**Amphipoda of the Northeast Pacific** (Equator to Aleutians, intertidal to abyss): XXII. Eusiroidea - a review. Donald B. Cadien, LACSD
22July2004 (revised 8Mar2015)

## 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 Eusiroidea

Establishment of a new subordinal group, the Senticaudata, by Lowry and Myers (2013) entailed reexamination of many interfamily relationships in amphipods. Their findings suggest that previous hypotheses of phylogeny need considerable revision, particularly in the families forming the Eusiroidea. Barnard & Karaman (1991) treated nearly all the groups often placed in this superfamily as within the Eusiridae. According to Bousfield & Shih (1994) the superfamily Eusiroidea consists of the families Pontogeneiidae, Eusiridae, Bateidae, Calliopiidae, Paraleptamphopidae, Gamarellidae, Gammaracanthidae, and Paramphithoidae. McLaughlin et al (2005) reduced the Pontogeneiidae to subfamily status within Eusiridae, and the Paramphithoidae to a subfamily within Epimeriidae. To this Bousfield (2001) adds the Amathillopsidae. This family, along with the Paramphithoidae were transferred to the Iphimedioidea by Lowry & Myers (2000). We should perhaps note here the evolution in ELBs thoughts regarding this superfamily evident in Bousfield & Shih (1994), Bousfield & Hendrycks (1995), Bousfield (2001), and McLaughlin et al (2005), in which he was the chief architect of the amphipod section.

Based on the new analysis of Lowry and Myers (2013) these families fall differently, being spread among three Infraorders, and in three different Superfamilies. The Calliopiidae and Pontogeneidae (restored to full family status) fall within the Calliopioidea within the Infraorder Hadziida. The Paraleptamphopidae, Gammarellidae, and Gammaracanthidae are placed in the Superfamily Gammaroidea in the Infraorder Gammarida. The remaining families, Eusiridae, and Bateidae were not assigned by those authors, as they fell outside the Suborder Senticaudata. Although other suborders will eventually be addressed utilizing the same methodology used for the Senticaudata, in the interim these are viewed as belonging to the Infraorder Eusirida in the Superfamily Eusiroidea , and placed in Subclass B. This is a placeholder which contains those superfamilies not included in the Senticaudata which fell into the "transitional" group of superfamilies in Bousfield 2001.

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Key to the NEP Families of Superfamily Eusiroidea (modified from Bousfield & Hendrycks, 1995) – D. Cadien 2 Jan 2014

Gnathopod one vestigial, of two articles.....Bateidae
Gnathopod one normal, of seven articles.....Eusiridae

So back to the age-old question of what belongs in the group. Why should you look at a specimen and opine "This is a eusiroid"? We can consult the diagnosis of the superfamily as emended in Bousfield & Hendrycks 1995, but that is a fairly fruitless enterprise. While there appears to be a constellation of character states found in the typical eusiroid (or not), there seem to be no unique synapomorphies for the group. The superfamilial "diagnosis" is a veritable poster-child for J. L. Barnard's comments on the Bousfield generated superfamily concepts. As here, while these concepts may be reasonable approximations in evolutionary terms, they remain a group of variants in search of a standard. In the diagnosis the few unqualified statements treat characters which are both invariate in the superfamily, and widely present elsewhere in the gammaroid amphipods. Please do read the diagnosis, but don't become discouraged by it (outraged is OK). Some parts of it may stick with you and prove helpful. I suggest a more productive course would be to examine illustrations of as many of the species listed below as possible. Allow your own mind to synthesize their content into your own concept of "eusiroid" based on the leg-work done previously by others grouping these families and species together.

**Diagnosis of the Eusiroidea**

"*Plesiomorphic, variously carinate or processiferous, rostrate, free-swimming and epibenthic amphipods, usually with moderately dimorphic terminal male stage; peduncles and flagella of antennae 1 and 2 bearing calceoli and less often brush setae; accessory flagellum small, vestigial, or lacking; eyes large, subrectangular; mouthparts more or less basic; upper lip without pronounced marginal notch; lower lip, inner lobes lacking or weakly developed; mandibular molar and palp usually strong; inner plates of maxilla 1 and 2 marginally setose, outer plate of maxilla 1 with 11 apical spine teeth; maxilliped plates and palp well developed, setose; coxal plates medium deep, 4$^{th}$ excavate; anterior peraeonal segments short, abdomen (especially pleon) segments large; coxae 5-7 posteriorly lobate; gnathopods 1 and 2 non- (or weakly) amplexing, subsimilar, usually weakly subchelate (gnathopod 1 vestigial in Bateidae), occasionally large and raptorial (Eusiridae); peraeopods 5-7 basically homopodous; brood plates large, broad; coxal gills simple, present on peraeopod 7; sternal gills occasionally present (some Pontogeneiidae); pleopods well developed, often powerful; uropods lanceolate, rami of 1 subequal, of 2 unequal; uropod 3, rami foliaceous, outer ramus 1-segmented; telson lobes distally separated, usually narrowly, apices with small notch and spine (seta), or entire*." (from Bousfield 1978). [Note: this diagnosis includes pontogeneids, which are no longer viewed as members of the superfamily]


*Eusirus tridentatus* sympagic on Antarctic pack ice (photo Ingo Arndt)(from Krapp et al 2008)

**Ecological Commentary**

Eight of these species have been reported to occur in the SCB by SCAMIT reporting agencies. Most members of the superfamily have lifestyles which do not lend themselves to constant occurrence in shelf depth benthic samples. The bateids are shallow water algal associates (Ortiz 1991), while many eusirids are offshore nectobenthic forms (Birstein & Vinogradov 1958, 1960, 1964, 1970). It is among these, however, that most of the reported species occur. The genus *Rhachotropis* is composed of species that split their time between the benthic and hyperbenthic zones, resting in one and feeding in the other. Similarly both bathypelagic and sympagic [living on pack ice] specimens of *Eusirus holmi* are found in the Arctic (MacNaughton et al 2007). Other species of *Eusirus* are reported as sympagic on Antarctic ice (Krapp et al 2008).

