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Ecology, Life History and Redescription of
Pericoptus truncatus (Fabricius)

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Abstract

THE paper is intended as a first step towards a revision of the genus *Pericoptus* based on a knowledge of the distribution and bionomics of its constituent species. *Pericoptus truncatus* (Fab.) (Scarabaeidae, Dynastinae) occurs between the driftwood zone and the first dune ridge on sandy beaches, probably throughout New Zealand. The duration of the larval stadia is very variable, so the life cycle may occupy either two or three years. All larval instars undertake long migrations on the beach surface. The pupa occurs at 18 to 30 inches below the beach surface in late summer and early autumn. The adults may emerge as early as mid-March but usually remain deeply buried until September. Broun's (1879) description of the final instar larva has been revised and greatly extended, and his description of the adult extended to include the detail of the tibial sculpture and the male genitalia.

INTRODUCTION

THE relevant New Zealand literature on the genus *Pericoptus* is confined to three papers by Broun (1879, 1880 and 1904), a short account by Hudson (1934), and a paper by Given (1955). The genus contains five described species, *P. truncatus* (Fab.), *P. punctatus* (White), *P. frontalis* Broun, *P. nitidulus* Broun and *P. stupidus* Sharp. Broun (1880 and 1904) gave descriptions of the first four species whose types are held by the British Museum (Nat. Hist.), and Broun (1880) described *P. stupidus* whose type is in the Muséum National d'Histoire Naturelle in Paris. Given (1955) figured the hind tibiae and male genitalia of the British Museum types, listed their type localities and gave an account of the synonymy.

Accounts of the immature forms are confined to *P. truncatus*. The final instar larva and its habitat have been dealt with in some detail by Broun (1879), and a more superficial account of larval form and habits was given by Hudson (1934).

Distribution records are scanty. Broun recorded *P. truncatus* from Great Barrier Island, and Hudson gave its distribution as "Wanganui and throughout the Wellington district, and is almost certainly to be found on the sea-coast elsewhere". Published localities for the other four species are confined to the type localities.

The published descriptions raise problems of identification. Broun's account of *P. truncatus*, though far from complete by modern standards, is adequate for the identification of specimens, and reasonably certain determinations of *P. punctatus* can be made from his account in conjunction with Given's drawings. The value of Broun's descriptions of *P. frontalis* and *P. nitidulus* based on head sculpture, is doubtful for purposes of practical identification. They appear to be separable on the basis of Given's illustrations, but specimens are rare in collections in New Zealand. The description of *P. stupidus* given by Broun could be applied to any of the species except *P. truncatus*. Given (1955) states that Sharp himself considered it to be allied to *P. punctatus*. Broun (1880) concurred. In the absence of published drawings from the type, *P. stupidus* stands in the way of further progress in the systematics of the genus. It is not possible therefore to erect new species for specimens which do not fit the other descriptions, because it cannot be said with certainty that they are not *P. stupidus* without recourse to the solitary type specimen. Drawings from the type sent to me by courtesy of the Muséum National d'Histoire Naturelle indicate that even then the distinction would not always be easy to make. It is intended that the following account of the biology and taxonomic morphology of *P. truncatus* should form a basis for a revision of the genus in that it will provide details of one species with which the equivalent characters of the less common species can be compared. The value of *P. truncatus* for this purpose lies in its morphological and ecological distinctness and its wide distribution, so that it is readily available and easily identifiable.

The paper is the result of research carried out at the University of Canterbury in 1955 and at Massey College in 1960 and 1961.

DISTRIBUTION

Pericoptus truncatus (Fab.) inhabits sandy littoral areas of New Zealand from Ninety-Mile Beach to Surat Bay, near Bluff, and probably occurs throughout the country on sandy beaches where driftwood is present. Given (pers. com.) has observed it at Ninety-Mile Beach, a specimen from Dargaville is in the collection of the Entomological Research Station at Lincoln, the Auckland Museum has specimens from Muriwai Beach, Tauranga and Opotiki, and McCallum (1960) records it from Port Waikato. The collection at Plant Diseases Division, D.S.I.R., Auckland, contains specimens from Great Barrier Island, Kawhia, Devonport, Titirangi, Orewa, Ruakakea, Anawhata, Whangapoua, Whangamata, Gisborne, Taranaki, New Plymouth, Foxton and Waiterere Beach. I have, in addition, specimens from Wanganui, Takaka, Pegasus Bay, Taumutu and Surat Bay.

HABITAT

The habitat is fairly clearly delimited, extending from the driftwood zone above mean high-water spring, to include the line of dunes fronting the beach. Where storms carry driftwood through gaps in the dunes, the larvae are sometimes found, but they are rare on the landward face of the fronting dunes and do not seem to occur at all on dunes further inland.

Within these boundaries larvae, pupae and adults may occur at the appropriate times under any part of the surface, regardless of the presence or absence of organic matter, but they are much commoner among the roots of marram grass and occur in high concentrations under and within well anchored driftwood. Eggs have been found only in these last two situations. These situations are made attractive not only by the presence of food for the larvae, but also because

the presence of organic matter tends to stabilise the water content of the sand, and this in turn prevents the grains from collapsing into a compact mass, such as occurs when surface tension forces are reduced by saturation or desiccation (see Terzaghi and Peck, 1948, p. 118 "bulking"). This phenomenon also explains an observed larval preference for situations in which the water content lies between 9% and 20% of the amount necessary to saturate the interstices between the grains, and the larval habit of making short surface journeys in the appropriate direction when the percentage saturation falls outside these limits.

In depth the habitat extends down to four feet (in Canterbury at least), with eggs occurring from six inches to eighteen inches, larvae from the surface to two feet six inches, pupae from one foot six to two feet six, and newly emerged adults from two feet six to four feet. Mature adults occur from the surface and above down to eighteen inches.

