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A Review of the Biology of *Pericoptus truncatus* (Fabr.) (Coleoptera: Scarabaeidae: Pentodontini) from New Zealand and a Revised Description of the Third Instar

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Abstract

The life history of *Pericoptus truncatus* (Fabr.) from New Zealand is reviewed, and a modern description of the third instar is provided. Larvae of *P. truncatus* live just beyond oceanic high tide under and within well anchored driftwood and beneath beach sand, where they feed on rotting wood or plant roots. The larvae are remarkable for their large, spatulate claws, which aid them in traveling through the sand as well as on the surface during nocturnal surface migrations between the backshore and the foredune area, presumably to feed on plant roots and find sand with water content high enough to allay desiccation.

I apprehend that naturalists
still have much to learn respecting
the various modes of life of New Zealand insects.
— T. Broun, 1879

The dynastine genus *Pericoptus* Burmeister, 1847 (Coleoptera: Scarabaeidae: Dynastinae) contains five species, all from New Zealand (Endrödi 1985). It is the only dynastine genus endemic to New Zealand (Given 1955). *Pericoptus truncatus* (Fabr.) (Fig. 1) is referred to in New Zealand by New Zealanders of European descent as the "black sand scarab" or "large sand scarab" and by the indigenous Maori people as *mumutaua*, *mumutawa*, *mumuwaru*, *mumuwharu*, or *ngungutawa* (the thick-set beetle of the sand-hills; a large, short earth worm (presumably larvae); a large, brown beetle) (Miller 1952).

Broun (1879) was the first to "describe" the larva of *P. truncatus*. The "description" is of *gestalt* only and lacks specific morphological details, *viz.*, "The larva of this beetle may be said to be of an elliptically cylindrical form, being somewhat contracted near the middle …". Broun did observe that the larvae fed on the buried portion of decomposing logs lying on beach sand. He surmised that they did not take all their sustenance from "decayed ligneous matter", but that their true home was probably the loose drift above the high water mark. He

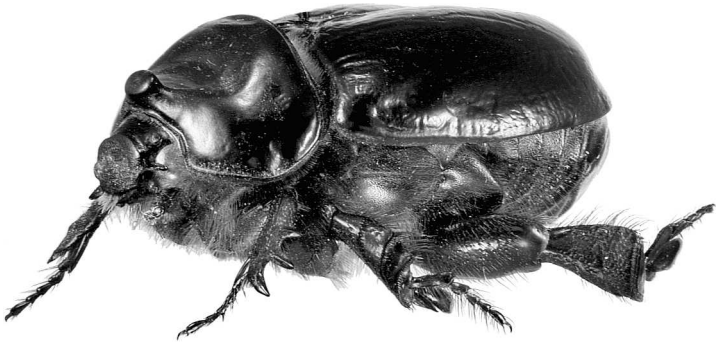


Fig. 1. *Pericoptus truncatus*, male.

observed that adults would walk along the beach and then bury themselves in loose, dry sand, but he could never dig a hole deep enough to find one.

Dale (1963) and Stephenson (1999) observed that *P. truncatus* larvae, pupae, and adults occur under any part of the sand surface from the driftwood zone above the high tide mark to the dunes fronting the beach, regardless of the presence of organic matter. They were most common among the roots of the foredune plants and under and within well-anchored driftwood (Fig. 2). Given (1966) remarked that larvae live under driftwood just above high tide level on sandy beaches. Crumpton (1974) noted that *P. truncatus* larvae are salt-tolerant and *gregarious* (emphasis ours; gregarious probably not accurate) and live just under the sand surface above the high tide mark, where they are found in rotting wood. The larvae feed on the roots of vegetation, such as marram grass, *Ammophila arenaria* (L.), and on well anchored dead wood (Dale 1963; Knox 1969; Morton and Miller 1973). During the day, all stages remain deeply buried in the sand. Dale (1963) suggested that *P. truncatus* occurs throughout New Zealand where there are sandy beaches with driftwood. Dale also described all the larval stages, pupa, and adult, although his descriptions are not complete by today's standards, hence, our redescription of the third stage larva.

