

Amphipoda of the Northeast Pacific (Equator to Aleutians, intertidal to abyss): XXI.
Pontoporeioidea - an updated and expanded review
Donald B. Cadien, LACSD 22July2004 (revised 27Feb2015)

Preface

The purpose of this review is to bring together information on all of the species reported to occur in the NEP fauna. It is not a straight path to the identification of your unknown animal. It is a resource guide to assist you in making the required identification in full knowledge of what the possibilities are. Never forget that there are other, as yet unreported species from the coverage area; some described, some new to science. The natural world is wonderfully diverse, and we have just scratched its surface.

Introduction to the Pontoporeioidea

J. L. Barnard and Karaman (1991) did not separate this group of families from the Superfamily Phoxocephaloidea. We follow Bousfield (1979) in treating the two groups of families as separate at the superfamily level. Only two of the four families included in this superfamily are represented in the NEP fauna; the Pontoporeiidae and the Haustoriidae. In both cases the NEP houses a few species in very few genera. The Zobrachoidae and the Urohaustoriidae are families occurring in the Southern Ocean (J. L. Barnard & Karaman 1991), and are unrepresented in the NEP. J. L. Barnard and C. M. Barnard (1983) treated this entire superfamily as part of the Gammaroidea s. l., segregating it as cluster k of their gammaroid group. Erection of the subclass Senticaudata (Lowry & Myers 2013) has modified the placement of this group relative to the gammaroids. They include the gammaroids, including nearly all the “traditional” gammaroid families in their new subclass. The pontoporeioids, however, are united with the Phoxocephaloids outside the Senticaudata, or any as yet created subclass in the Infraorder Phoxocephaliida. While no subclass group currently exists, the informal group of “natant” families (Bousfield 2001) could serve as a temporary home. This is construed here to include two infraorders of “hyperiid”, and three benthic infraorders: Lysianassida, Synopiida, and Phoxocephaliida.

Diagnosis of the Pontoporeioidea

“Plesiomorphic, generally smooth bodied, weakly rostrate, fossorial gammarideans; dimorphic terminal pelagic male often suppressed (lacking in Haustoriidae) but, when present, bearing plate calceoli and usually brush setae on flagella of both antenna 1 and 2; accessory flagellum short; mouthparts basic, with strong mandibular molar and palp; plates of maxillae 1 and 2 strongly setose and spinose; maxilliped plates and palp well developed and strongly setose; lower lips with distinct inner lobes; coxal plates deep, 4th moderately excavate behind; coxa 5 anteriorly or equi-lobate, coxae 6 and 7 posteriorly lobate; gnathopods 1 and 2 weakly amplexing, unlike, subchelate or simple; peraeopods 5-7 adactylate (or nearly so), markedly heteropodous; brood plates sublinear to broad; coxal gill lacking on peraeopod 7; sternal gills occasionally present (some Pontoporeia); pleopods normal to very powerful; uropods sublinear or lanceolate, rami of 1 and 2 subequal; uropod 3 foliaceous to spinose, outer ramus usually 2-segmented; telson lobes variously separated or fused, apices with spines or setae.” (Bousfield 1979).

Ecological Commentary

Pontoporeoids are burrowing animals, and bear the typical morphological adaptations seen in other groups which “swim” through sandy sediments (Bousfield 1970). Like phoxocephalids, urothoids, and platyischnopids, members of the pontoporeoid families bear fairly robust appendages, and robust antennae. In some areas of the world they are important in energy flow within communities (Elmgren *et al* 1990, Cavaletto *et al* 1996, Gardner *et al* 1990), but in the NEP they usually have less central roles in community function.

They are primarily found in fully marine, or brackish waters, but some live in freshwaters. To some extent this follows family lines, with members of the Haustoriidae, Zobrachoidae, and Urohaustoriidae typically marine, and Pontoporeiidae primarily brackish or fresh. While most species are found in only one of these salinity regimes, others have some tolerance of salinity fluctuations (Filipov 2006). Members of the genus *Pontoporeia* (including *Monoporeia* and *Diporeia*) are among the best known of glacial relict taxa, with holarctic distributions reflecting vicariant events associated with glaciation (Segerstråle 1971a, 1971d, 1977; Bousfield 1989).

Species in pontoporeoid families preferentially inhabit well oxygenated sediments in shallow waters, and many are very active, forced by waves to constantly reestablish their position (Lindström 1991). While some frequent silty sands, most inhabit clean sandy sediments. These characteristics, along with known tolerances in temperature fluctuation (Segerstråle 1978b) and oxygen levels (Johannson 1997) make them useful as bioassay animals (Sundelin 1983, 1984; Eriksson Wiklund *et al* 2002).

Feeding within pontoporeoid families primarily involves particle capture, either from suspended particles in the water, or sedimentary deposits. None seem to have evolved raptorial modifications allowing a predatory life style. Like some phoxocephalids, however, some pontoporeiids may be selective deposit feeders with a taste for the larvae of other invertebrates (Oakden 1984, Oliver *et al* 1982, Oliver & Slattery 1985). The authors cited view this as micropredatory activity, but without specialized adaptations to prey (even larval prey) capture, this is perhaps more accurately viewed as selective deposit feeding. Enequist (1950) does not report on the behavior of any *Pontoporeia* species, but does describe feeding and locomotory behavior in both *Bathyporeia* and some species in Haustoriidae. He reports the animals suction feed on fine particulates while burrowing in, and moving forward through the sediments. The broad body form and setose appendages help maintain the lateral walls of the feeding “tube” formed by the forward excavation. It is within this space that the suctorial particle capture takes place. He also mentions the capture of larger organic aggregates, potentially including larvae of infaunal species. In his examination of *Eohaustorius sencillus* guts Slattery (1985) found only an organic paste and diatom frustules, but opportunistic consumption of encountered larvae remains possible although undocumented.