The significance of the landward limit has been studied mainly in Canterbury, but no definite conclusion has been reached. Analysis of sand grain size and sorting, shows no such boundary, nor does salinity when measured by the method of chloride determination by titration with silver nitrate. There is experimental evidence that *P. truncatus* is less tolerant of low temperatures than *P. punctatus* (White) which inhabits areas remote from the foreshore, but this factor could not be expected to operate in the warmer regions of the North Island which nevertheless show the same habitat restrictions of *P. truncatus*. Nocturnal migrations of the larvae between the driftwood zone and the dunes are a feature of the larval habits, and this suggests that landward distribution may be restricted by some (perhaps nutritional) necessity for the larvae to return to the driftwood zone from time to time. The distances involved (final instar larvae commonly cover fifty to eighty yards in a night) are not inconsistent with this view. Further, the observed growth rates of larvae (see page ?) indicate that development is much more rapid among driftwood than among grass roots, so there is an obvious selective advantage involved if some of the larvae move to the driftwood from the dunes from time to time (see also page 7). The landward boundary of the habitat would seem then to be the result of the interaction of two factors, on the one hand the advantage of remaining near an abundant though precarious food supply in the driftwood and on the other the necessity for a secure retreat in the dunes from the hazards of storm conditions on the beach. If this is the case it is indeed a remarkable adaptation to an unstable environment.

SECTION I.—LIFE HISTORY

The life cycle occupies up to three years, a greater span than that recorded for any Australian or American genus of the sub-family (Cumpston, 1940, Carne, correspondence; Hayes, 1929; Chapin, 1932), though other Scarabaeids are known to have equally long life cycles. Eggs are laid from early October to mid-November, and the larvae emerge from late November to mid-December. This gives an incubation period of about two months, a figure which is confirmed by eggs kept in the laboratory. The discrepancy between the period of deposition and the period of emergence, suggests that eggs which are deposited later have a shorter incubation period than those deposited early in the season, presumably in response to higher temperatures.

The eggs are deposited singly under driftwood or marram grass, and the number in any particular situation suggests that the female deposits her full complement, twelve to sixteen, within an area of two or three square feet. When deposited, the eggs are elongate ovate, 3.7mm by 2.5mm, creamy in colour,

and covered by a sticky secretion which hardens on exposure to the atmosphere, and appears to induce a diapause in the embryo when this occurs under dry conditions. Under normal conditions the eggs cease to be sticky after about one week, become paler in colour and begin to expand and become more spherical. Expansion continues until the fourth week (6mm by 5mm) when translucent areas become visible through the chorion. During the last week of incubation the spiracles of the larva are visible through the chorion.

First Instar Larva

The newly hatched larva has a head width of 2.9mm to 3.3mm and an overall length of about 11mm. It is pinkish in colour and has orange head and claws. The head and legs are large in proportion to the body, as compared with the condition after it has begun to feed, and the body is much wrinkled and tapered posteriorly. In detailed morphology it appears to differ little from the subsequent instars except in the form of the spiracles, where the raised central portion or bulla is very weakly developed, and the spiracles consist almost entirely of the spiracular plate.

Soon after hatching the larva consumes the chorion of the egg, but does not commence to feed on plant matter until it is seven days old, subsisting meanwhile on the yolk contained in the midgut. Once feeding begins the body extends and rapidly assumes the normal larval proportions, while the gut contents showing through the body wall confer a purple colour which is gradually displaced by a creamy colour from before back as fat body is laid down between the gut and the body wall.

In Canterbury most of the larvae undergo the first ecdysis (length about 23mm) between late January and mid-March, the inhabitants of the marram grass being generally later than the larvae among the driftwood. A few persist through the winter, and an occasional fully expanded first instar larva can be found as late as November. The exuviae are presumably eaten, for though final instar exuviae are commonly found and are very durable, neither first nor second instar exuviae have been found in the field, while second instar mandibles have been observed among the gut contents of a final instar larva.

Second Instar Larva

At the beginning of the second stadium the head width is 5.2mm and the total length only 18mm. The spiracular bulla is well-developed and the ends of the C-shaped spiracular plate are less widely separated by it than in the first instar larva. The instar can be most positively recognised by the mean head width of 5.5mm. With a total length in excess of 30mm the second ecdysis takes place for many larvae from mid-June to early August, but second instar larvae are still common as late as December, and a few can be found at all times of year.

Final Instar Larva

At the beginning of the third stadium the head width is about 7.7mm and the length about 30mm. The duration of the instar cannot be accurately determined and can only be established by inference, but it is apparently very variable. Third instar larvae in all stages of growth can be found at all times of year. Fully grown (50mm) larvae seem to be absent from the surface layers from July to the end of September, although some can be found at depths of two to three feet at this time. (Larvae of all sizes and stages are less common among driftwood during this unstable period of the winter storms).

Fully grown final instar larvae have been taken at depths of two to three feet at other times of the year as well, and three of these taken in January