Dale (1963) conducted a detailed life history study of *P. truncatus* and reported a two- or even three-year life cycle. Eggs were laid from early October to mid-November at depths of 15–45 cm, and larvae hatched from mid-November to late December. Eggs were laid singly under driftwood or marram grass. The newly hatched larvae consumed the chorion of the egg and did not begin feeding on plant material for several days after that. Molting to the second stadium occurred between late January and mid-March, although a few first instars persisted through the winter. The larval exuvium was presumably eaten, because first and second instar exuviae were never found with viable larvae, and second instar mandibles were seen in the gut contents of third instars. Molting to the third stadium occurred from mid-June to early August, although some second instars were found as late as December. The length of the third stadium was variable, depending on nutritional and climatic conditions. Third instars were found at all times of the year. Dale (1963) recorded nocturnal surface migrations of larvae between the backshore and the foredune area, presumably to find sand with water content of 9–20% that would allay desiccation or saturation, respectively. He recorded nocturnal "migrations" of third instars over the surface for distances of 50–80 meters! Such distances for a C-shaped white grub are made possible, no

Fig. 2. The coastal habitat of *Pericoptus truncatus* on the west coast of South Island, New Zealand. Larvae live under, or inside, the decaying logs at the high tide mark, feeding on the damp, decaying trunk of the decomposing logs. Photo courtesy of T. Jackson.

doubt, by the highly modified claws (Fig. 10) that are enlarged and spatulate that might serve as ''oars'' to propel the larva over the surface or beneath the sand. We do not know of any other sand-inhabiting scarab larvae with such large, spatulate claws. Dale also noted that larvae of all sizes and ages were less common amongst the driftwood from July to the end of September when winter storms made this particular habitat unstable. Typically, the length of larval life ranged from 13 to 25 months. Roberts (1977) suggested that in the desiccation-prone habitat for *P. truncatus*, moisture content of the substrate could act as a microclimatic limiting factor on egg and/or prepupal development, thus necessitating a diapause stage in at least some individuals, which would then lengthen the life cycle. Dale recorded pupation primarily during January and February, but some were as late as April. When the adults emerged (March to May), they spent the winter in the sand at depths of 60–120 cm. Adults began their nocturnal surface activity in early September (occasional mass flights are known), and eggs were laid in October and November. Females apparently died beneath the sand after laying their eggs. Dale found no evidence of feeding by adults.

Adults of *P. truncatus* have several natural enemies. Melville (2005) observed adult variable oystercatchers, *Haematopus unicolor* Forster (Charadriiformes: Haematopodidae), foraging on coarse beach sand at Nelson, New Zealand and noted that the birds were probing vigorously in the sand, with their bills being inserted the full length to the feathering at the base (~90 mm). He saw the birds catch and eat what appeared to be beetle larvae. He excavated the area where the birds had been feeding and found a layer of clean, coarse sand about 70–80 mm

deep and then a layer of decaying drift wood 10–120 mm thick, below which was clean sand. It appeared that the driftwood had been left on a high tide and then subsequently buried by sand. Among the decaying wood, which included well decomposed leaf matter and twigs, were several sand scarab larvae. Melville was unable to determine his species of *Pericoptus* since the larvae could not be identified to species-level due to a lack of larval descriptions. The larva described herein was taken in association with adults, and this is the only species of New Zealand Dynastinae that lives in beach dunes close to the ocean. The larvae of the other four species of *Pericoptus* remain undescribed. Because of the lack of larval descriptions for New Zealand scarabs, larvae of *Pericoptus* species cannot be distinguished readily based upon morphology alone, but *P. truncatus* larvae are more easily recognized because they occur in a specialized habitat under and within well anchored driftwood and beneath the beach sand above the high tide zone.

