly coarser than those of apex of elytra and seldom separated by as much as one diameter; surface between punctures with a lightly impressed, transverse, alutaceous microsculpture. *Pygidium* sculptured like caudal part of propygidium but on apex with punctures finer and sparser; some specimens with a complete or nearly complete, narrow, median longitudinal line which is impunctate. *Prosternum* with median carinae widely diverging anteriorly and attaining anterior margin; lateral carinae on each side joined to median at a point very slightly nearer to anterior margin than to coxal cavity. Hypomeron not pubescent. Mesosternal disk with punctures as coarse as those of elytral apex but usually separated by two to four diameters; meso-metasternal suture very coarsely crenate. Metasternal disk broadly, feebly, longitudinally concave. Front tarsi with a long, flat, broadly lanceolate, testaceous seta on ventral apex of each of four basal segments; middle tarsi with a fringe of five or six very long (as long as fifth tarsal segment), moderately slender, close, curved, testaceous setae on each of four basal segments, these setae arising from inner ventral margin.

♀: Differs from male as follows: (1) the middle of the metasternal disk is only slightly concave on caudal third; (2) the four basal segments of the front tarsi have stout ventral spines but no long, flat, lanceolate setae; and (3) the four basal segments of the middle tarsi have no fringe of very long, slender, curved setae.

Distribution: Palaearctic Region, N. India.

Habits: Sacharov (1921) records it at Astrachan where it was found to be a predator on the larvae of *Dermestes lardarius*, L., and *D. frischii*, Kug., in stores of air-dried and smoked fish. Zacher (1927) records it attacking fresh meat and occurring in granaries in Germany. According to Reichardt (1941), it is very common in carrion but less common in dung, and it is also found in hamster burrows and in the flowers of *Dracunculus* and *Amorphophallus*.

Saprinus semipunctatus (Fabricius).

1792. *Hister semipunctatus*, Fabricius, Ent. Syst., **1**, p. 73.

♂: Length, 5-10 mm.; breadth, 4·6 mm. Body broadly oval and strongly convex. Cuticle strongly shining; black and nearly always with a distinct blue-green or blue metallic lustre; funicle of antennae, tarsi, and sometimes also tibiae dark rufopiceous. *Head* with marginal stria complete or nearly complete and rather strongly arcuate across front. Surface on each side near eye with a group of very coarse, dense, oval punctures; surface between these with punctures about half as coarse and usually separated by one to two diameters though punctures are denser on clypeus; surface between coarse punctures sparsely, microscopically punctate and smooth or (usually base and clypeus) finely, transversely alutaceous; sides of clypeus longitudinally alutaceous. *Pronotum* with apical and lateral striae coarse and complete, but lateral striae ending a short distance before base. Surface of most of disk very sparsely punctate with two distinct kinds of microscopic punctures, the larger being twice as coarse as the smaller; on each side near lateral margin with a broad belt of very coarse punctures, this belt extending mesally near apex and near base; on middle of belt the punctures are nearly twice as large as supra-orbital ones of head and are contiguous to separated by half of one diameter; basal belt of coarse punctures broadly interrupted at middle of base. *Elytra* with apical stria deep, complete, and joined to sutural which extends to basal third or fourth; third stria very short and extending from about middle of elytra to basal third; fourth stria extending from near base to about middle; fifth is slightly shorter than fourth; and sixth is confined to basal third,

is usually rather irregular, and is crossed by a number of fine, short, deeply impressed lines. Surface of apical half at sides and apical fourth or fifth near suture with round punctures which are about as coarse as supra-orbital ones of head and are separated by one to three diameters; interval between fifth and sixth stria usually similarly but more sparsely punctate as well as coarsely, obliquely rugose; surface elsewhere with very sparse microscopic punctures which are finer than those present between the coarse apical punctures. Striae sparsely and irregularly crenate with coarse punctures; sutural stria more finely and indistinctly crenate than other dorsal striae. *Propygidium* on caudal three-fourths with rather shallow, round or oval punctures which are as coarse as coarser ones of elytra and are nearly contiguous to occasionally separated by more than one diameter: Surface between punctures microscopically and transversely alutaceous. *Pygidium* sculptured like propygidium but with punctures very slightly deeper and sparser; some specimens with an indistinct, median longitudinal, impunctate line. *Prosternum* with median carinae nearly parallel but moderately diverging anteriorly beyond point at which they are joined to lateral carinae; lateral carinae joined to median at a point which is three times as far from coxal cavity as from anterior margin. Hypomeron with numerous long, erect testaceous setae. Mesosternal disk finely, sparsely punctate but with a few coarse and dense punctures at sides and along caudal margin; meso-metasternal sutural line fine and not crenate. Metasternal disk on middle broadly and moderately shallowly concave for all of its length. Front tarsi with a long, flat, lanceolate, testaceous seta on ventral apex of each of four basal segments.