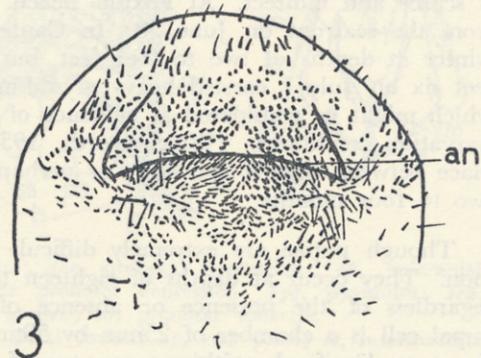
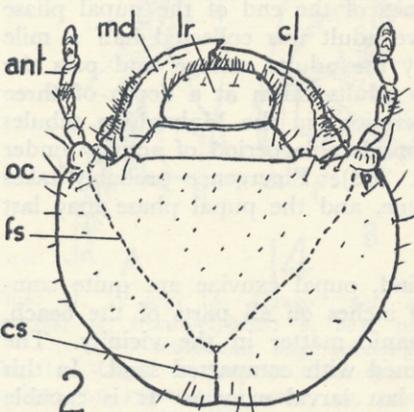
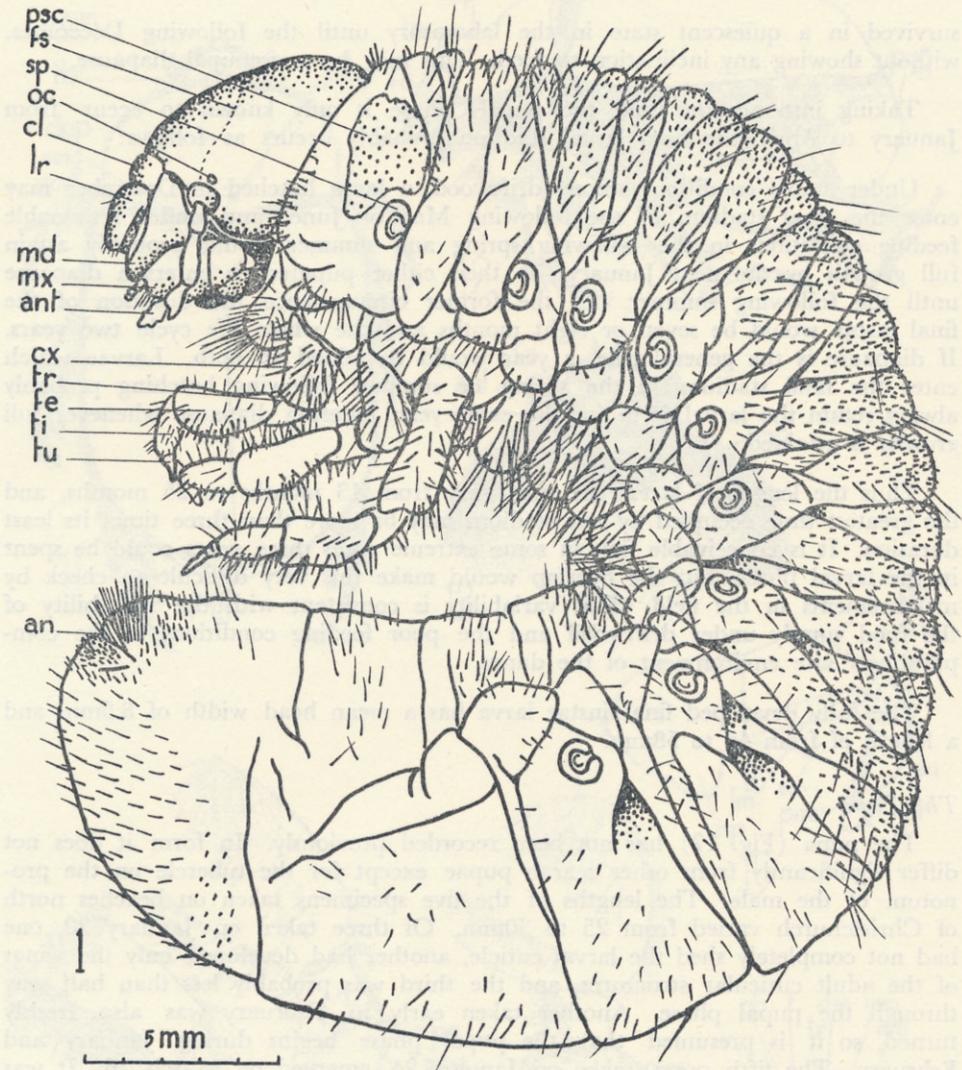


FIG. 1.—Final instar larva, entire lateral. *an*, anal slit; *ant*, antenna; *cl*, clypeus; *cx*, coxa; *fe*, femur; *fs*, frontal suture; *lr*, labrum; *md*, mandible; *mx*, maxilla; *oc*, ocellus; *psc*, prothoracic sclerome; *sp*, spiracle; *ti*, tibia; *tr*, trochanter; *tu*, tarsungulus.
 FIG. 2.—Final instar larva, dorsal aspect of head. *ant*, antenna; *cl*, clypeus; *cs*, cephalic suture; *fs*, frontal suture; *lr*, labrum; *md*, mandible; *oc*, ocellus.
 FIG. 3.—Final instar larva, anal region. *an*, anal slit.

survived in a quiescent state in the laboratory until the following December, without showing any inclination to feed. This may be a prepupal diapause.

Taking into account that the pupal phase is only known to occur from January to April, the final larval stadium probably occurs as follows:

Under stable conditions among driftwood, a larva hatched in December may enter the final stadium in the following May or June, and under reasonable feeding conditions in the following spring and summer would probably attain full growth by the next January. It then either pupates or enters a diapause until the following summer. In the former circumstance the duration of the final instar would be seven or eight months and the whole life cycle two years. If diapause is the general rule, a year would be added to both. Larvae which enter the final stadium in the spring or summer following hatching probably always retain the larval form for the extra year, entering diapause whenever full growth is attained.

Thus the length of larval life may vary from 13 months to 25 months, and the greatest time occupied by any stadium may be more than three times its least duration. It is conceivable that in some extreme cases three years could be spent in the larval phase, but the overlap would make this very difficult to check by measurements in the field. This variability is consistent with the mutability of the food supply under driftwood and the poor feeding conditions in the comparatively safe environment of the dunes.

The fully developed final instar larva has a mean head width of 8.5mm and a length of from 45 to 58mm.

The Pupa

The pupa (Fig. 17) has not been recorded previously. In form it does not differ significantly from other scarab pupae except for the tubercle on the pronotum of the male. The lengths of the five specimens taken on beaches north of Christchurch varied from 25 to 30mm. Of three taken on January 20, one had not completely shed the larval cuticle, another had developed only the wings of the adult cuticular structures, and the third was probably less than half way through the pupal phase. Another taken early in February was also freshly turned, so it is presumed that the pupal phase begins during January and February. The fifth pupa, taken on January 24, emerged on March 16. It was the only specimen that survived. Other evidence of the end of the pupal phase is scarce and indirect. At Foxton Beach a live adult was collected half a mile from the seafront on June 30. In Canterbury the adults emerge and pass the winter at depths of two to four feet, but two adults taken at a depth of three feet six on July 7 carried heavy crystalline secretions in the Malpighian tubules which might be considered as evidence of a considerable period of activity under starvation conditions. (Wigglesworth, 1950, p. 382). Emergence probably takes place between March and May or perhaps June, and the pupal phase may last two to four months.

Though pupae are extremely difficult to find, pupal exuviae are quite common. They occur at depths of eighteen to 30 inches on all parts of the beach, regardless of the presence or absence of organic matter in the vicinity. The pupal cell is a chamber of 25mm by 50mm, lined with compacted sand. In this the pupa lies freely within or on top of the last larval exuviae. It is capable of some flexion of the abdomen, but is otherwise immobile.

