

A New Species of Phoxocephalid (Crustacea: Amphipoda: Gammaride: Phoxocephalidae) from Hawai'i¹

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In the course of a survey of infaunal benthic invertebrates in Hanalei Bay, Kaua'i, Hawai'i in 1994, an unidentified amphipod was recovered in large numbers from a depth of 8–21 m in carbonaceous sand of coralline origin. Densities of 355/m² of this amphipod were found in coarse grain sands ($\phi = 1.20$), and densities up to 1357/m² were found in fine sediments ($\phi = 2.93$) (DeFelice, 1997). The amphipod seemed to bear a close resemblance to organisms described by Pillai (1957) and Barnard (1957, 1960, 1991) and was assigned to the genus *Mandibulophoxus* (Muir, 1997) where it was reported as a new record for the genus in Hawai'i. Congeners have previously been found in Africa (Barnard, 1957), India (Barnard, 1957; Pillai, 1957), Australia (Barnard & Drummond, 1978), and California (Barnard, 1957; Gray & McCain, 1979). Previous to this discovery, the only phoxocephalid recorded from Hawai'i was *Paraphoxus centralis* (Schellenberg) (Barnard, 1971).

Some confusion has surrounded the systematics of *Mandibulophoxus*. Barnard (1957) erected the genus to accommodate a species recovered from deep waters off the California coast. The type species, *M. gilesi* Barnard, was based on a single individual. A similar species from Indian waters was identified by Pillai (1957), which he named *Pontharpinia uncirostratus*, conforming to an earlier description by Giles (1890). On the basis of Pillai's (1957) description, Barnard (1960) synonymized *P. uncirostratus* under *M. gilesi*.

Gray & McCain (1969) reexamined Barnard's identification when additional specimens of *Mandibulophoxus* sp. were recovered from Tomales Bay, California. On the basis of a variety of characters from their specimens and from descriptions in Pillai (1957) and Giles (1890), they determined that the Californian specimens, including those of Barnard (1957, 1960), should be assigned to *M. gilesi*, but that the specimen described by Pillai (1957) differed sufficiently to maintain separate species status and be transferred to *Mandibulophoxus*.

Table 1 provides a comparison of the differences noted by Gray & McCain (1969) between *M. gilesi* and *M. uncirostratus*, and also provides the same character comparisons for the specimens from Hanalei Bay, described below as *Mandibulophoxus hawaiiiloa*.

The Hawaiian specimens are clearly most closely allied to *M. uncirostratus* (Giles). In particular, the short inner ramus of uropod 3 is distinctive, whereas *M. gilesi* has inner and outer rami equal in length. While the Hawaiian population does share some characters with both *M. uncirostratus* (Giles) and *M. gilesi* Barnard, we believe that there are sufficient differences and distinctive characters to warrant the new species described below.

Mandibulophoxus hawaiiiloa Muir & DeFelice new species

Figs. 1–2

Diagnosis. The species can be distinguished from its congeners by the characters given in Table 1.

Description. A small phoxocephalid: 11 specimens (type and paratypes deposited in the Bishop Museum), with mean length (rostrum to base of 3rd uropod) 2.3 mm (range 1.8–2.85 mm); beige in