♀: Differs from male in having no long and lanceolate ventral setae on four basal segments of front tarsi.

Comparative Notes: Its larger size, blue or blue-green metallic lustre, pubescent hypomera, and non-crenate meso-metasternal suture will serve to distinguish it from *S. semistriatus* (Scriba).

Distribution: Mediterranean Region, S. Europe, Iran, Caucasus, Turkestan, Turkmen.

Habits: Sacharov (1921) records it with *S. semistriatus* at Astrachan where it was found to be a predator of the larvae of *Dermestes lardarius*, L., and *D. frischii*, Kug., in stores of air-dried and smoked fish. According to Reichardt (1941), it is usually found on dead animals, particularly large ones, and has been found in hamster burrows and in the flowers of *Dracunculus*.

Dendrophilus punctatus (Herbst) (fig. 48).

1792. *Hister punctatus*, Herbst, in Jablonsky, Nat. Ins. (Käf.), **4**, p. 41, pl. 36, f. 5.
1775. *Hister pygmaeus*, Fabricius, Syst. Ent., **1**, p. 53.
1798. *Hister corticalis*, Paykull, Fauna Suec., **1**, p. 50.
1825. *Hister punctulatus*, Say, J. Acad. nat. Sci. Philad., **5**, p. 45.
1830. *Dendrophilus cooperi*, Stephens, Ill. Brit. Ent., **3**, p. 159.

♂: Length, 2·6-4·0 mm.; breadth, 1·8-2·3 mm. Body broadly oval and strongly convex. Cuticle moderately strongly shining and black with tarsi and segments 2-8 of antennae dark rufo-piceous; tibiae sometimes dark rufo-piceous; antennal club brown and densely clothed with fine, testaceous hairs. *Head* with round punctures which are about as coarse as facets of eyes and are usually separated by one diameter; head also with a few finer (about two-thirds as coarse) punctures. Surface between punctures with a fine, indistinct (mag. × 75), reticulate microsculpture. *Pronotum* at broadest point, which is at base, nearly twice as broad as long (65:38) and base twice as broad as apex (65:32). Sides evenly arcuate; apex and sides completely margined, base not margined. Disk with round or

feebly oval punctures which are very slightly coarser than those of head and are separated by one and a half to two diameters, rarely more; disk also with sparse punctures about half as large as the latter; towards sides and base punctures gradually become coarser and denser so that near hind angles they are almost half again as large as those of middle of disk and are separated by half of one to one diameter, but very near lateral margins they are nearly as fine as on middle of disk. Surface between punctures with a reticulate microsculpture like that of head but at sides of pronotum this microsculpture is more evident. *Elytra* with first two striae absent; third and fourth well impressed and extending to slightly beyond middle; fifth and sixth slightly more strongly impressed and extending to apical third or even apical fifth but indistinct beyond basal three-fifths; seventh (outer marginal stria) distinctly more deeply impressed than others, complete or nearly so, and nearly contiguous at both base and apex to inner epipleural stria; oblique humeral stria shallow and indistinct; apical half of elytra sometimes with a scarcely visible stria between sixth and seventh striae. Punctures of middle of

FIG. 48. *Dendrophilus punctatus* (Herbst).

disk sparser and slightly finer than those of middle of pronotal disk; elsewhere with punctures slightly coarser and as dense as those of basal sides of pronotum; near apex surface is sometimes very feebly, longitudinally rugose. *Propygidium* one-fourth as long as pygidium (8:33) and exposed apical half with round punctures which are about as coarse as those of elytral apex and are separated by one-fourth to two-thirds of one diameter; basal half, which is usually concealed by elytra, with sparser and much finer punctures. Surface between punctures with a fine reticulate microsculpture. *Pygidium* feebly convex or nearly flat, but sometimes with a feebly convex median longitudinal line on basal two-thirds. Surface sculptured like caudal half of propygidium but with punctures half again to twice as coarse; apex with punctures much shallower and as fine as those of middle pronotal disk. *Prosternum* with caudal margin of process broadly, strongly, evenly rounded. Carina in front of anterior coxa prominent, nearly straight, and not extending further anteriorly than prosternal carinae. Mesosternum with apex shallowly, arcuately emarginate and without an apical marginal line; side of disk with a distinct and nearly complete marginal line which anteriorly extends slightly mesally;

caudal marginal line with numerous deep and rather irregular crenations. Surface sculptured like middle basal sides of pronotum. Metasternum with lateral stria on each side extending caudally and outwards in a nearly straight line to a point near middle of episternum. Disk very finely and sparsely punctate; sides with punctures as coarse and nearly as dense as those of pygidium.