The Imago

The earliest observed emergence is that of the laboratory specimen mentioned above on March 16. When newly emerged it was pale brown with the extremities of the appendages dark brown and the unexposed areas under the elytra creamy. It assumed the normal colouring after two weeks, without coming to the surface during that time. In Canterbury the adults burrow deeper after emergence, and have been found from July 7 to late September at depths of two to four feet, in an inactive state. Of twelve collected during July, seven were male and five female, but they were not associated in pairs. Adults were first observed near the surface on September 5, which is also the date of the first observed copulation.

The pair were found under an inch of sand near the seaward foot of the dunes. They lie at right angles to one another, the posterior ends abutting with the ventral surface of the male adjacent to the dorsal surface of the female. The genital armature of the female is exerted and completely envelops the protrusible part of the male organ. Disengagement is achieved by the male twisting through 180° and dragging clear by the action of the front and intermediate legs on the sand assisted by the hind legs pushing against the partner's abdomen. Copulation was also observed on October 10.

The first eggs were found on October 14, when thirty-seven were collected. The female taken on September 5 died on October 29 without producing any eggs. The last newly deposited eggs were collected on November 15.

The beetles fly during September and October in Canterbury, but may do so earlier in the North Island. Most flying takes place in October in both islands, and the phenomenon of massed flights has been reported from Tauranga and Opotiki on October 13 (Mr E. E. Turbott, correspondence) and at Waiterere, near Foxton, on October 16. There is some evidence that males fly during the early part of the evening and females from about 9.30 p.m. to midnight, and that flights are confined to the evening and the few hours before dawn. Flights have been observed only on fairly calm nights when the surface sand is not compacted by recent rain. Their function appears to be purely distributive and has not shown any connection with pairing, in the observations made to date. That flight is not a necessary prelude to mating has been shown by a pair kept in a jar of sand from July to October, when ten fertile eggs were produced.

Live females are rare in the field after mid-November, but skeletons are common at depths of twelve to eighteen inches, which suggests that they die after depositing their eggs without returning to the surface. This is the explanation of the apparent disparity of the sexes observed among the dead specimens so common on the surface in late December and January (Broun, 1879) for the males, which normally survive among the eggs and young larvae until early December, usually die on the surface, where their skeletons are often aggregated by the wind.

Neither observations of adult habits nor examination of the alimentary canal has yielded any indication that the adults feed.

SECTION II.—DESCRIPTION

DESCRIPTION OF THE FINAL INSTAR LARVA

The larvae of the three species so far studied (*P. truncatus*, *P. punctatus*, and an unnamed species), are, apart from the greater dimensions of *P. truncatus*, extremely similar in form, and Broun's (1879) and Hudson's (1934) descriptions are quite unable to separate them. The new description of the larva which

follows, is patterned on the work of Böving and Craighead (1931) and Hayes (1929), and takes account of the value of the mouthparts and especially the epipharynx, as features of identification.

The average overall length of the final instar larva (Fig. 1), assessed from a sample of 148 larvae from Canterbury beaches, is 43 mm, with extremes of 29mm and 58mm. The body conforms to the typical shape of scarabaeid larvae, being curved when at rest so that the head capsule lies near the anus. In cross-section the body is D-shaped except for the last two abdominal segments, whose ventral surface is not flattened, so the section is subcircular. With the exception of the 9th and 10th abdominal segments, the dorsal surface of each segment is folded into three ridges which ride over one another when the body is extended. These folds are gathered together under the raised pleural areas on each segment. The cribriform spiracles occur on the first thoracic and the first eight abdominal segments.

The head is sclerotised and brown, the remainder of the cuticle being transparent except for sclerotised areas (psc) above the prothoracic spiracles (sp), the spiracular plates and the tarsunguli (tu) of the legs. Fat body showing through the cuticle gives the body a creamy colour except where the gut contents show through on the last two abdominal segments, giving them a purplish-brown appearance.

The dorsal surface is liberally supplied with short setae as far back as the 7th abdominal segment, and on these segments and the eighth abdominal a sparse row of longer setae occurs along the posterior edge of each dorsal fold. Slender setae occur over the ventral surface of all segments, on the dorsal surface of the 9th and 10th abdominal, and on the pleura and legs.

The Head Capsule (Fig. 2) has a width of $8.2\text{mm} \pm 0.7\text{mm}$. In the dorsal aspect its posterior and lateral margins form the major arc of a circle cut off by the clypeo-frontal suture, the mandibular facets and the bases of the antennae. The epicranial suture is short, straight and darkly pigmented for the posterior third of its length. It joins the frontal sutures to form a broad Y whose arms diverge to the bases of the antennae. Directly behind each antennal base is a single ocellus. The sculpture is coarsely rugose on the anterior part of the frons, grading to a more finely rugose texture posteriorly and laterally. Very short setae occur in pits on the frontal area and longer setae extend sparsely over the parietal and occipital regions. Longer, more slender setae occur around the lateral and posterior margins with three prominent ones anterolaterally on the frons and one fairly prominent behind each ocellus.

The Clypeus (Fig. 2) is very broadly trapezoidal in outline, the lateral margins converging anteriorly and the well-marked clypeo-frontal and clypeo-labral sutures being almost straight. Its sculpture is coarsely rugose like that of the frons. It carries one long and one shorter seta near each lateral margin.

The Labrum (Fig. 2) is sub-elliptical in outline and slightly asymmetrical, the right side being more developed and less acutely rounded than the left. Its sculpture is coarsely rugose. It bears two long setae near the lateral extremities and two less prominent ones anterior to these near the limits of the anterior margin. A further pair occur nearer the midline a little posterior to the anterior pair. The anterior and anterolateral margins bear many stout bristles.