Fresh-water pontoporeiids rely on diatoms either in sediments or in bottom water for their nutrition. Post bloom consumption of settled phytoplankton leads to variable lipid concentrations in pontoporeiids in a predictable seasonal cycle (Autio *et al* 2003; Hill *et al* 1992; Johnson 1987; Lehtonen 1996, 2004). Much of the annual productivity in these species centers on the food stores gathered in the spring post-bloom feast (Goedkoop 2004, Goedkoop & Johnson 2001). Lipids stored in the body see the animals

through the much leaner summer, fall and winter months. In areas where the bloom is restricted, stores are not adequate, and the life cycle is annual. Where plankton bloom derived food is abundant, some of the population will overwinter, living two years. Although other food sources are utilized (i.e. bacterial flora) this contributes little to the energy budget of the animals (Goedkoop & Johnson 1994). Reproductive problems in these amphipods are a consequence of inadequate nutrition (Sundelin et al 2008).

Availability of food can be limiting to pontoporeiid populations, and many exhibit either intrapopulation competition (Elmgren *et al* 2001), or interspecies competition between co-occurring *Monoporeia affinis*, and *Pontoporeia femorata* (Lopez & Elmgren 1989, Uitto & Sarvala 1991). These two species partition their habitat to minimize conflict (Busdosh *et al* 1982, Hill & Elmgren 1987), and respond differently to physical factors (Steele & Steele 1978, Johansson 1997). In addition to the food competition mentioned above, pontoporeiids also are involved in interference competition with other members of the benthos. The inverse relationship between abundances of *Monoporeia affinis* and the bivalve *Macoma balthica* has been known for many years (Segerstråle 1973, 1978a; Elmgren *et al* 1986). The burrowing activities of pontoporeiids also have a profound impact on the meiofauna (Olafsson & Elmgren 1991).

Pontoporeiids serve as food for other animals, and form a significant link connecting the benthic and pelagic portions of lacustrine food webs (Goedkoop & Johnson 1996, Gardner *et al* 1990). They are also consumed by benthic predators such as worms (Abrams et al 1990) and isopods (Hill & Elmgren 1992). They are even consumed at the very top of the food chain by whales (Hazard & Lowry 1984).

Reproduction is linked to availability of food through vision. Pontoporeiids have good vision (Donner 1971) which is used to synchronize their actions to seasonal changes in day length (Segerstråle 1970, 1971b, 1971c, 1971e, Donner *et al* 1987). As these are also linked to the timing of the phytoplankton bloom which forms the majority of the annual nutritional input to pontoporeiid populations, vision is critical to their lipid content and reproductive condition.

Conlan (1991) classes both Pontoporeiidae and Haustoriidae as non-mate guarding groups that do not engage in precopulatory grasping. Males find females either with pelagic searching (pontoporeiids) or benthic searching (haustoriids), the latter not apparently involving chemosensory mate location (Conlan 1991). During their swimming excursions male *Pontoporeia femorata* are classed as major suprabenthic swimmers by Sainte-Marie and Brunel (1985). At the superfamily level (using data from a number of Pontoporeiidae and Haustoriidae), pontoporeoids were found to have an average lifespan of 18.8 months, with an expected lifetime fecundity of 34.2 embryos/female (Sainte-Marie 1991). While endocrine disruptors have been shown to have an impact on reproduction in the group (Jacobson & Sundelin 2006), the primary variable affecting reproductive output of pontoporeiids is apparently food (Sundelin *et al* 2008).

NEP Pontoporeioidea from McLaughlin *et al.* (2005)

* = Taxa on the SCAMIT Ed. 9 list (Cadien and Lovell 2014).

Valid taxa **bolded**, synonyms not.

Family Pontoporeiidae

Diporeia erythrophthalma (Waldron 1953) – Lake Washington, freshwater

Monoporeia affinis (Lindstrom 1855) – distribution uncertain in NEP; in brackish to freshwater

Pontoporeia affinis Lindstrom 1855 (see Monoporeia affinis)

Pontoporeia affinis erythrophthalma Waldron 1953 (see Diporeia erythrophthalma)

Pontoporeia femorata Krøyer 1842 – distribution uncertain in NEP; in brackish to freshwater

Family Haustoriidae

Acanthohaustorius n. sp. Dexter 1974 – Costa Rica to Columbia; intertidal

Eohaustorius barnardi Bousfield and Hoover 1995 – Pt. Conception to San Diego, Ca; 5-20m

Eohaustorius brevicuspis Bosworth 1973 – Strait of Juan de Fuca, Puget Sound, Washington to Crescent City, Ca; 0-1m

Eohaustorius eous (Gurjanova 1951) – Kamchatka to Aleutians; 5-25m

Eohaustorius estuarius Bosworth 1973 Crescent Beach Washington to Sooes Estuary, Oregon; 0-1m in brackish waters

Eohaustorius sawyeri Bosworth 1973 – British Columbia to Carpinteria, Ca.; 2-22m

Eohaustorius sencillus J. L. Barnard 1962 – Southern Oregon to SCB; 1-20m

Eohaustorius washingtonianus (Thorsteinson 1941) – Prince William Sound, Alaska to Central California; 0-2m

Haustorius eous Gurjanova 1951 (see *Eohaustorius eous*)

Haustorius washingtonianus Thorsteinson 1941 (see *Eohaustorius washingtonianus*)

Family Zobrachoidae – no representatives in the NEP

Family Urohaustoriidae - no representatives in the NEP

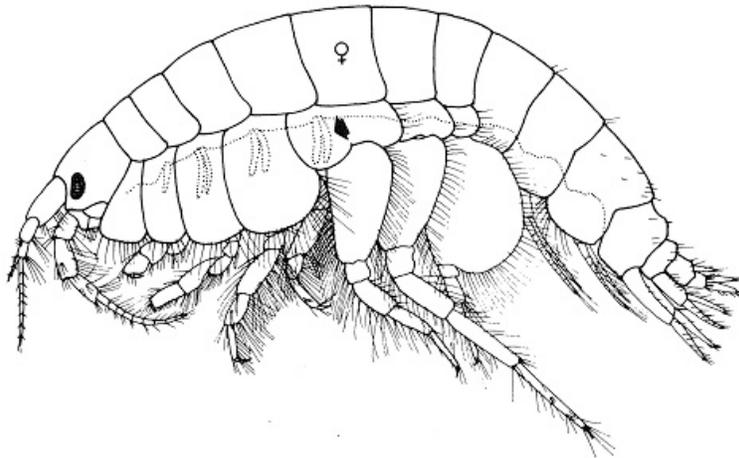
Comments by Family

Family Pontoporeiidae – The family Bathyporeiidae, created by Bousfield (1979) from within the Pontoporeiidae, has since been recombined with the latter family. McLaughlin *et al* (2005), the amphipod portion of which was organized and directed by Bousfield, no longer separates the two. The family apparently has a number of previously unrecognized forms, apparently divergent glacial relict populations, throughout North America. Bousfield (Ed Hendrycks, pers. comm.) is currently working on the family and has already identified a number of new genera, and numerous additional species.