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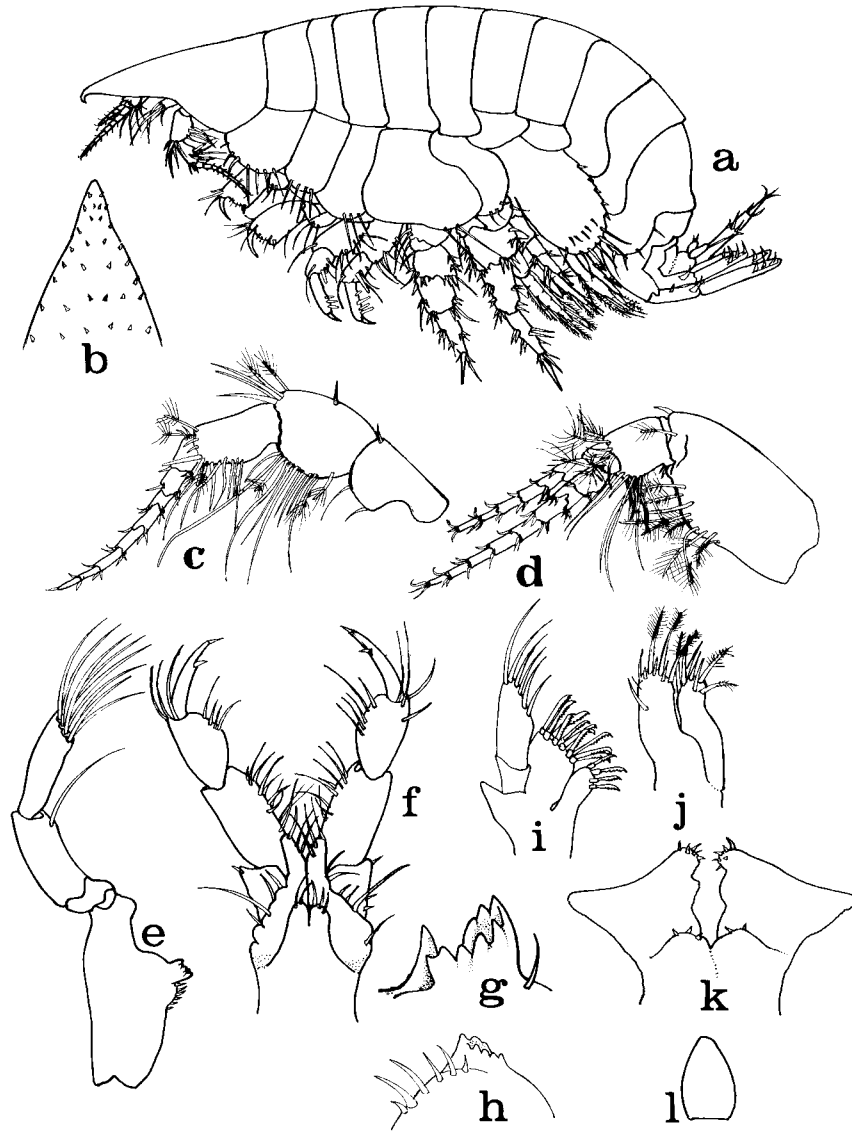


Fig. 1. *Mandibulophoxus hawaiioloa* Muir & DeFelice n. sp. **a**, whole animal; **b**, rostrum, dorsal view; **c**, antenna 2; **d**, antenna 1; **e**, left mandible; **f**, maxilliped; **g**, cutting edge, right mandible; **h**, cutting edge, left mandible; **i**, left maxilla 1; **j**, left maxilla 2; **k**, lower lip; **l**, upper lip.