Brown (1967) observed heavy infestations of presumably ectoparasitic mites (Laelaptidae: Hypoaspidinae) on *P. truncatus* larvae. Mites were numerous in the folds of the skin, especially near the head. Dale (1956) first noted the presence of two different species of eugregarines in the anterior and posterior midgut of larval *P. truncatus*, and Crumpton (1974) described one of these as a new species, *Hirmocystis pterygospora* Crumpton (Eugregarinida: Hyrmocistidae), and the other as belonging to the genus *Stylocephalus* (Eugregarinida: Stylocephalidae).

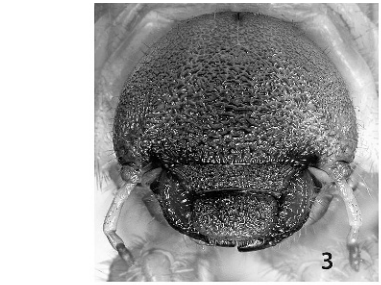
Pericoptus truncatus (Fabr.)

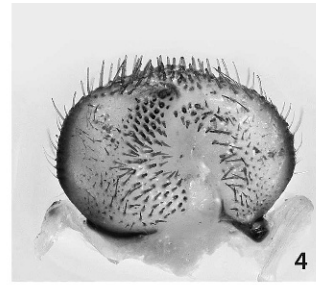
Third-stage larva

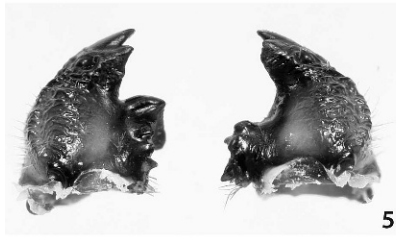
(Figs. 3–10)

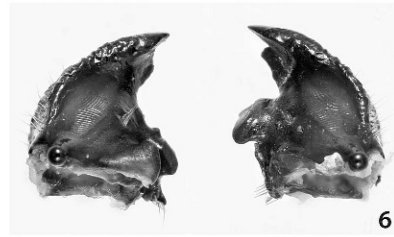
This description is based on five third instars labeled (1) "NEW ZEALAND, MC, Woodend Beach, 17 July 2002, R. J. Townsend"; (2) "Collected from sand under drift-wood or in drift-wood just above high tide mark on beach"; (3) *Pericoptus* sp., (*Pericoptus truncatus* (F.))". Larvae are deposited in the collections of the University of Nebraska State Museum (Lincoln, Nebraska).

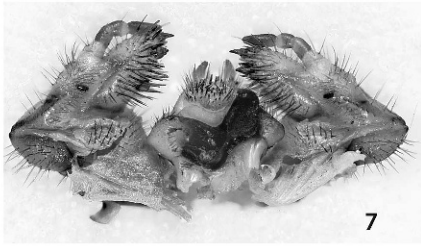
Head. Maximum width of head capsule 7.5–8.9 mm. ***Cranium*:** Color light brown. Surface strongly rugose (Fig. 3), with numerous, short epicranial setae. Frons with 3 anterior angle setae. Epicranial suture Y-shaped (almost obscured by surface rugosity), deeply depressed at base before reaching epicranial arms. Cranium with 2–4 dorsoepicranial setae in a line diverging from center-base of head. Tentorial pits evident. Ocellus present posterior to base of antenna. ***Clypeus*:** Shape subtrapezoidal. Surface strongly rugose, with 1–2 exterior clypeal setae. ***Labrum*:** Surface strongly rugose, slightly asymmetrical, margins rounded, with 2 long posterolateral labral setae, 2 short anterolateral setae, and anterior margins with many short, stout setae. ***Epipharynx*:** Shape slightly asymmetrical (Fig. 4). Acroparia with 50–60 setae. Haptomeral region with cone-like process. Acanthoparia with 10–12 medium sized setae. Right chaetoparia with 23–38 thick setae and 20–25 slender setae around pedium. Left chaetoparia with 9–13 thick setae and 20–25 slender setae around pedium. Dexiotorma well developed. Laeotorma shorter than dexiotorma and with pternotorma. Crepis absent. Zygum with 2 blunt heli. Plegmatia not developed. Gymnopariae extensive, glabrous on margins, with minute setae at center. Pedium glabous, curving left from zygum. ***Mandibles*:** Dorsal and lateral surfaces rugose. Left mandible (Figs. 5–6) with 2 scissorial teeth; large molar area trilobed, with additional sharp projection at base of dorsum of mandible; first molar lobe sharper and more