♀: Externally similar to male.

Comparative Notes: This species is very close to *D. xavieri*, Marsaul, but may be distinguished by the absence of the first and second elytral striae and the punctures of the elytra which only gradually become slightly finer towards the middle of the disk instead of being abruptly finer on the basal half.

D. championi Lewis (1886) from Turkey, which is considered by some authors to be a synonym of *D. punctatus*, is a good species. It is striate like *D. xavieri* and punctate like *D. punctatus* but much more coarsely so.

Distribution: Europe, N. America.

Habits: In a hornet's nest in Germany (Erné, 1877); occasionally in pigeon-houses in France (des Gozis & Fauvel, 1886); in dead animals, in rotten wood, and in the nests of *Acanthomyops fuliginosus* in Britain (Fowler, 1889); in a London granary (Donisthorpe, 1897); at sap of tree and in the nests of *Acanthomyops fuliginosus* in Germany (Ganglbauer, 1899); in nests of starlings, daws, owls, and woodpeckers in Germany where it is the most regular beetle inhabitant of birds' nests (Gerhard, 1909); in a cellar in a granary, in bird and owl nests, in a bone heap, and in the nests of *Formica rufa* in Britain (Fowler & Donisthorpe, 1913); in a bone works at Acton Bridge, Cheshire (Walker, 1916a); in birds' nests in France (Auzat, 1917); in a granary at Cothill, Berks (Walker, 1916b); in a starling's nest in Sussex (Bennett, 1915); under floors of granaries and railway sheds in the U.S.S.R. (Zvierezomb-Zubovskii, 1917); in hornet nests in Europe (Bickhardt & Wasmann, 1925); in owl's castings and in a sack-heap on the Isle of Sheppey (Walker, 1932); frequently in waste grain in flour mill basements in the U.S.A. (Cotton & Good, 1937); in Windsor Forest in loose hay, straw-refuse, in company with *Acanthomyops brunneus*, in squirrels' nests, and in some numbers in birds' nests (Donisthorpe, 1939); in flour mills in various parts of Eastern and Central U.S.A. (Ross, 1940); and in a woodpecker's nest in Surrey (Duffy, 1944).

During 1943 it was found in warehouses, granaries, and mills in London, Bristol, and Liverpool.

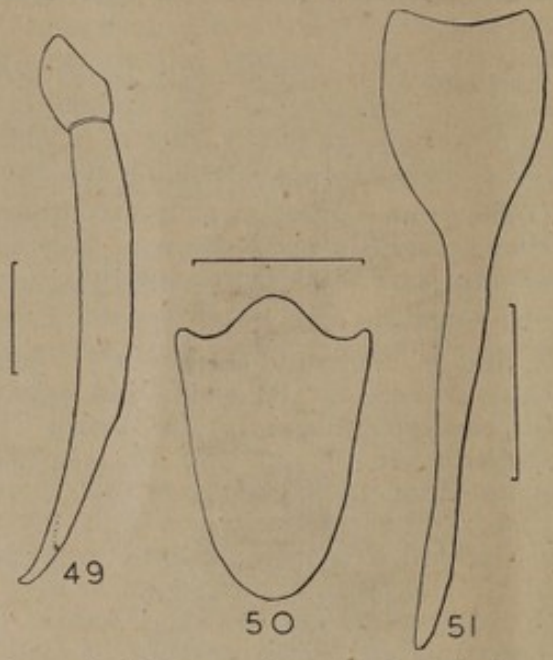
Dendrophilus xavieri, Marseul (figs. 49-51).

1873. *Dendrophilus xavieri*, Marseul, Ann. Soc. ent. Fr., (5) **3**, p. 226.
1938. *Dendrophilus sexstriatus*, Hatch, J. Kans. ent. Soc., **11**, p. 18.

♂: Length, 2·5-3·7 mm.; breadth, 2·0-2·3 mm. Externally very similar to *D. punctatus* (Herbst), from which it may be distinguished as follows: (1) elytra with first stria usually distinct and nearly as long as second but occasionally obsolete or absent except very near base, whereas in *D. punctatus* the first stria is always absent; (2) second stria usually as long and nearly as deeply impressed as third but sometimes feebly impressed and nearly obsolete on middle of disk, whereas in *D. punctatus* the second stria is wanting or only indistinctly represented behind middle of disk by a row of punctures; (3) the intervals of the basal half of the elytra between suture and fifth stria with the punctures abruptly finer and much sparser than those of apical half, the area between the suture and second stria on middle of disk being highly polished and very strongly shining with punctures only about a fourth as coarse as those of apical half and separated usually by five to ten or more diameters, whereas in *D. punctatus* the punctures gradually become finer towards middle of disk and, except for a few very near suture, are about two-thirds as large as apical punctures and are usually separated by

two to four diameters; and (4) surface between punctures on middle of disk between first and second intervals without a visible (mag. × 75) microsculpture, whereas in *D. punctatus* there is here a very fine but distinct microreticulation.