Location of the pelagic population of *Rhachotropis natator* in the water column was reported as 600-1100m, while samples from above and below those depths did not contain specimens (Brusca 1967). Slightly different results were reported by J. L. Barnard (1954), who found the species in tows between 1029-1884m off Southern California. Birstein & Vinogradov reported it between 500-1000m in Northwestern Pacific samples. *Eusiropsis risii* is reportedly an upper mesopelagic species, taken between 100 and 500m (Thurston 1976, Birstein & Vinogradov 1958). *Eusirella multicalceola* was reported as shallowly as 200m, but most commonly between 500-2000m (Birstein & Vinogradov 1958). Other records (Thorsteinson 1941, J. L. Barnard 1964, Bousfield & Hendrycks 1995) indicate a much broader occurrence down to at least 2926m. While some of the larger *Eusirus* seem to spend little time in the water column, others are truly nectobenthic (Andres 1996). Sainte-Marie & Brunel (1985) reported species of *Rhachotropis* only from the uppermost series of their water column samples, further off the bottom than other nectobenthic amphipods.

Several species have been described from waters adjacent to hydrothermal vent sites, but well off the bottom (Bellan-Santini 2006), and without evident association with the vents themselves. Other species initially placed in the Eusiridae and described from vents (Bellan-Santini & Thurston 1996) are now viewed as pontogeneids and placed elsewhere. So, despite the high regional diversity in this superfamily, you won't see many

specimens of these species in benthic monitoring samples collected at shelf depths in the SCB.

Some eusirids, based on gut analysis, are active predators on other amphipods (MacNaughton et al 2007). This report of predatory behavior of *Eusirus holmi* seems similar to *in situ* observations of *Rhachotropis* species in local waters. These rest on sea pens, and leave their perch to hunt actively in the benthic boundary layer, presumably for other swimming crustaceans (Cadien, unpublished). Detailed description of the predatory feeding of *Eusirus perdentatus* are provided by Klages and Gutt (1990). This is a very large animal, and is a sit-and-wait predator as opposed to smaller *Rhachotropis* who make active predatory excursions. Examination showed that copepods, amphipods, polychaetes and a few other invertebrates were present in the guts.

**List of NEP Eusiroidea by family** based on McLaughlin et al. (2005) augmented by known provisionals. *= Taxa on SCAMIT Ed. 9 list (Cadien and Lovell 2014). Valid taxa **bolded**, synonyms not.

Family Bateidae

**Batea catharinensis** Műller 1865 – Western Atlantic, New England to Brazil, NEP Isla Cedros to Bahia Magdalena, Baja California, Mexico: 20-50m

**Batea conductor** (J. L. Barnard 1969) – Bahia de Los Angeles, Gulf of California Mexico: 0m

**Batea coyoa** J. L. Barnard 1969 – Bahia de Los Angeles, Gulf of California, Mexico: 2-30m

***Batea lobata** Shoemaker 1926 – Morro Bay, Central California to Pt. Loma, SCB: 0-9m

**Batea rectangulata** Shoemaker 1925 – Bahia de San Francisquito, Gulf of California, Mexico: 2-40m

**Batea susurrator** J. L. Barnard 1969 – Bahia de Los Angeles to Bahia de La Paz, Gulf of California, Mexico: 9-37m

***Batea transversa** Shoemaker 1926 – SCB to Isla Partida, Gulf of California, Mexico: 0-60m

Carinobatea conductor J. L. Barnard 1969 (see Batea conductor)

Family Eusiridae

Atylus monoculoides Haswell 1879 (see Eusiroides sp A)

**Cleonardo biscayensis** Chevreux 1908 – North Atlantic, North Indian, and NEP Oceans: 3450-4050 (in NEP)

**Cleonardo macrocephala** Birstein and Vinogradov 1955- NWP, NEP off Central California 3450-3500m

**Cleonardo moirae** Bousfield & Hendrycks 1995 – British Columbia to Cascadia Slope, Oregon: 732-1950m

**Eusirella multicalceola** (Thorsteinson 1941) – NWP, NEP from Gulf of Alaska to Cascadia Slope, Oregon: 434-2926m

**Eusirogenes sp CS1** Cadien 2004§ - Cascadia Slope, Oregon: 732m

*Eusiroides monoculoides (Haswell 1879) (see Eusiroides sp A)

[**Eusiroides sp A** SCAMIT 2015§ – SCB to Isla San Martin, Baja California, Mexico: 0-53m] transferred to Pontogeneidae in the Calliopioidea