Diagnosis: “ *The body is medium or slender, or rarely broad; the urosome (and occasionally the pleon) often is toothed or setose dorsally. The rostrum is weak. The eyes are small, ovate, and few-faceted, or rarely lacking. Antenna 1 often is geniculate at peduncle 1, which may form a pseudorostrum with the opposite member. Sexual*

dimorphism is pronounced, usually with a (smaller) terminal pelagic male. In antenna 1 the flagellum is occasionally calceolate (male) or rarely elongate (*Pontoporeia*). In antenna 2 the peduncular segments are little expanded, and the flagellum is short in the female or usually elongate and calceolate in the male. The mouthparts are basic and setose; the maxillae are normal, and the maxilliped palp is dactylate (four-segmented). The gnathopods are weakly subchelate, subsimilar or dissimilar (*Bathyporeia*), weakly (rarely strongly) sexually dimorphic, and amplexing in males. Peraeopods 3-7 have dactyls, which are small and masked by spines; the bases of peraeopods 5-7 (especially 7) are very broadly expanded, the distal segments are moderately so, and the coxae are equally or anteriorly lobate; peraeopod 5 often is geniculate at segment 4. The pleopods are normal, and the rami are subequal. Uropod 3 is large, and the rami dimorphic. Sternal gills are present in some *Pontoporeia*. The telson lobes are separate or fused basally. The brood plates usually are large, and the margins are richly setose.” (Bousfield 1982).

Steele (1991), points out that all three types of brood plates are present in the pontoporeiids despite Bousfield’s characterization of “large” as the usual state for the family. He indicates the differences in brood plate morphology may be useful in tracing evolutionary divergence within the group. Genera within the family were reevaluated by Bousfield (1989) who separated *Pontoporeia* into three genera; *Pontoporeia* s.s., *Monoporeia*, and *Diporeia*. All three are reported from the NEP, although, due to nomenclatural confusion in the identity of the animals, some of the historic distributional records may not be accurate. The genus *Priscillina* is also reported from the NEP, but only from Arctic portion above the Aleutians. None of the other genera in the family are known from the NEP.



Diporeia female (*filiformis* group) (from Bousfield 1989)

Diporeia - A single species is known from the NEP, *D. erythrophthalma* from the freshwaters of Lake Washington near Seattle. Originally described as a subspecies of *Pontoporeia affinis* (Waldron 1953), it has since been transferred to *Diporeia* (in the revision of Bousfield 1989), and raised to full specific status. Chapman (2007) provides information on the animal, and a key separating it from *Monoporeia*. No collections from either brackish or marine waters have yet been reported.

Diagnosis:” Urosome 1 with weak dorsal hump (or lacking); posterior pleosome and urosome often dorsally setulose (Fig. IB). Lateral head lobe not produced, subacute.

Antenna 1, accessory flagellum 3-4 segmented. Antenna 2, peduncular segments 4 and 5 normal, with one major fanwise group of lateral facial spines; segment 5, antero-distal process very weak, spine group weak.

Gnathopod 1, propod deeply ovate; palm with group of three postero-distal spines; carpus longer than deep, hind lobe shallow, unevenly rounded below. Gnathopod 2 weakly parachelate; propod medium, about two-thirds length of carpus; palm relatively strong, postero-distal angle with two to three spines.

Coxa 4 distinctly excavate behind. Coxa 5 shallow, almost aequilobate, anterior lobe rounded below. Basis of pereopod 5 longer (deeper) than basis of pereopod 6.

Uropod 1, rami sparsely spinose, especially outer margin of inner ramus. Uropod 2, rami with long slender marginal spines except on inner margin of outer ramus. Uropod 3, rami short, outer ramus lacking terminal segment.

Telson squared, about as wide as long, lobes cleft to base, apices with long and short slender spines. Sternal gills double on pereopod segments 3-5, single on segment 2.”
(from Bousfield 1989)



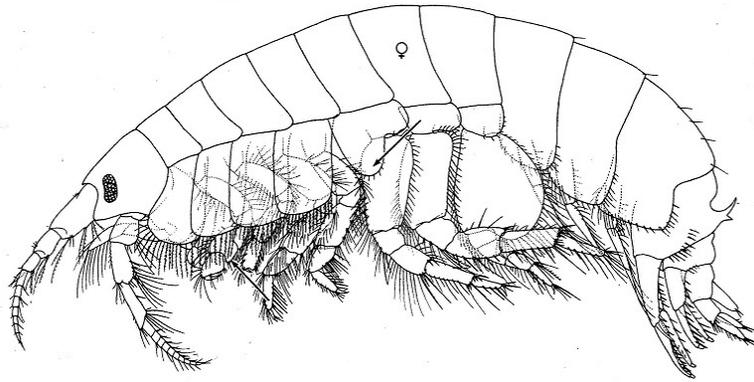
Monoporeia affinis, gravid female (Photo: Rasmus Neideman)

Monoporeia – A single member of this genus is reported from the boreal portion of the NEP, *Monoporeia affinis*. As reported by Bousfield (1989) there is good reason to suspect that the species identified as *M. affinis* in the NEP differs from that known from other boreal and arctic records, particularly in Europe. His earlier report of the species from numerous locations across the continent (Bousfield 1958) stresses uncertainty over the meaning of the “varietal” names he synonymized there under *M. affinis*. He suggested that the records he listed might not apply to Lindstrom’s species. This contention was further supported by the results of later molecular work (Väinölä and Varvio 1989). Chapman (2007) reports only *Monoporeia* sp. Despite the probability that previous records refer to one or more undetected cryptic species in the genus, the possibility of circumarctic distribution for *M. affinis* cannot yet be ruled out. It is

retained here in support of earlier records from the northern portion of the NEP which may, or may not be correctly identified.