♀: Externally similar to male.



FIGS. 49–51. *Dendrophilus xavieri*, Mars., male. (49) Lateral view of genitalia. (50) Dorsal view of tenth abdominal tergite. (51) Ninth abdominal sternite.

Comparative Notes: *D. xavieri* was sunk as a synonym of *D. punctatus* by Ross (1940), who appears to have been guided to some extent by a statement of Wenzel's (*in litt.*) that every gradation could be found between the two in a large series. I have been unable to find any significant gradation in the series of 33 specimens of both species before me. Moreover, as has been pointed out by Ross himself, the distribution of *D. xavieri* supports the view that it is a distinct species. *D. xavieri* occurs on the Pacific Coast of N. America from Canada to California, while *D. punctatus* has not yet been found in this region and is, so far as is known, confined to the Eastern and Central United States. *D. xavieri* has extended its range into the latter region but is there much rarer than *D. punctatus*.

The male genitalia of the two species are nearly identical, and I have been able to find no differences which can be considered to be of specific importance. A few specimens have been dissected of both species, and it appears from these that the anterior sides of the eighth abdominal tergite are not so strongly produced forwards in *D. xavieri* as in *D. punctatus*.

Distribution: Japan, N. America, England.

Habits: Marseul (1873) records it in Japan at the foot of old trees and in the nest of a black ant. Ross (1940) records it in Vancouver in a culture of *Tenebrio*, etc. in bran and in rotting vegetation in San Francisco. During 1942-43, one was found on pumice in a Bristol warehouse, one in rotting grain in the basement of a London flour-mill, and four in a Liverpool flour mill.

Carcinops quattuordecimstriata (Stephens) (figs. 52-53, 55).

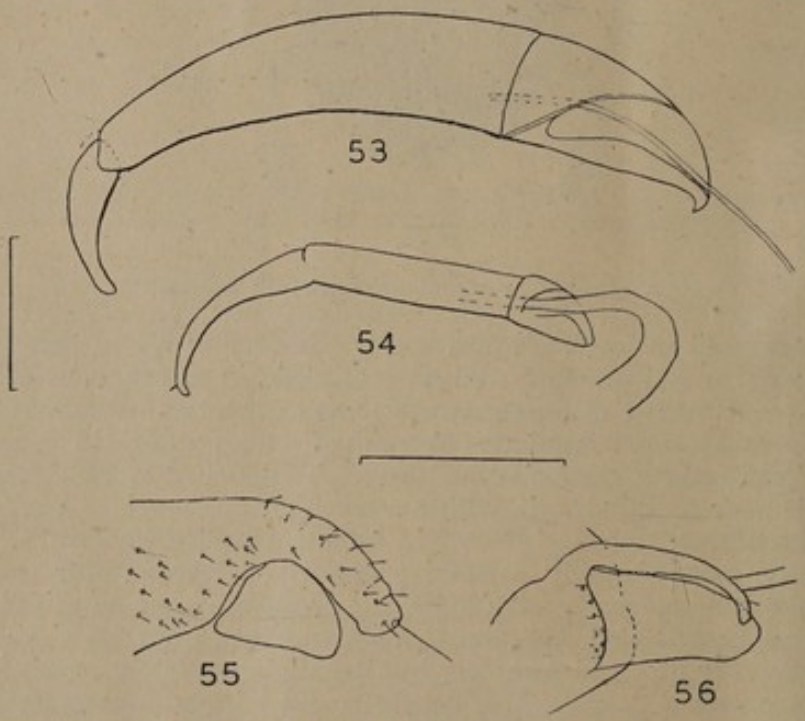
1832. *Dendrophilus quattuordecimstriatus*, Stephens, Brit. Ins., **5**, p. 412.
1834. *Paromalus pumilo*, Erichson, in Klug, Jahrb. Insectenk., **1**, p. 169.
1845. *Hister nana*, Leconte, Boston J. nat. Hist., **5**, p. 61, pl. 4, f. 4.