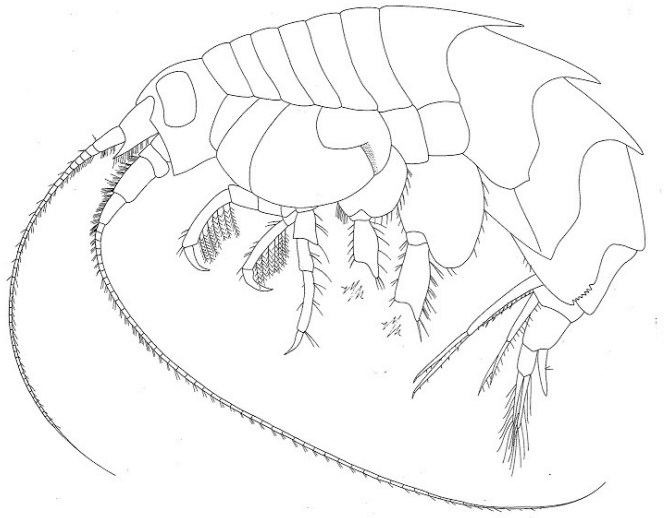
**Eusiropsis riisei** Stebbing 1897 – Tropical Western Atlantic, Northwest Pacific, NEP off Ecuador: 600m in NEP
**Eusirus columbianus** Bousfield & Hendrycks 1995 – SE Alaska to Cascadia Slope, Oregon: 30-732m
**Eusirus cuspidatus** Krøyer 1845 – North Atlantic, Aleutians, Chukchi and Bering Seas, Gulf of Alaska: 40-400m
**Eusirus longipes** Boeck 1861 – Northeast Atlantic to Arctic, Mediterranean, Japan to SCB in the Pacific: 6-591m
**Eusirus sp A** of Dickinson 1976 – San Diego Trough: 1244m
**Eusirus sp 1** of Dickinson 1976 – San Diego Trough: 1200-1235m
Gracilipes distincta Holmes 1908 (see Rhachotropis distincta)
Gracilipes multicalceolus Thorsteinson 1941 (see Eusirella multicalceola)
Gracilipes natator Holmes 1908 (see Rhachotropis natator)
**Rhachotropis americana** Bousfield & Hendrycks 1995 – British Columbia to Cascadia Slope, Oregon: 1150-1372m
***Rhachotropis barnardi** Bousfield & Hendrycks 1995 - British Columbia to SCB: 150-450m
**Rhachotropis boreopacifica** Bousfield & Hendrycks 1995 – British Columbia: 549m
**Rhachotropis calceolata** Bousfield & Hendrycks 1995 – British Columbia to Cascadia Slope, Oregon: 1227-1372m
**Rhachotropis cervus** Barnard 1957 – SCB to Baja California, Mexico: 1000-1335m
***Rhachotropis clemens** Barnard 1967 – Oregon to Baja California, Mexico: 92-1200m
**Rhachotropis conlanae** Bousfield & Hendrycks 1995 – SE Alaska: 29m
***Rhachotropis distincta** (Holmes 1908) – Eastern and Western North Atlantic, North Pacific from Kamchatka to SCB: 305-7000m
Rhachotropis faeroensis of Thomas and McCann 1995 non Stephensen 1944 (identity unknown, but report believed invalid)
**Rhachotropis gubilata** Barnard 1964 – Oregon to Panama: 1609-2816m
**Rhachotropis inflata** (Sars 1883) – Eastern and Western North Atlantic, Kara Sea, NEP from Oregon to SCB: 9-154m
**Rhachotropis ludificor** Barnard 1967 – Cascadia Abyssal Plain to Baja California, Mexico: 1748-2820m
**Rhachotropis luculenta** Barnard 1969 –Bahia de Los Angeles, Gulf of California, Mexico: 38-46mm
**Rhachotropis multisimus** Barnard 1967 – Cascadia Abyssal Plain to Baja California: 748-2803m
**Rhachotropis minuta** Bousfield & Hendrycks 1995 – British Columbia: 60m
**Rhachotropis natator** (Holmes 1908) – British Columbia to SCB: 510-5000m
**Rhachotropis oculata** (Hansen 1888) – Artic, Northeast and Northwest Atlantic, North Pacific from Sea of Okhotsk to SCB: 18-274m
***Rhachotropis sp A** Velarde 1987§ - Southern California Bight: 30-305m
Rhachotropis sp A of Dickinson 1976 – Cascadia Abyssal Plain to San Diego Trough: 1244-2800m

Rhachotropis sp B of Dickinson 1976 – Cascadia Abyssal Plain: 2809-2820m
Rhachotropis sp C of Dickinson 1976 – Cascadia Abyssal Plain: 2820m
**Rhachotropis sp CS1** Cadien 2004§ - Cascadia Slope, Oregon: 1372m
**Rhachotropis sp CS2** Cadien 2004§ - Cascadia Slope, Oregon: 732m
Rhachotropis sp Hyp1 Roney 2001§ (see Rhachotropis sp A Velarde 1987)
Rhachotropis sp OC2 Pasko 2005? (see Rhachotropis barnardi)
**Rhachotropis sp SD1** Velarde 2006§ - San Diego: ?
Rhachotropis sp 1 of Dickinson 1976 – San Diego Trough: 1229-1238m
Rhachotropis sp 2 of Dickinson 1976 – San Diego Trough: 1200m
Rhachotropis sp 3 of Dickinson 1976 – San Diego Trough: 1230-1324m
**Triquetrimana brevipalpa** Hendrycks and Conlan 2003 – off Central California: 3500m
Tritropis oculata Hansen 1888 (see Rhachotropis oculata)

**Comments by Family**

**Family Bateidae** – Bateids are rather aberrant eusiroids in that the first gnathopod is simple. Shoemaker (1926) described both of the locally reported species, considering them along with other Atlantic species present in the USNM collections. Perhaps the most salient feature of the genus *Batea* is that the first gnathopod is not just simple, it is lacking beyond the basis, which terminates in a group of setae. No ischium, merus, carpus, propodus, or dactylus are present in either sex. The first coxa is vestigial, forming the first part of the biarticulate first gnathopod. Only one genus, *Batea*, which now also contains species formerly allocated to the synonymized *Carinobatea*.

**Diagnosis:** "*Coxa 1 vestigial or absent, not seen from lateral view, hidden behind coxa 2, part of coxa 2 hidden by coxa 3; gnathopod 2 composed of 1 article besides coxa 1; accessory flagellum vestigial or absent; plates of maxilliped well developed. Otherwise like Eusiridae*." (from J. L. Barnard and Karaman 1991)



*Batea cuspidata* (from J. L. Barnard & Karaman 1991)

**Batea -** No comprehensive key to the NEP bateids exists, although with a little modification that of Barnard (1969b) will serve.

Key to NEP Bateidae – D. Cadien 29 Jan 2015 (modified from Barnard 1969b)

1. Pleon segments 1 and 2 dorsally cusped.....*B. conductor* (Barnard 1969)
   Pleon lacking dorsal cusps.....2
2. Coxa 2 quadrate.....*B. rectangulata* Shoemaker 1925
   Coxa 2 subtriangular.....3
3. Palm of G2 oblique.....4
   Palm of G2 nearly transverse.....*B. transversa* Shoemaker 1926
4. Teeth of epimeron 3 well developed.....5
   Teeth of epimeron 3 obsolescent, formed of flattened lobes separated by embedded setae.....*B. lobata* Shoemaker 1926

5. Rostrum tapering unevenly.....*B. catharinensis* Shoemaker 1926
   Rostrum tapering evenly.....6
6. Posteroventral margin of P7 basis with slit; dorsal and ventral margins of G2 palm not parallel, diverging at 10 degrees or more.....*B. susurrator* Barnard 1969
   Posteroventral margin of P7 basis lacking slit; dorsal and ventral margins of G2 palm subparallel.....*B. coyoa* Barnard 1969