Diagnosis: “*Urosome 1 with weak dorsal hump (not bifid) (Fig. 1C). Lateral head lobe normal, subacute. Antenna 1, accessory flagellum J...-5 segmented. Antenna 2, peduncular segments 4 and 5 broader, length 1-2 x breadth, each with one major fanwise group of lateral facial spines; segment 5 with small, spinose antero--distal process. Gnathopod 1, propod ovate, convex palm smoothly continuous with posterior margin; carpus longer than deep, hind lobe medium-deep, squared below (Fig. 2B). Gnathopod 2 weakly subchelate; propod short, about half length of carpus; palm small, posterior angle with pair of short spines and two to three long plumose slender spines.*

Coxa 4 weakly excavate behind. Coxa 5 weakly antero-lobate, anterior lobe rounded below. Basis of pereopod 5 shorter than in 6. Uropods 1 and 2, rami sparsely spinose, spines lacking on outer margins. Uropod 3, rami short, <1 1/2 X length of peduncle; outer ramus with vestigial (barely visible) terminal segment. Telson short, wider than long; lobes fused basally (one-half), apices each with several slender spines. Sternal gills (when present) median finger-like processes on pereaeon segments 2-5.”
(from Bousfield 1989)



Pontoporeia femorata (from Bousfield 1973)

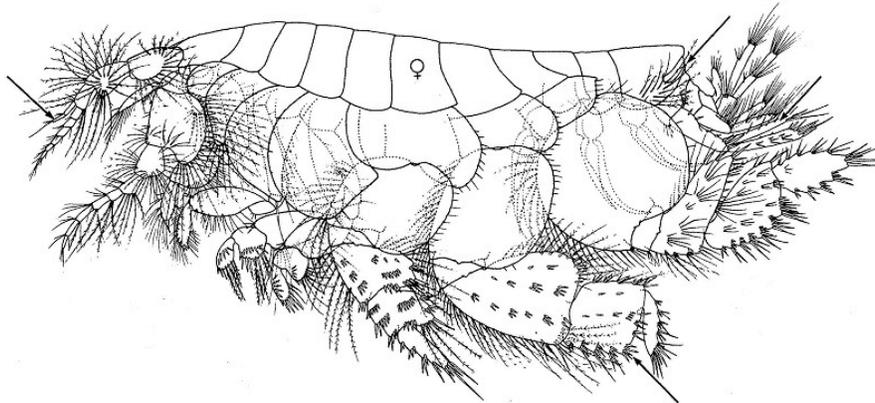
Pontoporeia – The species *Pontoporeia femorata* is recorded from coastal fresh/brackish waters in Alaska, but is otherwise not known from the NEP. Like *Monoporeia*, this form may prove to be an unrecognized locally distributed species rather than *Pontoporeia femorata* as known from Europe.

Diagnosis: “*Antenna 1 not geniculate; mandibular palp not on basal process, molar ridged; outer plate of maxilla 2 not enlarged; maxillipedal palp 4-articulate; coxae 1-2 of normal size, rounded-quadrangle below; gnathopod 1 subchelate, articles 5-6 subequal in length, gnathopod 2 slightly chelate; at least pereopods 1, 2, 5 dactylate; rami of uropod 3 equal in length; telson cleft halfway or more.*“ (from J. L. Barnard 1969)

Family Haustoriidae - Haustoriids are particularly well represented in the Northwest Atlantic (Bousfield 1965, 1970, 1973) where they have extensively diversified, with representatives of *Acanthohaustorius*, *Haustorius*, *Lepidactylus*, *Neohaustorius*, *Protohaustorius*, and *Pseudohaustorius*. Several investigations of the autecology of these species are available (Croker 1967a,b; Dexter 1967, 1971; Sameoto 1969a,b,c). In the

NEP the family is represented only by the genus *Eohaustorius*, which is not among the large NW Atlantic haustoriid contingent (McLaughlin *et al* 2005). *Eohaustorius* is a North Pacific endemic genus, with representatives in both the NWP and NEP. It appears to be most closely related to the NWA *Pseudohaustorius*, and likely resulted from migration west of NWA precursors prior to the Miocene formation of the Isthmus of Panama (Bousfield & Hoover 1995).

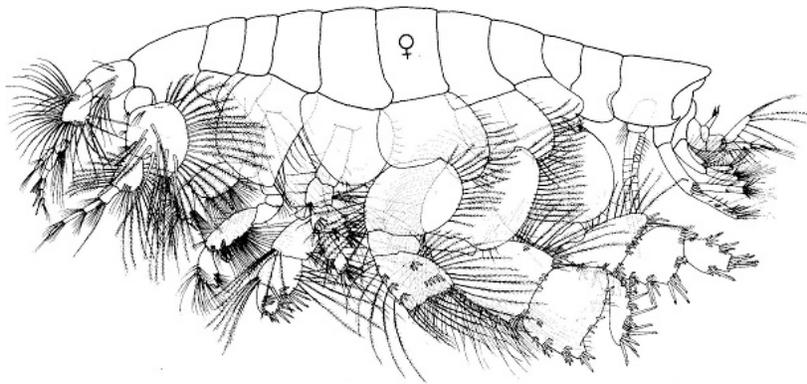
Diagnosis: “*The body is medium to very broad, smooth and narrowing and/or reflexed (often strongly) at the urosome. The appendages are very strongly fossorial. Sexual dimorphism is weak, and a terminal pelagic male is lacking. The rostrum is moderate. The eyes are very small and weakly (or not) pigmented. In the antennae the peduncular segments (especially of antenna 2) are broadly expanded behind and strongly spinose and setose; the flagella are short and lack calceoli; the accessory flagellum is two- to five-segmented. The mouthparts are basic, but specialized for filter feeding. The mandibular molar is strong, and the incisor is weak. In the lower lip the outer lobes lack a mandibular process, and the inner lobes are elongate proximally. The maxillae are very setose; in maxilla 2 the plates are often very large and baler-shaped; in the maxilliped the palp is three-segmented (the dactyl is lacking). Gnathopod 1 is simple, and 2 is microchelate; both are richly setose and alike in the male and female (2 is large and carpochelate in the Neohaustorius male). Peraeopods 3-7 lack dactyls, and the distal segments are expanded, strongly spinose, and often plumose-setose. Peraeopods 3 and 4 occasionally are unlike (Eohaustorius). Peraeopods 5-7 are dissimilar; segments 4 and 5 are variously expanded and spinose; the bases are broadly expanded; the coxae typically are posteriorly lobate. The pleopods are very powerful, the peduncles are cylindrical, and setose at the joints. The telson lobes are short, and variously fused to a V-cleft, or widely separated. On segment 6 (Eohaustorius), sternal gills are lacking. The brood plates are medium broad.*” (Bousfield 1982).