♂: Length, 1·6-2·7 mm.; breadth, 1·1-1·8 mm. Body broadly obovate in outline, rarely nearly subparallel. Cuticle strongly shining and black or (probably only in recently emerged specimens) dark rufo-piceous; black specimens with legs or only tarsi rufo-piceus and antennae with club brownish or reddish testaceous and funicle dark rufo-piceus. *Head* with marginal stria well developed on occiput and on sides and more or less truncate and much less deeply impressed at anterior margin, rarely with transverse anterior section of stria absent or scarcely visible; stria

FIG. 52. *Carcinops quattuordecimstriata* (Stephens).

occasionally interrupted at postero-lateral angles. Surface with two sizes of punctures as follows: (1) large round punctures about a third again as coarse as facets of eyes and separated by one to five or more diameters; and (2) punctures about one-half as coarse which are much more regularly distributed, being separated usually by two or three diameters; surface between punctures on middle of front, anteriorly, and on a narrow belt near occipital stria with a very fine transverse to partly reticulate alutaceous microsculpture; surface elsewhere smooth between punctures. *Pronotum* with sides slightly more strongly arcuate anteriorly. Apex with marginal line usually complete but occasionally very indistinct or even absent on middle half; side with marginal line broad, well impressed, and complete from apex to base; base with marginal line very fine and complete but usually completely concealed by base of elytra. Surface with a deep oval or nearly round puncture immediately in front of scutellum, this puncture being about half as large as scutellum; disk with punctures which are very slightly coarser than fine ones of head and are usually separated by three to five diameters; lateral third of pronotum with fine punctures similar to those of disk and also with punctures which are slightly coarser than coarse ones of head and are usually separated by two to five or even more diameters; coarse punctures often absent in a large oval area which is adjacent to lateral margin and half way between base and apex; surface between pronotal punctures smooth. *Elytra* with striae and strial punctures as shown in fig. 52; second to seventh striae extending from near base to near apex; first or sutural stria often absent on basal fourth or fifth and sometimes very feebly impressed elsewhere or only indicated by a row of large punctures; oblique humeral stria fine but long and distinct and posteriorly usually joining seventh stria. Intervals flat and with only fine punctures like middle of pronotal disk; apical non-striate belt of elytra with coarse and fine punctures intermixed as on lateral third of pronotum; coarse and fine punctures sometimes

present on apical half of first and second intervals and, more rarely, also on apical half or third and fourth intervals; intervals with surface between punctures smooth. *Propygidium* nearly as long as pygidium and, except for a narrow and finely punctate band as well as apical belt, with both fine and coarse punctures, the coarse punctures usually being slightly but distinctly larger than those of apex of elytra and separated by less than one to two diameters. *Pygidium* finely punctate throughout and basally with numerous, or only a few, coarse punctures which, however, are apparently never as coarse as those of propygidium. *Prosternum* with caudal margin of process broadly rounded and received into a broad arcuate emargination of anterior margin of mesosternum; median striae nearly parallel but slightly more approximate opposite anterior third of front coxa and joined together in a broad curve before apex of process. Mesosternal disk completely and thickly margined laterally and anteriorly; disk with coarse and fine punctures like sides of pronotum. Metasternum with inner lateral striae extending caudally and outwards to basal fifth; outer metasternal stria extending from middle coxal cavity feebly diverges laterally from inner stria and does not extend quite as far posteriorly as the latter; disk punctate like pronotum, *i.e.* with only fine punctures on middle and with both fine and coarse punctures on sides. Abdomen with lateral striae of first sternite nearly parallel but with inner one coarser and extending from near base of anterior



FIGS. 53–56. (53) Lateral view of male genitalia of *Carcinops quattuordecimstriata* (Steph.). (54) Same of *C. mayeti*, Mars. (55) Lateral view of ninth (?) abdominal tergite of *C. quattuordecimstriata*. (56) Same of *C. mayeti*.

process to very near caudal margin, whereas the outer one commences near the inner hind part of the coxal cavity and does not extend quite as near to the caudal margin of the segment.

♀: Externally similar to male.

Variations: Apart from the variations in punctuation and colour already mentioned, a few specimens have been seen which have only fine punctures on the meso- and metasternal disks and a few which have the coarse punctures confined to the extreme sides of these two sclerites.

Comparative Notes: The differences between this species and *C. mayeti*, Mars., are given under the heading of the latter and in the key.

Distribution: Cosmopolitan. According to Fauvel (1889), it is indigenous to Africa.

Habits: It has been found in rubbish and carrion in Britain (Fowler, 1889); in donkey and human excrement in Germany (Ganglbauer, 1899); in stale "German yeast" under the floor of a London bakehouse (Jennings, 1900); in glue works in Oxford and Queenborough (Fowler & Donisthorpe, 1913); in a bone works at Acton Bridge, Cheshire (Walker, 1916a); in stored cereals in Bordeaux (Dieuzeide & Tempère, 1924); in dead birds on Johnston Is. (Bryan, 1926); under bark in the Samoan Islands (Arrow, 1927); in a coniferous leader damaged by *Pissodes strobi* (Peck) in N. America (Taylor, 1928); in a granary at Reading (Joy, 1932); in rubbish in a glue works on the Isle of Sheppey (Walker, 1932); in the U.S.A. in stored grain, flour, and waste grain in flour mill basements where it is common (Cotton & Good, 1937); in haystack bottom, in cut grass, and in a bird's nest in Windsor Forest (Donisthorpe, 1939); and in wheat in the field and in storage in farms in Kansas (Cotton & Winburn, 1941).