The Antennae (Fig. 4) are five-segmented. The basal (first) segment is short and broad, the remaining four being more slender and approximately equal in thickness. The third segment is distinctly longer than the others, and the fifth

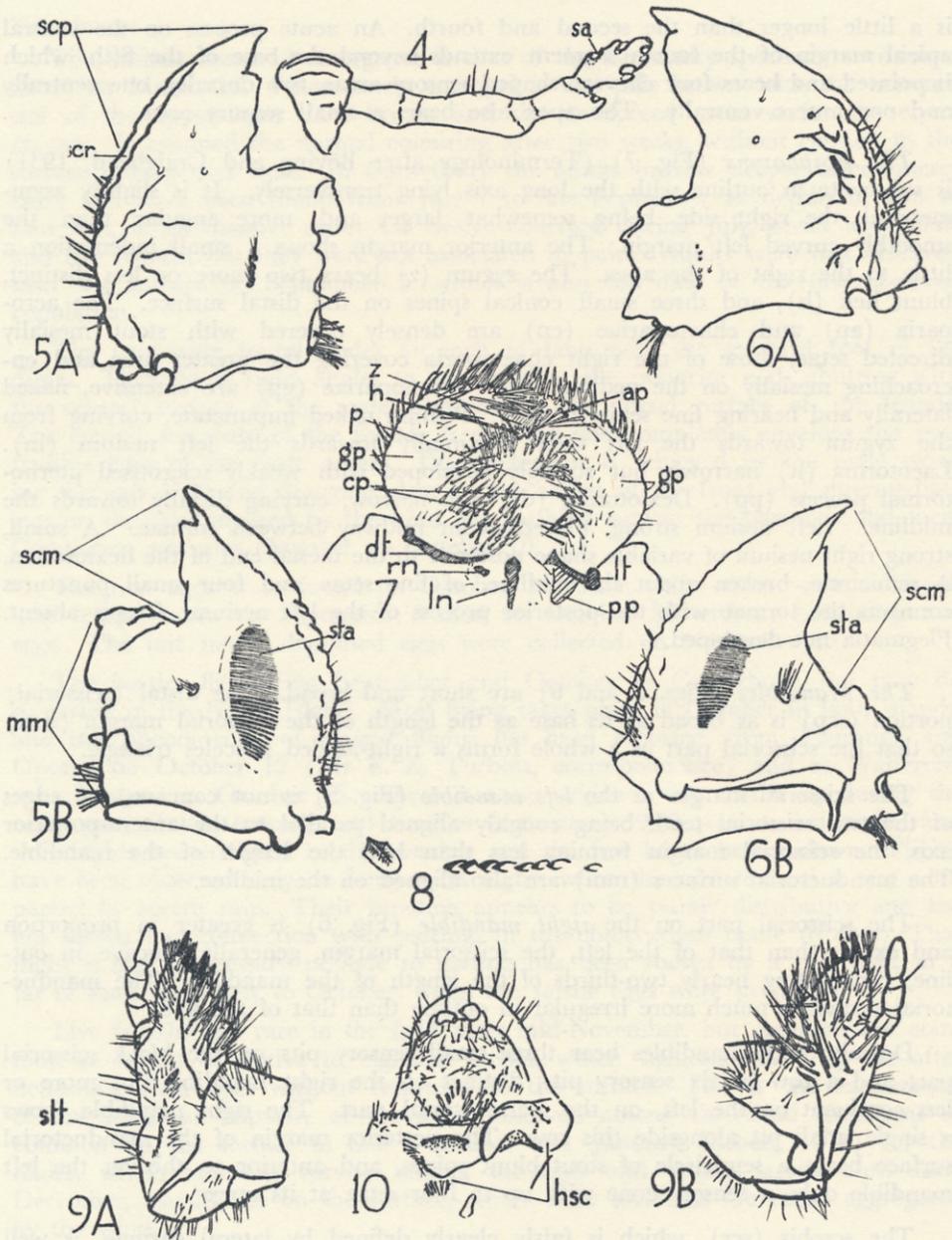


FIG. 4.—Final instar larva, left antenna. *sa*, sensory area.

FIG. 5.—Final instar larva, left mandible. A, dorsal; B, ventral.

FIG. 6.—Final instar larva, right mandible. A, dorsal; B, ventral. *mm*, manducatorial margin; *scm*, scissorial margin; *scp*, scissorial part; *scr*, scrobis; *sta*, stridulatory area.

FIG. 7.—Final instar larva, epipharynx. *ap*, acroparia; *cp*, chaetopariae; *dt*, dexiotorma; *gp*, gymnoparia; *h*, helus; *ln*, left nesium; *lt*, laetorma; *p*, pedium; *pp*, pternotormal process; *rn*, right nesium; *z*, zygum.

FIG. 8.—Final instar larva, stridulatory teeth of maxilla.

FIG. 9.—Final instar larva, left maxilla. A, dorsal; B, ventral. *stt*, stridulatory teeth.

FIG. 10.—Final instar larva, labium and hypopharynx. *hsc*, hypopharyngeal chitinisation.

is a little longer than the second and fourth. An acute process on the ventral apical margin of the fourth segment extends beyond the base of the fifth, which is pointed and bears four chevron-shaped sensory areas, two dorsally, one ventrally and one antero-ventrally. The apex also bears a small sensory area.

The Epipharynx (Fig. 7) (Terminology after Böving and Craighead, 1931) is sub-ovate in outline with the long axis lying transversely. It is slightly asymmetrical, the right side being somewhat larger and more angular than the smoothly curved left margin. The anterior margin shows a small indentation a little to the right of the apex. The zygum (z) bears two more or less distinct, blunt heli (h), and three small conical spines on the distal surface. The acroparia (ap) and chaetopariae (cp) are densely covered with stout mesially directed setae, those of the right chaetoparia covering the greater area and encroaching mesially on the pedium (p). Gymnopariae (gp) are extensive, naked laterally and bearing fine setae mesially. Pedium naked impunctate, curving from the zygum towards the left then proximally towards the left nesium (ln). Laeotorma (lt) narrowly but strongly developed with weakly sclerotised pternotormal process (pp). Dextiotorma (dt) also narrow, curving distally towards the midline. Left nesium strong, placed about midway between tormae. A small, strong right nesium of variable shape posterior to the mesial end of the dextiotorma. A semicircle, broken about the midline, of fine setae and four small punctures connects the tormae with the posterior process of the left nesium. Crepis absent. Plegmatia not developed.