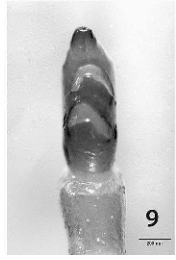


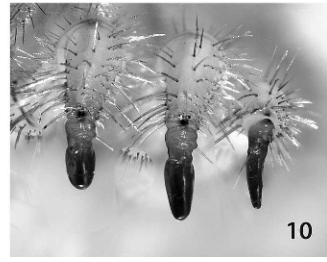












Figs. 3–10. Morphology of third instar *Pericoptus truncatus*. **3)** head, frontal view; **4)** Epipharynx; **5)** dorsal view of mandibles; **6)** ventral view of mandibles; **7)** dorsal view of hypopharynx and maxilla; **8)** antenna, lateral view, showing third antennomere projecting beneath fourth antennomere; **9)** antenna, dorsal view, showing large dorsal sensory spots; **10)** legs, left lateral view. Note spatulate claws on fore and middle legs.

protuberant than the rest; lateral edge with 11–15 setae; dorsal surface in apical half with 2 setae; basomedian angle with brustia consisting of 12 setae. Venter with elongate-oval stridulatory area with approximately 16 larger transverse ridges and a number of much smaller distal ridges. Right mandible (Figs. 5–6)

with 2 scissorial teeth, teeth slightly larger than those of left mandible; large molar area trilobed, all lobes blunt and subequal in size; lateral edge with 11–15 setae; dorsal surface in apical half with 2 setae. Venter with stridulatory area similar to that of left mandible. ***Maxilla*:** Galea and lacinia fused forming mala (Fig. 7). Mala with large uncus at apex and 3 subterminal unci fused at bases and subequal in size, 8–10 thick setae among unci. Cardo with abundant setae. Stridulatory area with row of 7 short, acute teeth and a large, distal, ovoid process. ***Labium*:** Hypopharyngeal sclerome asymmetrical; left side weakly sclerotized, with 25–30 setae; right side prominent, well sclerotized and with few setae. ***Antenna*:** Four antennomeres present. Basal antennomere short, broad. Second antennomere as long as next 2 antennomeres combined, surface with 8 setae on dorsum. Third antennomere projected below fourth antennomere for at least one-third of fourth antennomere's length (Fig. 8). Surface of fifth antennomere with 2 dorsal and 2 ventral sensory spots, dorsal spots are large and chevron-shaped (Fig. 9).

Thorax. Prothoracic sclerome prominent. Thoracic spiracle with C-shaped respiratory plate, size 1.05–1.08 mm high and 0.70–0.72 mm wide. ***Legs*:** Well developed, length 6–9 mm, metathoracic legs slightly longer than others. Claws (Fig. 10) long, 1.4–1.6 mm in length. Claws of pro- and mesothoracic legs enlarged, remarkably spatulate, metathoracic claws subcylindrical, slender.

Abdomen. Spiracles subequal in size, spiracular area with many moderately sized setae; distance between lobes of respiratory plate not touching. Scutum of segments I–VII covered with many short setae and several long setae; segments VIII–X lacking short setae, and segment X with many slender, long setae on dorsum. Segments VIII and IX on dorsum with few sparse, long setae. ***Raster*:** Teges composed of numerous short setae (<100) and two patches of 35–40 long setae on each side of transverse anal slit.

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