Records of its occurrence during 1942-44 in Britain in structures used to store food are as follows: 1 in broken rice in a railway wagon at Birkenhead, Cheshire; 13 on pumrice in a Bristol warehouse; 2 in an elevator boot; 1 in a Bristol flour mill; numerous adults and larvae in waste grain in the basement of a London flour mill; 6 in a London granary; 4 on palm kernals at Liverpool; and 1 in crushed bones on the Dundee docks.

Parasite: According to Jones (1929), it serves as an intermediate host of *Hymenolepis carioca*.

Carcinops mayeti, Marseul (figs. 54, 56).

1870. *Carcinops mayeti*, Marseul, Ann. Soc. ent. Belg., **13**, p. 94.

♂: Length, 1·4 mm.; breadth, 0·87 mm. Body broadly oval. Cuticle strongly shining and very dark rufo-piceous, nearly black; antennal club testaceous; legs paler rufo-piceous than body, sometimes slightly red-brown. *Head* with clypeus feebly concave and bent downwards so that it is more or less vertical and at an angle of about 60-70° to front. Marginal stria complete basally but absent on sides and front margin of anterior half of front. Surface on basal half with punctures which are slightly finer to slightly coarser than facets of eyes and are usually separated by one to two diameters, the surface between the punctures being scarcely visibly (mag. × 100) alutaceous; surface of concave part of clypeus (and front?) much more finely and sparsely punctate and also distinctly transversely microreticulate and less shining. *Pronotum* with apical and lateral marginal lines distinct and complete. Surface punctate like head but with fine punctures separated by two to five diameters and also with shallow, round to oval punctures which are two or nearly three times as large and are much more irregularly distributed; along base with a single row of punctures which are deeper and half again to twice as coarse as large punctures of disk; surface between punctures smooth or nearly so. *Elytra* with second to seventh stria extending from near base to near apex; first or sutural stria absent on basal third or fourth; apical half with a distinct or indistinct stria between sutural and second striae, this accessory stria sometimes being present only as a row of punctures; oblique humeral accessory stria very fine, indistinct, and posteriorly joining seventh stria; striae distinctly but irregularly crenate with large punctures which may be very widely separated or even absent on basal half of first three striae. Intervals flat and with fine punctures like pronotal disk but on apex with a few round, deep, much coarser punctures; surface between punctures smooth or nearly so. *Propygidium* slightly less than half as long as pygidium and with fine punctures similar to those of head but slightly sparser. *Pygidium* punctate like propygidium but with an occasional distinctly coarser, round puncture. *Prosternum* with caudal apex of process strongly rounded

behind (sometimes nearly angulate) and fitting into a deep, arcuate emargination of anterior margin of mesosternum; median striae subparallel, slightly more approximated at middle, feebly curved at extreme anterior end, and joined or nearly joined at caudal apex. Mesosternal disk completely and thickly margined laterally and anteriorly; surface only finely punctate like basal half of head but more finely so. Metasternum with inner lateral stria extending nearly straight backwards to a point near caudal margin of metasternum and mesal to mesal margin of hind coxa; outer metasternal stria broadly sinuate and extending outwards and caudally to a point beyond anterior margin of hind coxa and near episternum; surface punctate like mesosternal disk but middle more finely and sparsely so. Abdomen with a single and complete stria on each side of disk of first sternite; extreme side of this sternite with two narrow nearly complete and approximately parallel striae.

♀: Externally similar to male but with the clypeus feebly convex, on the same plane as the front of the head, similarly punctate, and with the sides and front completely margined.

Comparative Notes: *C. mayeti* differs from *C. quattuordecimstriata* in the following important particulars: (1) it is 1·4 mm. instead of 1·6-2·7 mm. long; (2) the front of the head has no anterior stria and the clypeus is concave; (3) each elytron has a supplementary stria between the sutural and second striae; (4) the propygidium is less than half as long as the pygidium and is only finely punctate instead of being nearly as long as the pygidium and having very coarse and fine punctures intermixed; (5) the inner lateral striae of the metasternal disk are nearly straight instead of oblique; (6) the disk of the first abdominal sternite has only a single lateral stria on each side instead of two; (7) the extreme side of the first sternite has two parallel striae instead of only one; and (8) the male genitalia have the parameres more than half as long as the basal piece instead of only about one-fourth as long (*cf.* figs. 54 & 53).

Distribution: Egypt, Arabia. Introduced into France but not established there.