Acanthohaustorius millsii, a western Atlantic species (from Bousfield 1973)

Acanthohaustorius – The presence of an unidentified and presumably new species in this genus was reported from Costa Rica and northern Pacific Columbia by Dexter (1974). No description of this animal is available to date. It is included here to bring attention to the presence of the genus in the NEP. Otherwise, genera other than *Eohaustorius* are unrepresented in the NEP.

Diagnosis: “*Small to medium large, generally similar to Haustorius (sensu stricto). Head broadest medially, margins convex, rostrum broadly acute. Peraeon lateral lobes prominent. Pleon narrowing abruptly behind peraeon, side plates acuminate, 3rd produced posteriorly into stout spinous process. Urosome somewhat reduced, longer than pleon 3, which overhangs it more or less. Urosome 1 stout, posteroventral lappet short. Urosome 2 as long as urosome 3, but narrower than uropod 1. Antenna 1: flagellum usually calceolate, accessory flagellum 2-segmented. Antennae 2: peduncular segment 4 deeply lobate, segment 5 broad, setose; flagellum: basal segment largest. Upper lip broad rectangular, apex smooth. Lower lip: inner lobes broad; outer lobes: inner margin subtruncate. Mandibular incisor mono or bicusate, lacinia simple on right side only, accessory plates fairly numerous (5-13) . Maxilla 1 : inner plate setae distally plumose; accessory baler plate moderately large. Maxilla 2 : outer plate broad, not elongate, apex blunt, inner margin plumose distally; inner plate narrow. Maxilliped: plates broad; palp segment 3 stout, geniculate. Gnathopod 1: segment 5 usually stout. Gnathopod 2: segment 6 slender. Peraeopods 1 and 2 not exceptionally powerful, posterior lobes of segment 5 short, coxa of peraeopod 2 very broad. Peraeopods 3-5: segments 4-5 moderately expanded. Peraeopods 4 and 5 not excessively lengthened, peraeopod 3 more than 2/3 peraeopod 5. Coxal gills smallest posteriorly. Brood plates rather large, broad, margins richly setose, very small on peraeopod 3. Pleopods strong, outer ramus 13-20-segmented, inner 10-15-segmented. Uropod 1 : peduncle stout, inner ramus shorter, spinose and setose behind. Uropod 2 strong, rami and peduncle subequal. Uropod 3: terminal segment of outer ramus long. Telson broad, sharply and deeply notched.*” (from Bousfield 1965)



Eohaustorius washingtonianus (from Bousfield and Hoover 1995)

Eohaustorius – An endemic North Pacific genus, with representatives on both the western and eastern margins of that ocean. Living either intertidally or subtidally on exposed sandy shores, species of *Eohaustorius* are active burrowing detritivores. Ecology and population characteristics of *Eohaustorius sencillus* were evaluated by Slattery (1985) in Monterey Bay. The zoogeographic analysis of Bousfield and Hoover (1995) show this as one of three species recorded from southern California, described by J. L. Barnard (1962) from material taken near Point Conception. Earlier records of a fourth species, *E. washingtonianus*, were allocated to *E. barnardi* when that species was described as new (Bousfield & Hoover 1995). It was described from the Puget Sound area (Thorsteinson 1941), and is common north of central California. The third southern

California taxon is *E. sawyeri*, described initially by Bosworth (1973) from central California, but ranging at least as far south as Carpinteria in the Santa Barbara Channel (personal obs.). All of these species are currently listed on the SCAMIT Edition 9 listing.

Four species are known from the northern part of the NEP above the SCB: *E. eous*, *E. estuarius*, *E. washingtonianus*, and *E. brevicuspis*. The first of these only ranges from the Sea of Okhotsk through western Alaska, while the next two range from Southeastern Alaska down to Central California. *Eohaustorius brevicuspis* has a narrower range, being known only between British Columbia and Central California. Original descriptions of these four are available in Gurjanova (1951), Bosworth (1973), and Thorsteinson (1941), but all are redescribed by Bousfield and Hoover (1995). All seven NEP species can be separated using the genus key provided by Bousfield & Hoover (1995, p.37).

Diagnosis: “Head broad, broadest in middle, lateral margins subparallel, rostrum strong. Accessory flagellum 2-articulate. Article 5 of peduncle on antenna 2 broad but scarcely lobate ventrally. Mandible with incisor. Outer plate of maxilla 2 little larger than inner, not lunate. Palp article 3 of maxilliped clavate. Anterior pereonites without pronounced lobes just above coxae. Coxae 1-2 much smaller than 3-4, disjunct in size from 3-4. Pereopod 4 distinctly smaller than and unlike pereopod 3. Posterodorsal border of pleonite 3 slightly decurved, strongly reflexed, forming lobe overhanging urosome. Epimeron 3 with posterior process. Urosome short, lappet absent; dorsal margin of urosomite 2 short, not occluded, about equal to urosomite 3. Uropod 1 slender, both rami armed with both spines and setae (mostly); rami subequal, distally expanding. Uropod 2 strong biramous. Article 2 on outer ramus of uropod 3 medium. Telsonic lobes widely separated at base; lobes slender-setose.” (from J. L. Barnard and Karaman 1991)

Literature Cited

- Abrams, Peter A., Catherine Hill, and Ragnar Elmgren. 1990.** The functional response of the predatory polychaete, *Harmothoe sarsi*, to the amphipod, *Pontoporeia affinis*. *Oikos* 59: 251-269.
- Autio, Liisa, Kalervo Mäkelä, Kari K. Lehtonen, Jorma Kuparinen, and Hannu Haahti. 2003.** Effects of algal sedimentation and *Monoporeia affinis* on nutrient fluxes, pore water profiles and denitrification in sediment microcosms. *Boreal Environment Research* 8: 229-243.
- Barnard, J. Laurens. 1962.** A new species of sand-burrowing marine Amphipoda from California. *Bulletin of the Southern California Academy of Sciences* 61(4): 249-252.
- , **1969.** The families and genera of marine gammaridean Amphipoda. *United States National Museum, Bulletin* (271): 1-535.
- , **and Charline M. Barnard. 1983.** *Freshwater Amphipoda of the world, 1. Evolutionary patterns and II. Handbook and bibliography.* Hayfield Associates, Mt. Vernon, Virginia, U.S.A. 830pp.