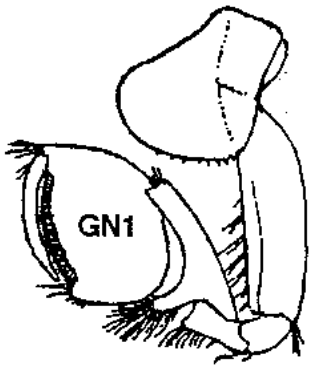
Of these species only *B. transversa* and *B. lobata* are known from Californian waters, the remaining species are Cortezian or Panamic. *B. susurrator* seems to be an Eastern Pacific cognate to *B. catharinensis* of the Western Atlantic (which also occurs in the Pacific on the outer coast of Baja California fide Garcia Madrigal 2007). Barnard (1979) treats *B. coyoa* as a subspecies of *B. transversa*, as he did in 1969. Barnard and Karaman 1991 treat it as a full species. *B. conductor* was originally described as a *Carinobatea*, but that genus was synonymized in Barnard and Karamana (1991) with the type genus. All bateids are shallow water algal associates, and are not often taken in monitoring surveys.

Diagnosis: "*Body segments dorsally smooth; antenna 1 article 1 without process; lower lip with inner lobes; maxilliped outer plates not quite reaching apex of second article of palp*." (from Ortiz 1991)

**Family Eusiridae** – The family contains 10 genera as currently construed. Eight of these occur in the NEP, and the remaining two are known from the NWP, and may eventually prove to have distributions including the NEP (Bousfield & Hendrycks 1995).

The eusirids, as opposed to the eusiroids, were recently monographed in the NEP by Bousfield & Hendrycks 1995. A substantial number of species are reported from the NEP between the pole and the equator. Some of these are nectobenthic and are usually found either in baited traps, or in water column samplings. Drawing the boundary between benthos and nectobenthos is both difficult, and probably inappropriate. We are nearly as likely to catch one of these forms swimming in the water over the bottom with our grab as we are to find it sediment associated.

Separation of genera within the Eusiridae s. s. should be possible (if not easy) using the key in Bousfield and Hendrycks (1995). The first couplet introduces a concept you are probably not familiar with. eusiroidean gnathopods. The authors give a short description of them in the first couplet, but to understand what is meant it is easier to look at an illustration.




Eusiroid first gnathopod of *Eusirus cuspidatus* (From Bousfield & Hendrycks 1995)

This is the eusiroidean gnathopod *par excellence*. You will find variations of this in other eusiroids, but it is not a character shared by all genera in the family let alone the entire superfamily. When you do see it, it is a key identifying character of the family. Anything with this sort of gnathopod configuration, with slender cup shaped carpus attached to the propod anteriorly rather than at its base, is definitely a eusirid. *Rhachotropis* lacks this character, as reflected in the key.

Key to NEP genera in the Family Eusiridae (modified from Bousfield & Hendrycks 1995) – D. Cadien 11 April 2006 (revised 15 January 2015)

1. Gnathopods eusiroid.....2
   Gnathopods non-eusiroid.....4
2. Propod of G1 larger than propod of G2.....*Eusirogenes*
   Propod of G1 and G2 subequal, or G1 smaller.....3
3. Coxal plates 1-4 deep, accessory flagellum of 1 elongate article.....*Eusirus*
   Coxal plates 1-4 shallow, accessory flagellum scale-like.....*Eusiropsis*
4. Pleon bearing dorsal teeth and/or carinae, or posterior cusps.....*Rhachotropis*
   Pleon lacking dorsal teeth, carinae, and posterior cusps.....5
5. G1 palm ½ the size of G2 palm.....*Cleonardo*
   G1 palm subequal to G2 palm.....7
6. G1 propod elongate, equal to or longer than carpus.....*Eusirella*
   G1 propod triangular, much shorter than carpus.....*Triquetrimana*

Diagnosis: "***Head*** *free, not coalesced with peraeonite 1; exposed; as long as deep, or longer than deep, or deeper than long; anteroventral margin weakly recessed or moderately recessed or concave or rounded or notched or straight or oblique, anteroventral margin shallowly excavate, anteroventral corner rounded or subquadrate or hooked; rostrum present or absent, short or moderate or long; eyes present, well developed or obsolescent, or absent; coalesced, or not coalesced; 1 pair; bulging, or not*

*bulging.* ***Body laterally compressed, or dorsoventrally flattened****; cuticle smooth, or processiferous.*

*Antenna 1 shorter than antenna 2, or subequal to antenna 2, or longer than antenna 2; peduncle with sparse robust and slender setae; 3-articulate; peduncular article 1 shorter than article 2, or subequal to article 2, or longer than article 2; antenna 1 article 2 longer than article 3; peduncular articles 1-2 not geniculate; accessory flagellum present, or absent; antenna 1 callynophore present, or absent. Antenna 2 present; short, or medium length, or long, or greater than body length; articles not folded in zigzag fashion; without hook-like process; flagellum shorter than peduncle, or as long as peduncle, or longer than peduncle; less than 5-articulate, or 5 or more articulate; not clavate; calceoli present, or absent.*

*Mouthparts well developed.* ***Mandible incisor dentate****; lacinia mobilis present on both sides; accessory setal row without distal tuft;* ***molar present****, medium, triturative; palp present.* ***Maxilla 1*** *present; inner plate present, strongly setose along medial margin or weakly setose apically;* ***palp*** *present, not clavate,* ***2 -articulate****. Maxilla 2 inner plate present; outer plate present.* ***Maxilliped*** *inner and outer plates well developed or reduced, palps present, well developed or reduced;* ***inner plates*** *well developed, separate;* ***outer plates*** *present,* ***small****; palp 4-articulate, article 3 without rugosities. Labium smooth.*

***Peraeon****. Peraeonites 1-7 separate; complete; sternal gills absent; pleurae absent.*

*Coxae 1-7 well developed, none fused with peraeonites.* ***Coxae 1-4*** *longer than broad or as long as broad, overlapping,* ***coxa 1 anteroventrally acuminate or coxae not acuminate****. Coxae 1-3 not successively smaller, none vestigial or coxa 1 reduced. Coxae 2-4 none immensely broadened.*