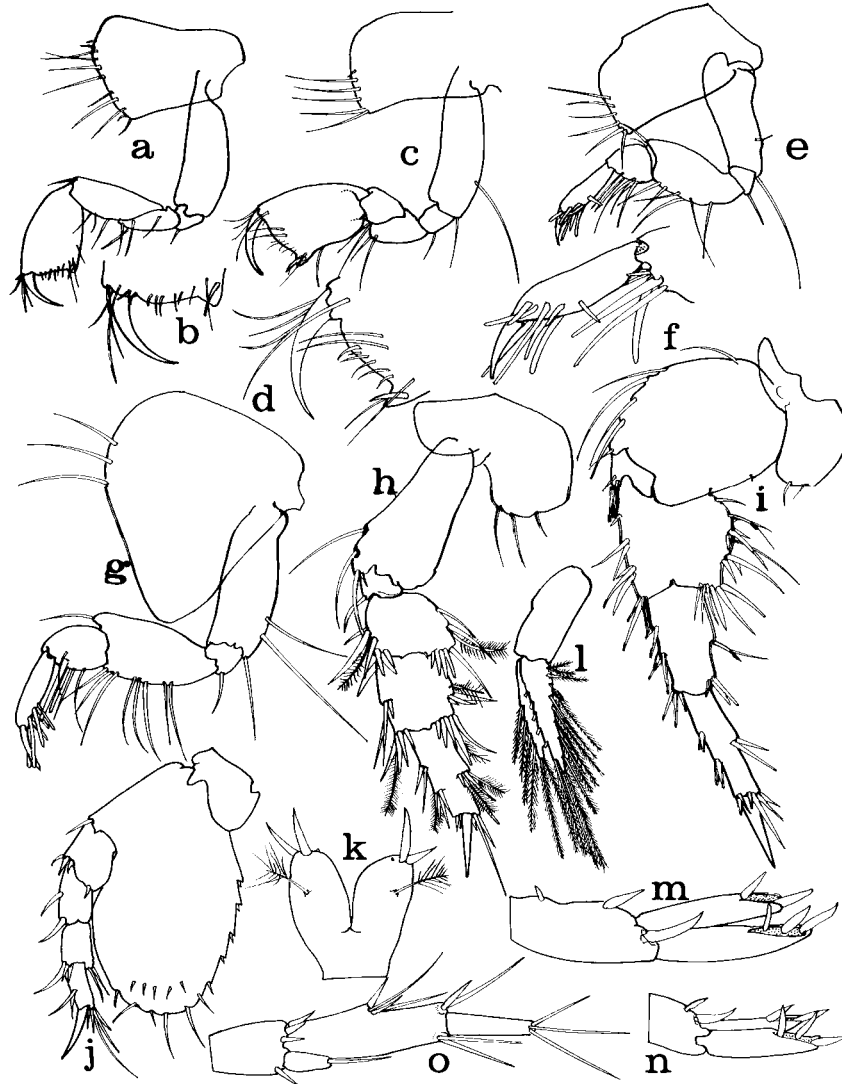


Fig. 2. *Mandibulophoxus hawaiioloa* Muir & DeFelice, n. sp. **a**, gnanthopod 1 (pereopod 1); **b**, gnanthopod 2 palm; **c**, gnanthopod 2; **d**, gnanthopod 2 palm; **e**, pereopod 2; **f**, pereopod 2, detail, article 6, 7; **g**, pereopod 2; **h**, pereopod 3; **i**, pereopod 3; **j**, pereopod 5; **k**, telson; **l**, pleopod 2 (inner setae omitted for clarity); **m**, uropod 1; **n**, uropod 2; **o**, uropod 3.

color and extremely laterally compressed; only females have been found so far.

Head and rostrum: (Fig. 1a, b) The head and rostrum together equal in length to first 4 pereion segments. Rostrum straight, somewhat broad at base, lower edge slightly convexly curved. Rostrum terminates with distinct apical hook. Series of small spines set in rows decorate dorsal surface of rostrum and line its edge. No eyes present.

Body: (Fig. 1a) Body convexly curved in profile. Thoracic segment 2 narrower than 1 or 3, other thoracic segments subequal in width. Pleonal segments 2 and 3 with convexly expanded lower posterior corners. 1st epimeral segment large, with distinctly convexly curved dorsal edge; other epimeral segments small.

Antenna 1: (Fig. 1d) 1st article long, hidden below rostrum, with long setae and hairs on ventral surface. 2nd article shorter ($< 0.5 \times$ article 1) with brush of long setae on ventral surface. Jointing of article 2 and article 1 allows antenna to protrude upwards from beneath rostrum and on either side of it. Article 3 very short ($< 0.25 \times$ article 1) with no setae, except a few marking flagellar joint. Flagellum with 8 articles, accessory flagellum with 5. Each joint marked by a few distal, stout spines.

Antenna 2: (Fig. 1c) Equal in length to antenna 1. Articles 1, 2 and 3 of peduncle equal in length. Article 1 with a few long ventral setae, article 2 ventrally expanded with numerous very long setae, forming distinct brush. An apical clump of 3–4 long setae also present on distal dorsal corner at joint with article 3. Article 3 with clump of long setae on ventral surface, pair of stout, blade-like spines at distal edge on either side of first flagellar segment. Flagellum with 6 articles, each joint marked by set of small, stout distal spines.

Maxilliped: (Fig. 1f) Inner plates free, small, with 3–4 long apical setae. Outer plates slightly longer than palp article 1, with numerous, long setae on inner edge, a few on outer edge. Article 1 of palp with sharp, pointed upper and outer corner, bearing short, stout spine. Article 2 long ($3 \times$ article 1), with line of 6–7 setae on inner edge, small brush of setae on outer distal corner at joint with Article 4. Article 4 curved, sharp with distinct terminal spin; small spine on inner edge at $2/3$ of its length.

Maxilla 1: (Fig. 1i) Inner plate equal in length to outer plate, somewhat distally expanded, bearing 4 complex apical setae. Inner plate large, with ca. 11 apical setae similar to those on inner plate. Palp 2 jointed, borne on winglike lateral expansion of outer plate. Palp with 6 or more apical spines, simple in structure, long, gently curved. Plates and palp of maxilla 1 completely folded with one another and maxilla 2 [it was impossible to render this realistically as the microscope preparations for *camera lucida* drawing distort the 3-dimensional structure of these mouthparts].