- , **and Gordan S. Karaman. 1991** The Families and Genera of Marine Gammaridean Amphipoda (except marine gammaroids). *Records of the Australian Museum* Supplement 13 (Parts 1 and 2): 1-866.
- Bosworth Jr., Weldon S. 1973.** Three new species of *Eohaustorius* (Amphipoda, Haustoriidae) from the Oregon coast. *Crustaceana* 25(3): 252-260.
- Bousfield, Edward L. 1958.** Fresh-water amphipod crustaceans of glaciated North America. *The Canadian Field-Naturalist* 72(2): 44-113.
- .1965.** Haustoriidae of New England (Crustacea: Amphipoda). *Proceedings of the United States National Museum* 117(3512): 159-240.
- . 1970.** Adaptive radiation of sandburrowing amphipod crustaceans. *Chesapeake Science* 1(3): 143-154.
- . 1973.** *Shallow-water gammaridean Amphipoda of New England*. Comstock Publishing Associates/Cornell University Press. Ithaca, New York, U.S.A. 312pp.
- . 1979.** A revised classification and phylogeny of the amphipod Crustacea. *Transactions of the Royal Society of Canada* 4(14): 343-390.
- . 1982.** Malacostraca, Peracarida, Amphipoda. . Pp. 232-294 IN: Parker, Sybil P. (ed.). *Synopsis and Classification of Living Organisms*, Volume 2. McGraw Hill, New York, New York.
- . 1989.** Revised morphological relationships within the amphipod genera *Pontoporeia* and *Gammaracanthus* and the glacial relict significance of their post-glacial distributions. *Canadian Journal of Fisheries and Aquatic Sciences* 46: 1714-1725.
- . 2001.** An updated commentary on phyletic classification of the amphipod Crustacea and its application to the North American Fauna. *Amphipacifica* 3(1): 49-119.
- , **and Phillip M. Hoover. 1995.** The amphipod superfamily Pontoporeioidea on the Pacific coast of North America. II. Family Haustoriidae. Genus *Eohaustorius* J. L. Barnard: systematics and distributional ecology. *Amphipacifica* 2(1): 35-64.
- Busdosh, Michael, Donald M. LaVigne, and Gordon A. Robilliard. 1982.** Habitat separation by the amphipods *Pontoporeia affinis* and *P. femorata* near Prudhoe Bay, Alaska. *Oikos* 39: 77-82.
- Cadien, Donald B. and Lawrence L. Lovell. 2014.** A Taxonomic Listing of Benthic Macro- and Megainvertebrates from Infaunal & Epifaunal monitoring and research programs in the Southern California Bight. Los Angeles, California, USA: 186pp.
- Cavaletto, Joann F., Thomas F. Nalepa, Ronald Dermott, Wayne S. Gardner, Michael A. Quigley, and Gregory A. Lang. 1996.** Seasonal variation of lipid composition, weight, and length in juvenile *Diporeia* spp. (Amphipoda) from lakes Michigan and Ontario. *Canadian Journal of Fisheries and Aquatic Sciences* 53: 2044-2051.
- Chapman, John W. 2007.** Gammaridea. Pp. 545-618 IN: Carlton, James T. (ed.). *The Light and Smith Manual: intertidal invertebrates from Central California to Oregon*. 4th edition. University of California Press, Berkeley, California, U.S.A. 1001pp.

- Conlan, Kathleen E. 1991.** Precopulatory mating behavior and sexual dimorphism in the amphipod Crustacea. *Hydrobiologia* 223: 255-282.
- Crocker, Robert A. 1967a.** Niche diversity in five sympatric species of intertidal amphipods (Crustacea: Haustoriidae). *Ecological Monographs* 37(3): 173-200.
- , **1967b.** Niche specificity of *Neohaustorius schmitzi* and *Haustorius* sp. (Crustacea: Amphipoda) in North Carolina. *Ecology* 48(6): 971-975.
- Dexter, Deborah M. 1967.** Distribution and niche diversity of haustoriid amphipods in North Carolina. *Chesapeake Science* 8(3): 187-192.
- , **1971.** Life history of the sandy beach amphipod *Neohaustorius schmitzi* (Crustacea: Haustoriidae) *Marine Biology* 8(3): 232-237.
- , **1974.** Sandy-beach fauna of the Pacific and Atlantic coasts of Costa Rica and Columbia. *Revistas de Biología Tropical* 32(1): 51-66.
- Donner, K. O. 1971.** On vision in *Pontoporeia affinis* and *P. femorata* (Crustacea, Amphipoda). *Commentationes Biologicae* 32(41): 1-17.
- , **A. Lindström, and M. Lindström. 1987.** Seasonal variation in the vertical migration of *Pontoporeia affinis* (Crustacea, Amphipoda). *Annotationes Zoologici Fennici* 24: 305-313.
- Elmgren, Ragnar, Sven Ankar, and Gunilla Ejdung. 1990.** Amphipods of the genus *Pontoporeia* as key elements in the Baltic benthos. *Annali Zoologici Fennici* 27: 303-4.
- , -----, **B. Mareleur, and Gunilla Ejdung. 1986.** Adult interference with postlarvae in soft sediments: the *Pontoporeia-Macoma* example. *Ecology* 67: 827-836.
- , **Gunilla Ejdung, and Sven Ankar. 2001.** Intraspecific food competition in the deposit-feeding benthic amphipod *Monoporeia affinis* : a laboratory study. *Marine Ecology Progress Series* 216: 183-93.
- Enequist, Paul. 1950.** Studies on the soft-bottom amphipods of the Skagerak. *Zoologische Bidrag Från Uppsala* 28: 297-492.
- Eriksson Wiklund, Ann-Kristin, and Brita Sundelin. 2002.** Bioavailability of metals to the amphipod *Monoporeia affinis*: interactions with authigenic sulfides in urban brackish-water and freshwater sediments. *Environmental Toxicology and Chemistry* 21(6): 1219-1228.
- Filipov, A. A. 2006.** Adaptability of the amphipod *Pontoporeia affinis* (Crustacea, Amphipoda) to salinity changes. *Russian Journal of Marine Biology* 32: 198-200.
- Gardner, W. S., M. A. Quigley, G. L. Fahnenstiel, D. Scavia, and W. A. Frez. 1990.** *Pontoporeia hoyi* – a direct trophic link between spring diatoms and fish in Lake Michigan. Pp. 632-644 In: M. M. Tiller and C. Serruya (eds.). *Large Lakes – Ecological Structure and Function*. Springer, New York.
- Goedkoop, W. 2004.** Multiple stressors acting on populations of the glacial relict *Monoporeia affinis* (Lindström) in Lake Mälaren, Sweden. *Internationale Vereinigung für Theoretische und Angewandte Limnologie, Verhandlungen* 29: 1789-1795.
- , **and Richard K. Johnson. 1994.** Exploitation of sediment bacterial carbon by juveniles of the amphipod *Monoporeia affinis*. *Freshwater Biology* 32(3): 554-563.