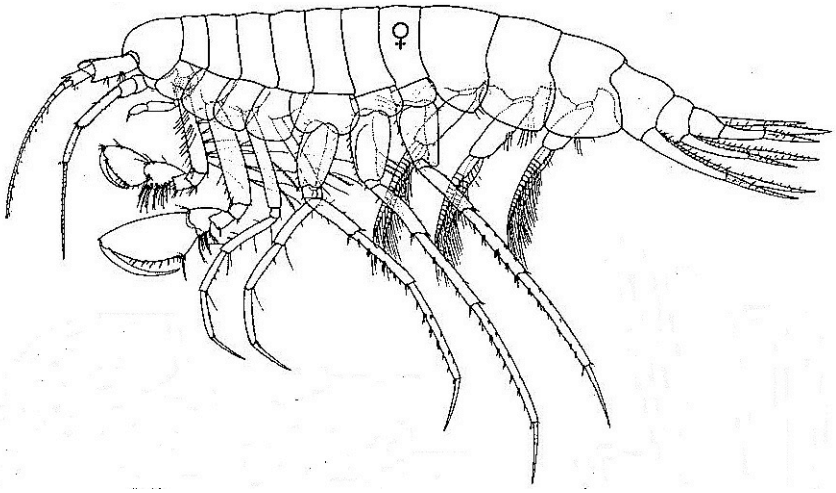
***Gnathopod 1*** *not sexually dimorphic; smaller (or weaker) than gnathopod 2, or subequal to gnathopod 2;* ***smaller than coxa 2, or subequal to coxa 2****; gnathopod 1 merus and carpus not rotated; gnathopod 1 carpus/propodus cantilevered on narrow hinge, or carpus/propodus not cantilevered; shorter than propodus, or subequal to propodus, or longer than propodus; gnathopod 1 slightly produced along posterior margin of propodus, or not produced along posterior margin of propodus; dactylus large. Gnathopod 2 sexually dimorphic, or not sexually dimorphic; simple, or subchelate; coxa subequal to but not hidden by coxa 3; ischium short; merus not fused along posterior margin of carpus or produced away from it; carpus/propodus cantilevered on narrow hinge or carpus/propodus not cantilevered, carpus short or elongate, shorter than propodus or subequal to propodus or longer than propodus, strongly produced along posterior margin of propodus or slightly produced along posterior margin of propodus or not produced along posterior margin of propodus.*

*Peraeopods heteropodous (3-4 directed posteriorly, 5-7 directed anteriorly), none prehensile. Peraeopod 3 well developed. Peraeopod 4 well developed. 3-4 not glandular; 3-7 without hooded dactyli, 3-7 propodi without distal spurs. Coxa well developed, longer than broad or as long as broad or broader than long; carpus shorter than propodus or subequal to propodus, not produced; dactylus well developed. Coxa subequal to coxa 3 or larger than coxa 3, not acuminate, with well developed posteroventral lobe or without posteroventral lobe; carpus not produced. Peraeopods 5-7 with few robust or slender setae; dactyli without slender or robust setae.* ***Peraeopod 5***

*well developed; shorter than peraeopod 6, or subequal in length to peraeopod 6;* ***coxa*** *smaller than coxa 4 or subequal to coxa 4, equilobate or with ventrally produced posterior lobe or with posterodorsal lobe or without posterior lobe;* ***basis expanded or slightly expanded****, subrectangular or subovate, with posteroventral lobe or without posteroventral lobe;* ***merus/carpus*** *free;* ***carpus*** *weakly expanded, or linear;* ***setae absent****. Peraeopod 6 shorter than peraeopod 7, or subequal in length to peraeopod 7; merus/carpus free; dactylus without setae.* ***Peraeopod 7*** *with 6-7 well developed articles; subequal to peraeopod 5, or longer than peraeopod 5;* ***similar in structure to peraeopod 6****; with 7 articles; basis expanded or slightly expanded, without dense slender setae; dactylus without setae.*

***Pleon****. Pleonites 1-3 without transverse dorsal serrations, without dorsal carina; without slender or robust dorsal setae. Epimera 1-3 present. Epimeron 1 well developed. Epimeron 2 setose, or without setae.*

***Uros****ome dorsoventrally flattened, or not dorsoventrally flattened;* ***urosomites 1 to 3 free****; urosomite 1 longer than urosomite 2, or much longer than urosomite 2; urosome urosomite 1 carinate, or urosomites not carinate; urosomites 1-2 without transverse dorsal serrations. Uropods 1-2 apices of rami with robust setae, or without robust setae. Uropods 1-3 similar in structure and size. Uropod 1 peduncle without long plumose setae, without basofacial robust seta, without ventromedial spur. Uropod 2 well developed; without ventromedial spur, without dorsal flange; inner ramus subequal to outer ramus, or longer than outer ramus.* ***Uropod 3*** *not sexually dimorphic;* ***peduncle*** *short or elongate;* ***outer ramus*** *shorter than peduncle or longer than peduncle,* ***1-articulate****, without recurved spines.* ***Telson laminar****; deeply cleft, or moderately cleft, or weakly cleft, or notched, or emarginate, or entire; longer than broad, or as long as broad; apical robust setae present, or absent*." (from Lowry and Springthorpe 2001).