The Mandibles (Figs. 5 and 6) are short and broad. The distal (scissorial) portion (scp) is as broad at its base as the length of the scissorial margin (scm) so that the scissorial part as a whole forms a right-angled isosceles triangle.

The scissorial margin of the *left mandible* (Fig. 5) is not concave, the edges of the two scissorial teeth being roughly aligned parallel to the antero-posterior axis, the scissorial margin forming less than half the length of the mandible. The manducatorial surfaces (mm) are also aligned on the midline.

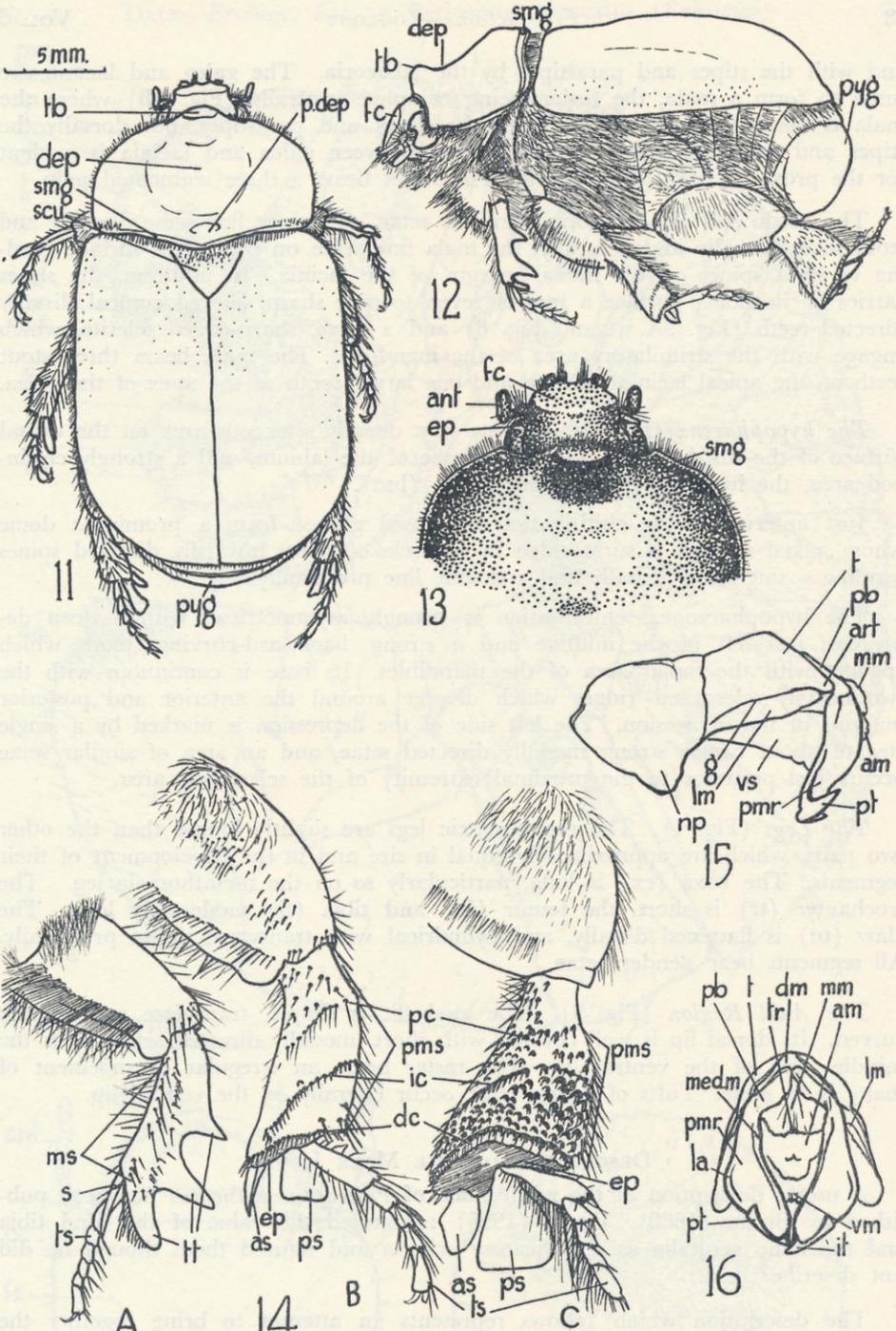
The scissorial part on the *right mandible* (Fig. 6) is greater in proportion and extent than that of the left, the scissorial margin, generally concave in outline, constituting nearly two-thirds of the length of the mandible. The manducatorial surface is much more irregular in outline than that of the left.

Dorsally both mandibles bear three small sensory pits on the black scissorial part and a row of six sensory pits, distinct on the right mandible but more or less confluent on the left, on the manducatorial part. The right mandible shows a single small pit alongside this row. The posterior margin of the manducatorial surface bears a semicircle of stout blunt spines, and anterior to this on the left mandible only, a sensory cone with up to four setae at its apex.

The scrobis (scr), which is fairly clearly defined by lateral carinae, is well supplied with setae proximally.

Ventrally both mandibles exhibit an elliptical stridulatory area (str) which is divided into a proximal portion of sixteen broad striations and a distal portion of many fine striations. A large sensory pit containing many bristles, and a small pit with one bristle occur alongside the stridulatory area. The ventral lateral carina bears a number of setae near its proximal end.

Maxillae (Fig. 9) (Terminology after Hayes, 1929). The cardo consists of two portions, a proximal sub-cardo and a distal alacardo united with each other



Figs. 11, 12 and 13.—Imago. *ant*, antenna; *dep*, pronotal depression; *ep*, epicranial process; *fc*, fronto-clypeus; *p. dep*, posterior pronotal depression; *pyg*, pygidium; *scu*, scutellum; *smg*, submarginal groove; *tb*, pronotal tubercle.

FIG. 14.—Legs. *as*, anterior tibial spur; *dc*, distal carina; *ep*, end plate; *ic*, intermediate carina; *ms*, submarginal setae; *pc*, proximal carina; *pms*, posterior marginal setae; *ps*, posterior tibial spur; *s*, spur of fore-tibia; *ts*, tarsus; *tt*, tibial teeth.