Habits: It has been found on ground-nuts imported into Marseilles (Marseul, 1870; des Gozis & Fauvel, 1886) and on ground-nuts imported into Cette (Ganglbauer, 1899).

Acknowledgments.

My best thanks are due to Mr. W. McAuley Gracie, M.B.E., for his permission to make use of the unpublished records of the Infestation Division of the Ministry of Food. I have also to thank Mr. R. A. Crowson for translating from the Russian parts of Reichardt's monograph of the Histeridae and Dr. F. van Emden for lending me some important Histerid larvae. I am indebted to the Department of Scientific and Industrial Research for defraying the cost of the drawings for figures 47, 48 and 52, which were prepared by Mr. Arthur Smith.

References.

ARROW, G. J. (1927). Insects of Samoa and other Samoan terrestrial Arthropoda. Clavicornia and Lamellicornia.—Part IV. Coleoptera, fasc. 1, pp. 35-66, 13 figs. London.

AUZAT, V. (1917). Revision des *Gnathoncus* (Col. Histeridae) français.—Bull. Soc. ent. Fr., **1917**, pp. 206-208.

BENNETT, W. H. (1915). The Coleoptera of the Hastings District.—Hastings Nat., **2** (4), pp. 185-192.

BICKHARDT, H. (1916). Biologische Notizen über paläarktische Histeriden.—Ent. Bl., **12**, pp. 49-54.

—— & WASMANN, E. (1925). In Blunck, Syllabus der Insektenbiologie. Berlin.

BÖVING, A. G. & CRAIGHEAD, F. C. (1931). An illustrated synopsis of the principal larval forms of the order Coleoptera.—Ent. amer., **11**, pp. 1-351, 125 pls.

BRYAN, E. H. (1926). Insects of Hawaii, Johnston Island and Wake Island. Coleoptera.—Bull. Bishop Mus., Honolulu, **31**, pp. 46-49.

COTTON, R. T. & GOOD, N. E. (1937). Annotated list of the insects and mites associated with stored grain and cereal products, and of their Arthropod parasites and predators.—Misc. Publ. U.S. Dep. Agric., no. 258, 81 pp.

—— & WINBURN, T. F. (1941). Field infestation of wheat by insects attacking it in farm storage.—J. Kans. ent. Soc., **14** (1), pp. 12-16.

DIEUZEIDE, R. & TEMPÈRE, G. (1924). Sur quelques insectes des entrepôts.—Rev. Zool. agric., **23** (5), pp. 116-119.

DONISTHORPE, H. (1897). The Coleoptera of a London granary.—Ent. Rec., **9**, pp. 77-78.

——. (1939). A preliminary list of the Coleoptera of Windsor Forest. London.

DUFFY, E. A. (1944). A record of *Dendrophilus punctatus* (Col. Histeridae).—Entomologist, **77**, p. 60.

ERNÉ. (1877). Ueber das Aufziehen der *Rhipiphorus paradoxus*.—Mitt. schweiz. ent. Ges., **4**, pp. 556-566.

FAUVEL, A. (1889). Liste des coléoptères communes à l'Europe et à l'Amérique du Nord.—Rev. Ent., Caen, **8**, pp. 92-174.

FOWLER, W. W. (1889). The Coleoptera of the British Islands, **3**.

—— & DONISTHORPE, H. St. J. (1913). The Coleoptera of the British Islands, **6**.

GANGLBAUER, L. (1899). Die Käfer von Mitteleuropa, **3**. Wien.

GERHARD, K. (1909). Käfer in Nestern.—Ent. Bl., **5**, pp. 128-132, 145-147.

DES GOZIS, M. & FAUVEL, A. (1886). Les Histérides Gallo-Rhénans.—Rev. Ent., Caen, **5**, pp. 152-213.

JENNINGS, F. B. (1900). *Carcinops quatuordecimstriata*, Steph. in a London bakehouse.—Ent. mon. Mag., **36**, p. 43.

JONES, M. (1929). *Hister* (*Carcinops*) *14-striatus* as intermediate host of *Hymenolepis carioca*.—J. Parasit., **15**, p. 224.

JOY, N. H. (1907). *Gnathoncus nidicola*, sp. nov., a Coleopterous inhabitant of birds' nests.—Ent. Rec., **19**, pp. 133-136, 1 pl.

——. (1909). A note on the male genitalia of *Anisotoma anglica* Rye and *Gnathoncus nidicola* Joy.—Ent. mon. Mag., **45**, pp. 219-220.

——. (1932). Coleoptera from a granary at Reading.—Ent. mon. Mag., **68**, p. 85.

MARSEUL, S. A. (1870). Descriptions d'espèces nouvelles d'Histérides.—Ann. Soc. ent. Belg., **13**, pp. 55-138.