Maxilla 2: (Fig. 1j) Lobes equal in size, slightly smaller than inner lobes of maxilla 1. Each with apical bunches of 7 or more setae, simple in structure.

Mandible: (Fig. 1e) Mandibles asymmetrical; left with blunt incisor process in curved row of 5 accessory teeth forming double row (Fig. 1g), with row of 6–7 curved spines (Fig. 1h). Right mandible with larger incisor with only 2–3 accessory teeth in single row, spine row of 8 or more teeth. No molar process.

Lips: (Fig. 1k,l) Upper lip pointed; lower bilobed, with small sharp spines on apices of both inner and outer lobes

Gnathopod 1, 2: (Fig. 2a–d) Gnathopods undifferentiated; gnathopod 1 slightly smaller, with elongate 5th article, article 5 is short in gnathopod 2. In both, palm defined by sharp cusp with sharp spine. Palm slightly rounded, with sparse setae and hairs. Dactyl curved, sharp, point folding against defining cusp. Insertion of dactyl marked by tuft of long setae.

Pereopod 1 & 2: (Fig. 2e–g) Pereopods 1 and 2 similar, 2 slightly larger, with triangular coxa, coxa of 1 rectangular. Posterior edges with long, curved setae. Dactyl $0.5 \times$ length of article 6. Article 6 with double row of long, blade-like spines on posterior edge, 2–3 similar spines at distal posterior corner of article 5. Pereopod 2 coxa largest, posterior edge produced backwards as far as pereopod 7 (Fig. 1a, 2 g).

Pereopod 3 & 4: (Fig. 2h,i) Both with markedly flattened articles 2, 4, and 5 with small coxae. Numerous long, curved setae and shorter stout spines on each. Pereopod 3 also with numerous long, plumose setae on anterior and posterior edges of articles 4–6. Pereopod 4 with only 2 short plumose setae on anterior edge of articles 4 and 5.

Pereopod 5: (Fig. 2j) Short, with small coxa and extremely enlarged, flat article 2 reaching to end of article 6, extended back to lie below pleon segments 1 and 2. All articles bear curved setae. Dactyl long (= article 6). Posterior edge of article 2 has 4 or 5 teeth with small spines; lower edge of

article has 5–6 long setae, some short hairs on outer surface.

Pleopods 1–3: (Fig. 2l) Similar in structure to one another, pleopod 1 largest. Each with basal peduncle with 2 rami. Pleopods bear numerous long, curved, plumose setae.

Uropod 1: (Fig. 2m) Long, with outer ramus bearing 3 large spines in marked groove on dorsal surface. Inner ramus bears 2 similar spines. Large, curved tooth on dorsal surface of peduncle at insertion of rami, 2 slightly smaller spines below this. [In some individuals, other small spines also occurred on the peduncle.]

Uropod 2: (Fig. 2n) Small, equal in size to peduncle of uropod 1, otherwise similar, with 3 large spines on outer ramus; 2 on inner, 1 large and 1 smaller curved tooth on peduncle.

Uropod 3: (Fig. 2o) Longest of uropods: Peduncle relatively short, outer ramus very long, 2-jointed, with number of sharp, curved setae of varying lengths; 3 long, straight setae define end of 2nd article. Inner ramus very short ($< 1/3$ 2nd article of outer ramus), with long, sharp, apical seta.

Telson: (Fig. 2k) Small, fleshy, completely divided. Each lobe terminated by sharp, stout spines. Most commonly, each lobe bears 2 such spines, together with very minute spine. Some individuals with 3 larger spines; some with 2 on 1 lobe, 3 on the other. Also, each lobe usually with single, long, plumose seta on outer and dorsal surface. Rarely, 2 plumose setae occur, 1 long, 1 very short.

Holotype: Female, 2.2 mm, BPBM S11298.

Paratypes: 10 females, BPBM S11299.

Type Locality: Hanalei Bay, Kaua'i, Hawai'i.