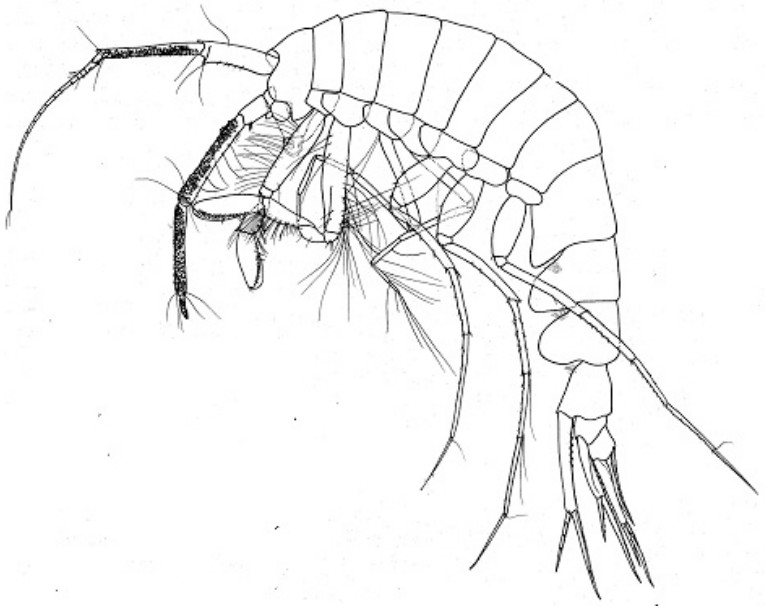



*Cleonardo moirae* (from Bousfield & Hendrycks 1995)

**Cleonardo –** A moderately sized genus of eleven species, of which three are recorded from the NEP; *C. biscaynensis*, *C. macrocephala*, and *C. moirae*. All these are deep-water species, and bathypelagic. As such they are unlikely to ever be taken during monitoring of benthic communities. Despite the unlikelihood of their benthic presence, specimens of *C. moirae* were taken with epibenthic sleds on the Cascadia Slope off

Oregon. Both of the remaining species were taken in sediment trap samples collected near Station M, in around 3500m of water off Central California (Hendrycks & Conlan 2003); new records for the NEP, with *C. biscaynensis* known previously only in the Atlantic and Indian Oceans, and *C. macrocephala* only from the Northwest Pacific and Antarctic. These disjunct distributions suggest that knowledge of these bathypelagic species remains scant, and future collections may help connect the dots.

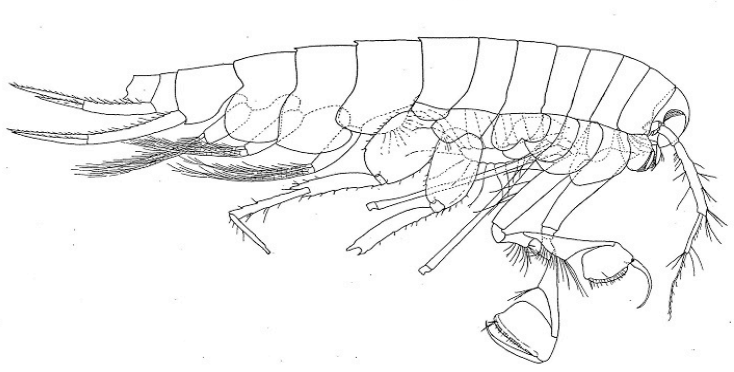
**Diagnosis**: "*Body ordinary, compressed, smooth. Rostrum small or large, lateral cephalic lobes ordinary or sinusoid, anteroventral margin of head not produced. Eyes absent. Antennae subequal or 1 longer than 2, calceoli present, peduncular article 1 as long as head, article 2 as long as or longer than article 1; article 3 not produced; article 1 of primary flagellum in male twice or more as long as article 3 of peduncle; strongly armed with aesthetascs;' accessory flagellum 1articulate, elongate. Labrum entire, subrounded, broader than long; epistome ·unproduced. Molar triturative, columnar, article 2 of mandibular palp unlobed, article 3 longer or shorter than 2. Labium: inner lobes small, forcing gape between outer ,lobes. Maxilla 1: inner plate with 2 apical setae, palp long, article 1 scarcely shorter than 2. Maxilla 2: inner plate much to slightly broader but not longer than outer, outer plate narrow, inner plate without 'facial 'row of setae but with other medial setae. Maxilliped: inner plate not relatively long, outer. plate longer than inner; palp of 4 articles, 4 slightly shorter than 3, 3 unlobed, 4 spinose or setulose along inferior margin. Coxae ordinary, coxa 1 not strongly produced anteriorly nor expanded ventrally, coxa 4 with posterior lobe, excavate. Gnathopods alike, large, subchelate, not or scarcely eusirid, carpus of both much shorter than propodus, with strong posterior lobe extending distad, with numerous long posterior setae, propodus large, expanded, ovate, palms very oblique. Pereopods 3-7 elongate, simple, dactyls simple, but often setose, article 2 not anteriorly lobate. Epimeron 3 smooth. Outer rami of uropods 1-3 shortened; rami with lateral and dorsal spines. Uropod 3 ordinary, not extended beyond uropod 1, peduncle without large process, rami lanceolate. Telson elongate, cleft, apices without long armaments."* (from J. L. Barnard and Karaman 1991)



*Eusirella multicalceola* (from J. L. Barnard 1964b)

**Eusirella** – A small genus of five species, with only *E. multicalceola* known from the NEP. Members are normally taken in the water column rather than on the bottom, which probably reflects the of time spent in each habitat. A single specimen of this taxon was collected at 732m on the Cascadia Slope with an epibenthic sled. The design of this device requires that the animal be within a meter of the bottom to be captured. Most representatives of the species have been captured mid-water well away from sediments.