Figs. 15 and 16.—Genitalia. *am*, apical membrane; *art*, articular portion of tectum; *dm*, dorsal membrane; *g*, groove; *it*, medial tooth; *la*, lateral angle of paramere; *lm*, lateral membrane; *med.m*, medial margin of paramere; *mm*, medial membrane; *np*, non-protrusible part; *pb*, phallobase; *pmr*, paramere; *vt*, ventro-lateral tooth; *t*, tectum; *tr*, trema; *vm*, ventral membrane; *vs*, ventral shield.

and with the stipes and parastipes by the labacoria. The galea and lacinia are fused to form a mala, the fusion being complete ventrally (Fig. 9B) where the mala is marked off by sutures from the stipes and parastipes, but dorsally the stipes and galea are fused and the suture between galea and lacinia is evident for the proximal part of its length. The stipes bears a three segmented palp.

The cardo and the labacoria bear fine setae, the stipes fine setae dorsally and stout setae laterally and ventrally, the mala fine setae on the galeal surface grading to stout spines on the mesial margin of the lacinia. In addition, the stipes carries on its dorsal surface a row of seven to nine sharp, curved conical distally directed teeth (Fig. 9A stt and Fig. 8) and a large, sharp-edged sclerite, which engage with the stridulatory area of the mandible. The mala bears three stout teeth on the apical lacinial portion and one larger tooth at the apex of the galea.

The hypopharynx (Fig. 10) consists of a densely setaceous area on the dorsal surface of the fused glossae and paraglossae of the labium, and a strongly chitinised area, the hypopharyngeal chitinisation (hsc).

Just anterior to the chitinisation the fused glossae form a prominent dome whose naked summit is surrounded by a circle of stout, inwardly directed spines forming a single line distally and a double line proximally.

The hypopharyngeal chitinisation is strongly asymmetrical, with a deep depression just left of the midline and a strong backward-curving tooth which engages with the molar area of the mandibles. Its base is continuous with the two heavily sclerotised ridges which diverge around the anterior and posterior margins of the depression. The left side of the depression is marked by a single row of about twelve strong mesially directed setae, and an area of similar setae occurs just posterior to the proximal extremity of the sclerotised area.

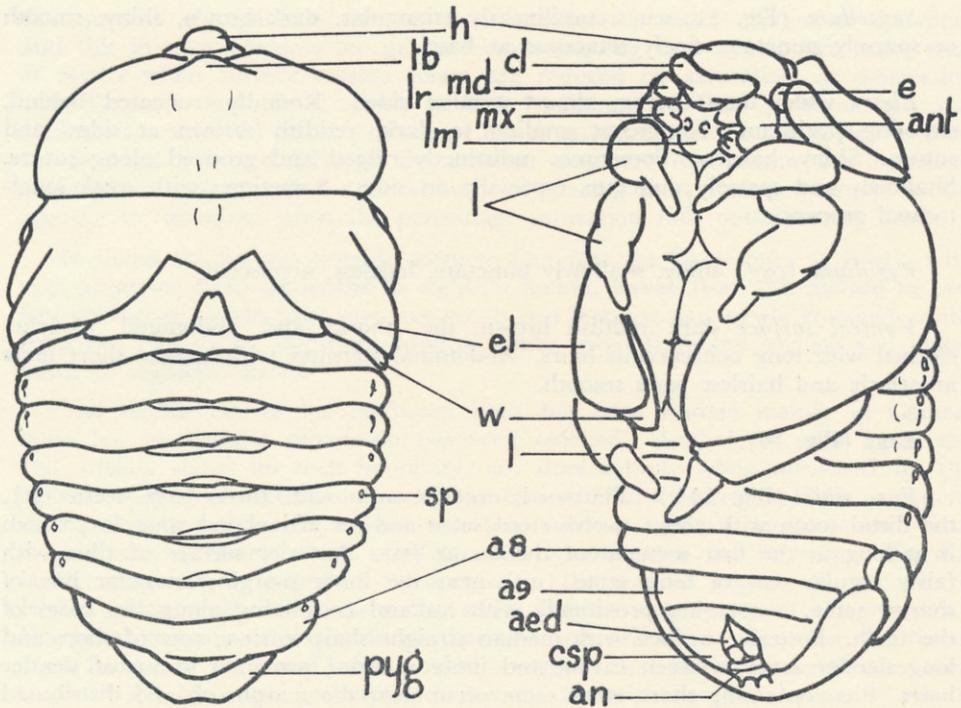
The Legs (Fig. 1). The metathoracic legs are slightly longer than the other two pairs, which are approximately equal in size and in the development of their segments. The coxa (cx) is long, particularly so on the metathoracic leg. The trochanter (tr) is short, the femur (fe) and tibia (ti) moderately long. The claw (tu) is flattened distally, and cylindrical with transverse ridges proximally. All segments bear slender setae.

The Anal Region (Fig. 3). The anal slit is simple, transverse and slightly curved. Its dorsal lip is well covered with short, mesially directed setae, as is the middle area of the ventral lip. The raster bears an irregular arrangement of many short setae. Tufts of longer setae occur laterally on the ventral lip.

DESCRIPTION OF THE MALE IMAGO

A useful description of the adult male of *Pericoptus truncatus* has been published by Broun (1880). Given (1955) recognised the value of the hind tibia and the male genitalia as classificatory criteria and figured them though he did not describe them.

The description which follows represents an attempt to bring together the work of Broun and Given, with respect to *P. truncatus*, and to present a complete illustrated account of the morphological characters which are likely to have taxonomic value. The description of the head and trunk regions is little altered from that of Broun (1880) though it here takes account of intraspecific variation, and the description is applied to figures for the first time. The accounts of the tibiae and the male genitalia are original.



17

FIG. 17.—Pupa of male. *a8*, *a9*, abdominal segments; *aed*, aedeagus; *an*, anus; *ant*, antenna; *cl*, clypeus; *csp*, clasper; *e*, eye; *el*, elytron; *h*, head; *l*, legs; *lm*, labium; *lr*, labrum; *md*, mandible; *mx*, maxilla; *pyg*, pygidium; *sp*, spiracle; *tb*, pronotal tubercle; *w*, wing.