- , and -----, 1996. Pelagic-benthic coupling: profundal benthic community response to spring diatom deposition in mesotrophic Lake Erken. *Limnology and Oceanography* 41: 636-647.
- , and -----, 2001. Factors affecting population fluctuations of the glacial relict amphipod *Monoporeia affinis* (Lindström) in Sweden's largest lakes. *Ambio* 30(8): 552-58.
- Gurjanova, Eupraxie F. 1951.** Bokoplavy morey SSSR i sopredel'nykh vod (Amphipoda – Gammaridea). *Opredeliteli Po Faune SSSR* 41: 1-1029.
- Hazard, Katherine W., and Lloyd F. Lowry. 1984.** Benthic prey in a Bowhead Whale from the Northern Bering Sea. *Arctic* 37(2): 165-168.
- Hill, Catherine, and Ragnar Elmgren. 1987.** Vertical distribution in the sediment in the co-occurring benthic amphipods *Pontoporeia affinis* and *P. femorata*. *Oikos* 49: 221-229.
- , and -----, 1992. Predation by the isopod *Saduria entomon* on the amphipods *Monoporeia affinis* and *Pontoporeia femorata*: experiments on prey vulnerability. *Oecologia (Berlin)* 91: 153-156.
- , Michael A. Quigley, Joann F. Cavaletto, and Wendy Gordon. 1992. Seasonal changes in lipid content and composition in the benthic amphipods *Monoporeia affinis* and *Pontoporeia femorata*. *Limnology and Oceanography* 27(6): 1280-1289.
- Jacobson, T. & B. Sundelin 2006.** Reproductive effects of the endocrine disruptor fenarimol on a Baltic amphipod *Monoporeia affinis*. *Environmental Toxicology and Chemistry* 25:1126-1131.
- Johansson, Birgitta. 1997.** Tolerance of the deposit-feeding Baltic amphipods *Monoporeia affinis* and *Pontoporeia femorata* to oxygen deficiency. *Marine Ecology Progress Series* 151: 135-41.
- Johnson, K. R. 1987.** The life history, production and food habits of *Pontoporeia affinis* Lindström (Crustacea: Amphipoda) in Lake Erken. *Hydrobiologia* 144: 277-283.
- Lehtonen, Kari K. 1996.** Ecophysiology of the benthic amphipod *Monoporeia affinis* in an open-sea area of the northern Baltic Sea: seasonal variations in body composition, with bioenergetic considerations. *Marine Ecology Progress Series* 143: 87-98.
- , 2004. Seasonal variation in the physiological condition of the benthic amphipods *Pontoporeia affinis* and *Pontoporeia femorata* in the Gulf of Riga (Baltic Sea). *Aquatic Ecology* 38: 441-456.
- Lindström, M. 1991.** Factors affecting the horizontal migration of the amphipod *Pontoporeia affinis* Lindström. I. Recording method and response to water currents. *Journal of Experimental Marine Biology and Ecology* 150: 149-162.
- Lopez, Glenn, and Ragnar Elmgren. 1989.** Feeding depths and organic absorption for the deposit-feeding benthic amphipods *Pontoporeia affinis* and *Pontoporeia femorata*. *Limnology and Oceanography* 34(6): 982-91.