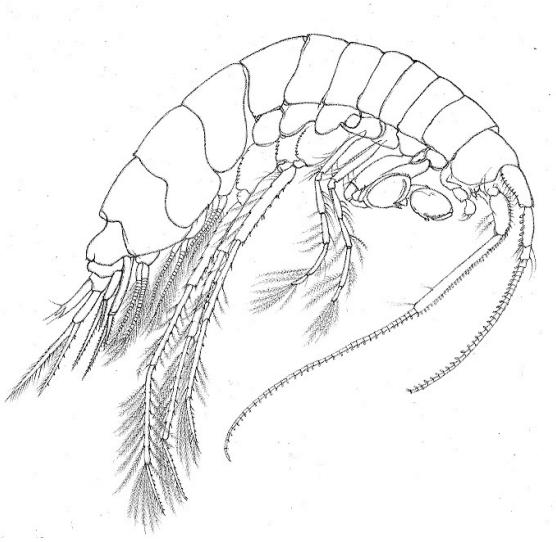
**Diagnosis**: "*Body slender, compressed, smooth. Rostrum small, lateral cephalic lobes ordinary; anteroventral margin of head not produced. Eyes absent. Antenna 1 longer than 2, peduncular article 1 as long as head, article 2 longer than article 1; article 3 very short, not produced; article 1 of primary flagellum ordinary to longer than article 3 of peduncle; accessory flagellum I-articulate, scale-like, or absent. Labrum entire, subrounded, [?broader than long]; epistome unproduced. Molar poorly triturative or simple, terete to conical, article 2 of mandibular palp unlobed, article 3 shorter than 2, linear, poorly setose. Labium: inner lobes present. Maxilla 1: inner plate without setae, palp short, article 1 longer than 2. Maxilla 2: inner plate weakly broader but not longer than outer, inner plate without facial row of setae and no other medial setae. Maxilliped: inner plate not relatively long, outer plate longer than inner; palp of 4 articles, 4 slightly shorter than 3, 3 unlobed, 4 not spinose along inferior margin. Coxae very short, coxa 1 strongly produced anteriorly or expanded ventrally, coxa 4 without posterior lobe, not excavate. Gnathopods diverse, large, 2 larger than 1, subchelate, not eusirid, carpus of both usually much shorter than propodus, with weak or no posterior lobe not extending distad, carpus with numerous long posterior setae, propodus ovate, elongate, palms very long and oblique, occupying most of posterior margin. Pereopods 3-7 elongate, simple, dactyls simple, they and propodi with long plumose setae, article 2 not anteriorly lobate. Epimeron 3 smooth. Outer rami of uropods 1-3 shortened; rami with lateral and dorsal spines. Uropod 3 ordinary, not extended beyond uropod 1, peduncle elongate but without large process, rami lanceolate. Telson elongate, cleft or incised, apices without long armaments.* " (from J. L. Barnard and Karaman 1991)



*Eusirogenes longifrons*, urosome lacking in part (from Shoemaker 1930)

**Eusirogenes** – A broadly distributed genus of six described species. The only record for the NEP is of a provisional species taken at upper slope depths off Oregon. As suggested by Bousfield & Hendrycks (1995) this is likely to prove an analogue of *E. homocarpus* from the Northwest Pacific. Only a single specimen has so far been collected, at 732m. The genus can be separated from others in the region by the above key to genera.

**Diagnosis: "***Body ordinary, compressed, weakly carinate. Rostrum small or large (type), lateral, cephalic lobes sinusoid; anteroventral margin of head not produced. Eyes absent. Antennae [?subequal] or 1 longer than 2, peduncular articles progressively shorter, article 1 as long as head, article 2 almost as long as article 1; article 3 not produced; article 1 of primary flagellum twice as long as article 3 of peduncle; accessory flagellum I-articulate, elongate. Labrum emarginate, broader than long; epistome unproduced. Molar triturative, columnar, article 2 of mandibular palp unlobed, article 3 shorter than 2. Labium: inner lobes [unknown in type] small, occasionally forcing gape between outer lobes. Maxilla 1: inner plate with 0-1 apical seta, palp long, article 1 short. Maxilla 2: inner plate much broader but not longer than outer, outer plate narrow, inner plate without facial row of setae and few other medial setae. Maxilliped: inner plate not relatively long, outer plate slightly longer than inner; palp of 4 articles, 4 as long as· 3, 3 unlobed, 4 not spinose along inferior margin. Coxae ordinary, coxa 1 not produced anteriorly nor expanded ventrally, coxa 4 with weak posterior lobe, scarcely excavate. Gnathopods diverse, large, 1 larger than 2, subchelate, both eusirid, carpus of both, much longer than propodus, with weak posterior lobe not extending distad, first without, second with numerous long posterior. setae, carpus of first, occasionally second, gnathopod very slender or linear, otherwise of second not strongly lobed, but broadly so; propodus stout, short, trapezoidal. Pereopods 3-7 elongate, simple, [unknown in type], dactyls simple, article 2 not anteriorly lobate. Epimeron 3 smooth or serrate. Outer rami of uropods 1-3 shortened; rami with lateral and dorsal spines. Uropod 3 [unknown in type] ordinary, but peduncle elongate, not extended beyond uropod 1, peduncle without large process,· rami lanceolate. Telson [unknown in type] elongate, weakly cleft or incised, triangular, without long apical armaments*." (from J. L. Barnard and Karaman 1991)

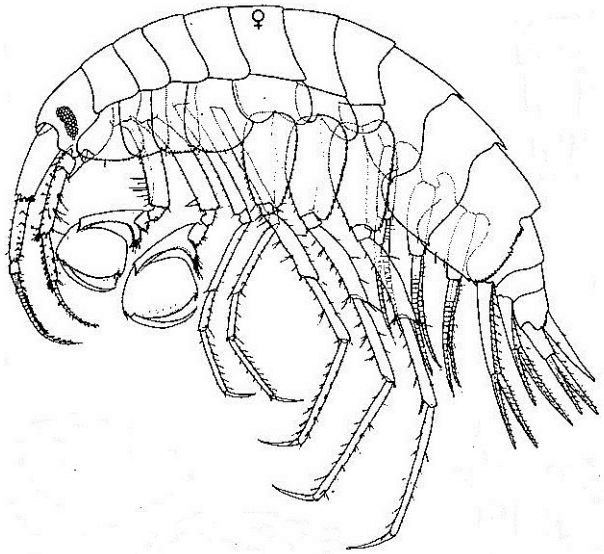


*Eusiropsis riisei* (from Stebbing 1897)

**Eusiropsis** – A small genus with one widely distributed species and a second known only from off Japan. *Eusiropsis riisei* is reported from the NEP only by Garcia Madrigal (2007) from waters off Pacific Ecuador just above the equator.