Head (Figs. 11, 12 and 13) small, dark brown to black, fronto-clypeus (*fc*) raised, flat to undulating, subpentagonal with fine transverse rugose sculpture anteriorly, smooth posteriorly, anterior margin emarginate or straight, anterior and antero-lateral margins slightly to moderately reflexed. Vertex rugosely punctate behind fronto-clypeus, slightly depressed and sometimes punctate on sides. Epicranial process (*ep*) prominent, bluntly to moderately acute, bearing four setae.

Antennae (*ant*) small ferruginous, ten jointed, three terminal segments forming club which is finely setaceous on exposed surfaces, finely pilose on apposed faces.

Pronotum (Figs. 11, 12 and 13) transverse, nigrescent, angularly rounded at sides, deeply emarginate behind head, somewhat lobed at the middle of its base, with regular continuous submarginal groove (*smg*). The tubercle (*tb*) is large and flattened above, the flattened area sub-circular to transversely ovate. More or less extensive deep transverse sometimes wrinkled depression (*dep*) behind tubercle, smaller sometimes indistinct depression (*p. dep*) in front of scutellum. Shiny, hairless except for close set ferruginous setae around margin, and sparse setae laterally on base.

Scutellum (Fig. 11, scu) curvilinearly triangular, dark brown, shiny, smooth or sparsely punctate, finely setaceous at base.

Elytra wider than thorax, almost parallel sided. Roundly truncated behind, exposing pygidium. Nigrescent grading to dark, reddish brown at sides and suture. Shiny, hairless. Sometimes indistinctly ridged and grooved along suture. Shallowly and sparsely punctate, especially on sides. Sometimes with weak longitudinal grooves.

Pygidium (pyg) shiny, shallowly punctate, hairless, nigrescent.

Ventral surface dark reddish brown, the thorax and abdominal pleurites clothed with long ochraceous hairs. Abdominal sternites with sparse, short hairs anteriorly and hairless parts smooth.

Legs (Fig. 14).

Fore tibia (Fig. 14A). Flattened, outer margin with three large teeth (tt), the distal tooth with about twelve stout setae and an articulated spur (s), which is as long as the first segment of the tarsus (ts). Anterior surface of tibia with fairly regular row of long setae (ms) near the inner margin; irregular line of shorter setae, converging proximally with ms and continuing along the bases of the teeth. Posterior surface with median straight sharp carina; row of short and long slender setae between carina and inner margin; proximal group of slender hairs. Pits containing short, stout setae occur near the margin of, and distributed over the disc of the two proximal teeth; a few similar pits occur near the distal half of the carina. The rest of the posterior surface is smooth and hairless.

Intermediate Tibia (Fig. 14B) is much less flattened than the fore-tibia, being sub-hemispherical in cross section. The outer (convex) surface is distinctly tricarinated, each carina providing support for a row of short stout setae. The distal carina (dc) marks off a semicircular area which forms the endplate (ep) of the tibia, and a site for the articulation of two fin-shaped spurs (as, ps) and the tarsus (ts). The intermediate carina (ic) follows a smooth curve from the posterior margin of the tibia to join or almost join the distal carina about half way round the semi-circumference of the end-plate. The proximal carina (pc) is shorter and sub-parallel to the intermediate. Close-set setaceous pits occur proximal to the proximal carina and four or five may also occur between the intermediate and distal carinae near the posterior margin. The posterior margin is itself well supplied with long, strong setae (pms).

Hind Tibia (Fig. 14C) is generally similar in structure to the intermediate but is proportionately shorter and broader, and the spurs (as, ps) are relatively larger. The intermediate carina (ic) is less distinct but extends right round the convex surface to almost meet the distal carina (dc) near the anterior spur (as). The proximal carina is variable and often not clearly defined. It may or may not reach the posterior margin. Distal to the intermediate carina the surface is deeply and closely pitted, as is the more anterior part proximal to it. The pits, which contain short setae, are confluent on the distal part of the tibia becoming somewhat more sparse proximally. The posterior margin carries many long robust setae (pms).

The Protrusible Part of the Male Genitalia (Figs. 15 and 16). (Terminology after Böving, 1942.)

The protrusible part of the male organ consists of a basal piece and paired claspers. The basal piece, which is continuous proximally with a lighter coloured hoof-shaped sclerite forming the non-protrusible part (np), consists of a dorsal hemicylindrical sclerite, the tectum (t), connected by lateral membranes (lm) to a ventral shield (vs) which is flat proximally and broadly V-sectioned distally, where it joins the parameres (pmr) of the claspers in a membranous area (vm).

The tectum is divided distally by a deep V, whose apex reaches half-way to the proximal margin. Within this V lies the phallobase (pb) connected to the tectum by the dorsal membrane (dm). Laterally the tectum is marked off from the lateral membrane by a groove (g), (deep distally and shallow proximally), running from the articular portions (art) of the tectum, to its basal margin. Below this groove the "lateral membrane" is sclerotised for the upper two-thirds, but is membranous and folded where it meets the ventral shield, allowing a to and fro movement of the ventral shield and claspers.

The claspers consist of the phallobase (pb) lying in the V of the tectum, and the parameres (pmr). The phallobase consists of sclerotised lateral regions, continuous with the parameres, joined by a medial membrane (mm) which is bilobed with many longitudinal folds. The medial membrane overlies the trema (tr), and the dorsal part of the apical membrane (am) which obscures the five distal spines of the aedeagus.

Viewed laterally the parameres form an obtuse angle with the phallobase, where the articular processes of the tectum are received by a deep fossa on each side. Viewed posteriorly (Fig. 16), the body of each paramere approximates to an isosceles triangle whose base (medm) and apex (la) are strongly reflexed so that the posterior surface is deeply concave. Ventrolaterally the margin is drawn up into a stout sharp-edged triangular tooth (pt). A small, more or less triangular blade (it) may also occur on the medial margin of each paramere, near the tip. The tips of the parameres are slightly asymmetrical, the left being shorter and straight-edged, the right curving around the tip of the left.

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