- McLaughlin, P. A., D. K. Camp, M. V. Angel, E. L. Bousfield, P. Brunel, R. C. Brusca, D. B. Cadien, A. C. Cohen, K. Conlan, L. G. Eldredge, D. L. Felder, J. W. Goy, T. A. Haney, B. Hann, R. W. Heard, E. A. Hendrycks, H. H. Hobbs III, J. R. Holsinger, B. Kensley, D. R. Laubitz, S. E. LeCroy, R. Lemaitre, R. F. Maddocks, J. W. Martin, P. Mikkelsen, E. Nelson, W. A. Newman, R. M. Overstreet, W. J. Poly, W. W. Price, J. W. Reid, A. Robertson, D. C. Rogers, A. Ross, M. Schotte, F. R. Schram, C.-T. Shih, L. Watling, and G. D. F. Wilson. 2005.** *Common and Scientific Names of Aquatic Invertebrates from the United States and Canada - Crustaceans*. Bethesda, Maryland, U. S. A.: American Fisheries Society. 565pp.
- Oakden, James M. 1984.** Feeding and substrate preference in five species of phoxocephalid amphipods from central California. *Journal of Crustacean Biology* 4(2): 233-247.
- Olafsson, Emil, and Ragnar Elmgren. 1991.** Effects of biological disturbance by benthic amphipods *Monoporeia affinis* on meiobenthic community structure: a laboratory approach. *Marine Ecology Progress Series* 74: 99-107.
- Oliver, John S., James M. Oakden, and Peter N. Slattery. 1982.** Phoxocephalid amphipod crustaceans as predators on larvae and juveniles in marine soft-bottom communities. *Marine Ecology - Progress Series* 7: 179-184.
- **and Peter N. Slattery. 1985.** Effects of crustacean predators on species composition and population structure of soft-bodied infauna from McMurdo Sound, Antarctica. *Ophelia* 24(3): 155-175.
- Sainte-Marie, Bernard. 1991.** A review of the reproductive bionomics of aquatic gammaridean amphipods: variation of life history traits with latitude, depth, salinity and superfamily. *Hydrobiologia* 223: 189-227.
- , **and Pierre Brunel. 1985.** Suprabenthic gradients of swimming activity by cold-water gammaridean amphipod Crustacea over a muddy shelf in the Gulf of Saint Lawrence. *Marine Ecology Progress Series* 23: 57-69.
- Sameoto, D. D. 1969a.** Comparative ecology, life histories and behavior of intertidal sand-burrowing amphipods (Crustacea; Haustoriidae) of Cape Cod. *Journal of the Fisheries Research Board of Canada* 26(2): 361-388.
- **1969b.** Some aspects of the ecology and life cycle of three species of subtidal sand-burrowing amphipods (Crustacea: Haustoriidae). *Journal of the Fisheries Research Board of Canada* 26(5): 1321-1345.
- **1969c.** Physiological tolerances and behavior responses of five species of Haustoriidae (Amphipoda, Crustacea) to five environmental factors *Journal of the Fisheries Research Board of Canada* 26(9): 2283-2298.
- Segerstråle, Sven G. 1970.** Light control of the reproductive cycle of *Pontoporeia affinis* Lindström (Crustacea Amphipoda). *Journal of Experimental Marine Biology and Ecology* 5: 272-275.
- **1971a.** The distribution and morphology of *Pontoporeia affinis* Lindström f. *brevicornis* (Crustacea Amphipoda) inhabiting North American lakes, with a description of a new aberrant male form from the area. *Commentationes Biologicae*, 38: 1-19.

- . **1971b.** On summer-breeding in populations of *Pontoporeia affinis* (Crustacea Amphipoda) living in lakes of North America. *Commentationes Biologicae*, 44: 1-18.
- . **1971c.** Further data on summer-breeding in Baltic populations of the amphipods *Pontoporeia affinis* and *P. femorata*, with comments on the timing problem involved. *Merentukimuslait. Julk., Havsforskningsinst. Skrifter*, 235: 19-23.
- . **1971d.** The zoogeographic problem involved in the presence of the glacial relict *Pontoporeia affinis* (Crustacea Amphipoda) in Lake Washington, USA. *Journal of the Fisheries Research Board of Canada* 28: 1331-34.
- . **1971e.** Light and gonad development in *Pontoporeia affinis*. *Fourth European Marine Biology Symposium*: 573-81.
- . **1973.** Results of bottom fauna sampling in certain localities in the Tvarminne area (inner Baltic), with special reference to the so-called *Macoma-Pontoporeia* theory. *Commentationes Biologicae* 67: 1-12.
- . **1977.** The taxonomic status and prehistory of the glacial relict *Pontoporeia* (Crustacea Amphipoda) living in North American lakes. *Commentationes Biologicae* 89: 1-18.
- . **1978a.** The negative correlation between the abundances of the amphipod *Pontoporeia* and the bivalve *Macoma* in Baltic waters, and the factors involved. *Annali Zoologici Fennici* 15: 143-45.
- . **1978b.** Upper limits of the depth range and temperature tolerance of the Baltic *Pontoporeia affinis* (Crustacea, Amphipoda). *Annotationes Zoologici Fennici* 15: 200-201.
- Slattery, Peter N. 1985.** Life histories of infaunal amphipods from subtidal sands of Monterey Bay, California. *Journal of Crustacean Biology* 5(4): 635-649.
- Steele, Donald H. 1991.** Is the oostegite structure of amphipods determined by their phylogeny or is it an adaptation to their environment? *Hydrobiologia* 223: 27-34.
- , and **Virginia J. Steele. 1978.** Some aspects of the biology of *Pontoporeia femorata* and *Pontoporeia affinis* (Crustacea, Amphipoda) in the northwestern Atlantic. *Astarte* 11: 61-66.
- Sundelin, B. 1983.** Effects of cadmium on *Pontoporeia affinis* (Crustacea: Amphipoda) in laboratory soft-bottom microcosms. *Marine Biology* 74: 203-12.
- . **1984.** Single and combined effects of lead and cadmium on *Pontoporeia affinis* (Crustacea, Amphipoda) in laboratory soft-bottom microcosms. Pp. 237-258 In: *Ecotoxicological Testing for the Marine Environment*. eds. G. Persoone, E. Jaspers, and C. Claus, Bredene, Belgium: State University, Ghent and Institute of Marine Scientific Research. 588pp.
- , **Rui Rosa, and Ann-Kristin Eriksson Wiklund. 2008.** Reproduction disorders in the benthic amphipod *Monoporeia affinis*: an effect of low food resources. *Aquatic Biology* 2: 179-190.
- Thorsteinson, Elsa D. 1941.** New or noteworthy amphipods from the north Pacific Coast. *University of Washington Publications in Oceanography* 4: 50-96.
- Uitto, A., and J. Sarvala. 1991.** Seasonal growth of the benthic amphipods *Pontoporeia affinis* and *P. femorata* in a Baltic archipelago in relation to environmental factors. *Marine Biology* 111: 237-246.

- Väinölä, R., and S. Varvio. 1989.** Molecular divergence and evolutionary relationships in *Pontoporeia* (Crustacea: Amphipoda). *Canadian Journal of Fisheries and Aquatic Science* 46: 1705-1713.
- Waldron, K. D. 1953.** A new subspecies of *Pontoporeia affinis* in Lake Washington with a description of its morphology and life cycle. Master's thesis, University of Washington, Seattle, WA, 123pp.