——. (1873). Coléoptères du Japon recueillis par M. Georges Lewis. Enumération des Histérides et des Hétéromères avec la description des espèces nouvelles.—Ann. Soc. ent. Fr., (5) **3**, pp. 219-230.

——. (1876). Mélanges.—Abeille, Paris, **16**, pp. 38-40.

REICHARDT, A. (1941). Faune de l'URSS. Insectes Coléoptères, Vol. V, No. 3, Sphaeritidae et Histeridae (1). [In Russian.] i-xiii, 421 pp., 177 figs. Moscow.

ROSS, E. S. (1940). A preliminary review of the North American species of *Dendrophilus*.—Bull. Brooklyn ent. Soc., **35**, pp. 103-108, 12 figs.

SACHAROV, N. L. (1921). Die Schädlinge der Fischprodukte im Astrachan'schen Gouvernement. [In Russian.]—Trud. saratov. Obshch. Est. **8** (2) pp. 3-39, 4 pls.

STEINKE, G. (1919). Die Stigmen der Käferlarven.—Arch. Naturgesch., **85** (7), pp. 1-56, 2 pls., 15 figs.

STRUBLE, G. R. (1930). The biology of certain Coleoptera associated with bark beetles in western yellow pine.—Univ. Calif. Publ. Ent., **5** (6), pp. 105-134, 6 figs.

TAYLOR, R. L. (1928). The Arthropod fauna of coniferous leaders weeviled by *Pissodes strobi* (Peck).—Psyche, **35**, pp. 217-225.

WALKER, J. J. (1916a). Occurrence of *Somotrichus* (*Lebia*) *elevatus* F., in Cheshire.—Ent. mon. Mag., **52**, pp. 203-204.

——. (1916b). Granary beetles at Cothill, Berks.—Ent. mon. Mag., **52**, pp. 16-17.

——. (1932). An annotated list of the Coleoptera of the Isle of Sheppey.—Trans. ent. Soc. S. Engl., **7** (2), pp. 81-140, 1 map.

WILLCOCKS, F. C. (1925). The insect and related pests of Egypt, **2**. Cairo.

ZACHER, F. (1927). Die Vorrats-, Speicher- und Materialschädlinge und ihre Bekämpfung. vii + 366 pp., 8 pls., 123 figs. Berlin.

——. (1940). Die Fauna der Mühlen und Speicher in Aegypten.—Int. Congr. Ent. (1935) **6**, pp. 353-368.

ZVIEREZOMB-ZUBOVSKII, E. (1917). A few words on insects underneath the floors of grain stores. [In Russian.]—Zh. prikl. Ent., **1** (1), pp. 44-46.

ROYAL SANITARY INSTITUTE

LIBRARY REGULATIONS

1. Books may be borrowed by Fellows, Members and Associates personally or by a messenger producing a written order. The person to whom books are delivered shall sign a receipt for them in a book provided for that purpose.

2. Books may be sent through the post, or by some equivalent means of carriage, upon a written order. All charges of carriage to the Institute shall be defrayed by the borrower.

3. A borrower may not have more than three volumes in his possession at one time.

4. A borrower will be considered liable for the value of any book lost or damaged while on loan to him, and if it be a separate volume, for the value of the whole work rendered imperfect.

Marking or writing in the volumes is not permitted, and borrowers are requested to call attention to damage of this character.

5. Books may be retained for 28 days. Periodicals may be retained for 14 days. Applications for extension of the loan period must be made in writing before its expiry. No book may be kept longer than 3 months.

New books will not be lent until after the expiration of one month from the date of their having been received by the Institute. The current number of a periodical may not be borrowed.

6. Borrowers retaining books longer than the time specified, and neglecting to return them when demanded, forfeit the right to borrow books until the volume or volumes be returned, and for such further time as may be ordered.

Any borrower failing to comply with a request for the return of a book shall be considered liable for the cost of replacing the book, and the Council may, after giving due notice to him, order the book to be replaced at his expense.

No volume may be reissued to the same borrower until at least seven days have elapsed after its return, neither may it be transferred by one borrower to another.

7. Books may not be taken or sent out of the United Kingdom.

8. Volumes returned through the post must be securely packed in a box, or otherwise protected.

Parcels should be addressed :

THE ROYAL SANITARY INSTITUTE,
90, BUCKINGHAM PALACE ROAD,
LONDON, S.W.1.

LONDON
PRINTED AND PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE
To be purchased directly from H.M. STATIONERY OFFICE at the following addresses:
York House, Kingsway, London, W.C.2; 13a Castle Street, Edinburgh 2;
39-41 King Street, Manchester 2; 1 St. Andrew's Crescent, Cardiff;
80 Chichester Street, Belfast;
or through any bookseller

1945

Price 2s. 6d. net

S.O. Code No. 70-445-1