The specific name continues the tradition established by Barnard (1955, 1970, 1971) of assigning names derived from the Hawaiian language. Hawai'i Loa was the mythical navigator of the first Polynesian canoe to reach the Hawaiian Islands and is a reflection of the long journey that settlers of these islands, such as the ancestor of this small amphipod, had to travel to reach here. It is also a tribute to Hawaii Loa College, the institution that first brought the senior author to the Hawaiian Islands.

Discussion. In addition to those detailed in Table 1, we note the following differences between our specimens and *M. uncistrostratus*, as described by Pillai (1957): a) *M. uncistrostratus* is larger (6.0 mm) where *M. hawaiiiloa* is small (ca. 2.0 mm); b) the rostrum in *M. uncistrostratus* is narrow and the lower edge is concave and shallowly excavate, where that of *M. hawaiiiloa* is broad and has a convex lower edge; c) article 2 and 3 of antenna 1 in *M. uncistrostratus* are the same length, and in *M. hawaiiiloa* article 3 is less than half the length of article 2; d) from the figures in Pillai (1957), the structure of the incisor process and cutting edge of *M. uncistrostratus* appears to be quite different to that of *M. hawaiiiloa*. In addition, the 2nd palp article of *M. uncistrostratus* has 2 well separated setae, where that of *M. hawaiiiloa* usually has only 1 (though rarely, 2 may occur together). The 3rd article of the mandibular palp in *M. uncistrostratus* has 6 setae, where there are 8 in *M. hawaiiiloa*; e) the coxa of pereopod 2 in *M. uncistrostratus* is smaller than that of *M. hawaiiiloa*, which extends to the 4th pereopod; f) the coxa of pereopod 3 in *M. uncistrostratus* is very much smaller than that of *M. hawaiiiloa*; g) coxa 7 of *M. uncistrostratus* is larger than that of *M. hawaiiiloa*; in *M. uncistrostratus* it extends as far as the end of the dactyl; in *M. hawaiiiloa* it extends as far as the end of the 6th article.

Barnard (1971), in a review of the amphipods of the Hawaiian Islands, noted the occurrence of only 1 phoxocephalid, *Paraphoxus centralis* (Schellenberg), whose location was given as Fern and Whale Islands. Congeners of this species are tropical American species (Barnard, 1970). Barnard (1971) expressed the hope that adequate sampling of soft bottomed substrates in Hawai'i would yield various phoxocephalid species, but apart from a report by Hobson & Chess (1979) of an unidentified phoxocephalid from Midway and Kure Atolls, no record apart from ours has been published.

While thus far only recorded from Hanalei Bay, Kaua'i, *Mandibulophoxus hawaiioloa* is locally abundant, and ecologically important: of 77 invertebrate taxa recorded in the Hanalei Bay sediments, it proved to be the most commonly encountered, occurring in 88% of all benthic samples taken. It was also found to be an important prey item of fishes in the area, and was recovered from stomach contents of bonefish (*Albula* sp.), blue-lined snapper (*Lutjanus kasmira* Forsskal), razor wrasse (*Xyrichtys pavo* Valenciennes) and sharphead wrasse (*Cymolutes lecluse* Matsuda *et al.*) (DeFelice, 1997).

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Table 1. Comparison of characters of *Mandibulophoxus uncirostratus*, *M. gilesi* and *M. hawaiiola* n.sp.

Character	<i>M. uncirostratus</i> Giles	<i>M. gilesi</i> Barnard	<i>M. hawaiiola</i> Muir & DeFelice, n. sp.
Spines on U1 rami	4 (i) 4 (o)	5 (i) 6 (o)	2 (i) 3 (o)
Spines on U2 rami	3 (i) 4 (o)	5 (i) 7 (o)	3 (i) 3 (o)
U3 inner ramus	< 0.5 × outer	equal to outer	< 0.3 × outer
Teeth, Art 2, Per 5	3 or 4	> 6	4 or 5
Ratio, Art4:5, Per 5	4 >> 5	4=5	4=5
Peritopod 4	numerous plumose setae	numerous plumose setae	few plumose setae
Rostrum	shallowly hooked along length	straight	straight, with terminal hook
Mandibular process	indistinct, rounded	distinct, narrow	distinct, narrow
Ratio arts 4:5, Per 5	4 < 5	4=5	4=5
Mand. palp setae	6	8	8
Mand. palp art 2	2 separated spines	2 spines together	single spine or none
Antenna 1 flagellum articles	9	14 - 16	8