**Diagnosis:** *"Body ordinary, compressed, smooth. Rostrum small, lateral cephalic lobes ordinary, anteroventral l margin of head not produced. Eyes absent. Antennae*

*subequal, calceolate, peduncular article' 1 as long as head, article 2 as long as article .1; article 3 .not produced; article 1 of primary flagellum short, accessory flagellum I-articulate, scale-like. Labrum entire, subrounded, broader than long; epistome unproduced. Molar simple, .boss-like, article 2 of mandibular palp unlobed, article .3 longer than 2. Labium: inner lobes present. Maxilla 1: inner plate naked, palp long, article 1 almost as long as 2. Maxilla 2: inner plate broader but not longer than outer, without facial row of setae and few other medial setae. Maxilliped: inner plates very short and mostly fused together, outer plate much longer than inner; palp of 4 articles, 4 slightly longer than 3, 3 unlobed, 4 not spinose along inferior ,margin. Coxae very short and progressively longer toward coxa 7; coxa 1 not produced. anteriorly nor expanded ventrally, coxa 4 hot twice as long as 1, with posterior lobe, excavate; coxa 1-3 posteroventral points. Gnathopods alike, medium, subchelate, both eusirid, carpus of both cryptic, much shorter than propodus, without posterior lobe, carpus without numerous long posterior setae, propodus very broad. Pereopods 3-7 elongate, simple, dactyls simple, but multisetulate or setose on inferior margins,' article 2 not anteriorly lobate. Epimeron 3 smooth. Outer rami of uropods 1-3 shortened; rami with lateral and dorsal spines. Uropod 3 huge, well extended beyond uropod 1, peduncle without large process, rami lanceolate. Telson elongate, weakly cleft, linguiform, lobes notched, with long apical armaments."* (from J. L. Barnard and Karaman 1991)

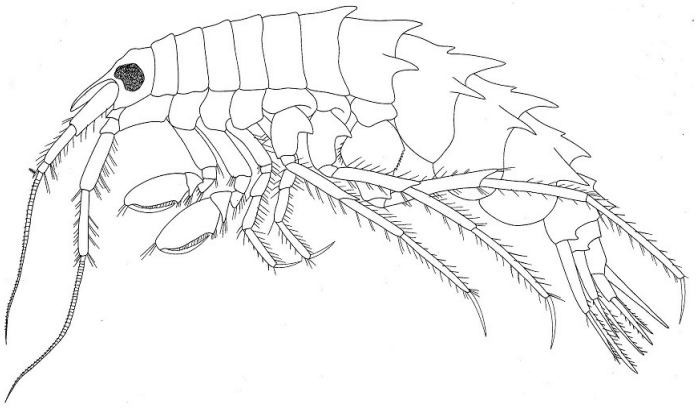



*Eusirus columbianus* (from Bousfield & Hendrycks 1995)

**Eusirus** – A good sized genus of 27 described species. It is represented in the NEP by several species, only one of which is reported from the SCB. Bousfield & Hendrycks (1995) provide a key to the genus in the North Pacific, but do not include *E. longipes*, which they believe does not occur here. They do, however, reproduce Sars figure of *E. longipes*, which can be referred to in identification of *Eusirus* specimens from the SCB. Differentiation of *E. hirayamae* Bousfield and Hendrycks 1995 from *E. longipes* seems weak.

**Diagnosis**: "*Body ordinary, compressed, often weakly carinate or toothed. Rostrum small to large, lateral cephalic lobes ordinary, anteroventral margin of head not produced. Eyes reniform or absent. Antennae subequal or 1 longer than 2 (type),*

*peduncular article 1 as long as head, articles progressively shorter, or article 2 as long as article 1 (type), often longer, article 3 short, not produced; article 1 of primary flagellum ordinary, or often more than twice .as long as article 3 of peduncle; accessory flagellum I-articulate, elongate. Labrum entire, subrounded, broader than long; epistome unproduced. Molar triturative, columnar, article 2 of mandibular palp unlobed, article 3 shorter, as long as or longer than 2. Labium: inner lobes small. Maxilla 1: inner plate with 12 apical setae, palp long, article 1 not longer than 2. Maxilla 2: inner plate broad, broader but not longer than outer, inner plate broad, often with strong medial setae. Maxilliped: inner plates not long, outer plate longer than inner; palp of 4 articles, 4 slightly shorter than 3, 3 unlobed, 4 not spinose along inferior margin. Coxae ordinary to short, coxa 1 not produced anteriorly but expanded ventrally, coxa 4 with posterior lobe and excavate or very poorly so. Gnathopods alike, subchelate, both eusirid. Pereopods 3-7 elongate, simple, dactyls simple, article 2 not anteriorly lobate. Epimeron 3 smooth or serrate (type). Outer rami of uropods 1-2 shortened; rami with lateral and dorsal spines. Uropod 3 ordinary, not extended beyond uropod 1, peduncle without large process, rami lanceolate. Telson elongate .or short, variable, cleft, incised or emarginate, apices without long armaments.*" (from J. L. Barnard and Karaman 1991)



*Rhachotropis aculeata* (from J. L. Barnard & Karaman 1991)

**Rhachotropis** – Far more diverse than any other genus in the family, *Rhachotropis* currently has 60 described species worldwide (Lörz et al 2012), with 16 of these occurring in the NEP.

The animals are vigorous swimmers, and feed raptorially. During a vertical distribution study in sediments off Palos Verdes, where samples were subdivided into narrow vertical bands, we found several of these deep in the sediment. This puzzling result was clarified when we recognized that such deep occurrences were always associated with a large seapen in the core. It became evident that the *Rhachotropis* were perching on the seapens, using them as hunting outposts, and were dragged along when the pens retracted into the sediments during sampling.

**Diagnosis**: "*Body ordinary to slender, compressed or depressed, carinate or toothed. Rostrum small to large, lateral cephalic lobes ordinary; anteroventral margin of head not produced. Eyes round, reniform, or absent. Antennae subequal, article 1 of antenna 1 as long as or longer than head, article 2 usually as long as article 1; article 3 shorter, not produced; article 1 of primary flagellum in female short, often twice as long as article 3 of peduncle in male; accessory flagellum 1 to 2-articulate but short. Labrum*

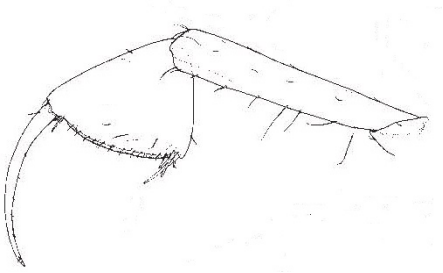
*entire, subrounded, broader than long; epistome unproduced. Molar triturative, columnar, article 2 of mandibular palp unlobed, article 3 as long as or longer than 2. Labium: inner lobes short. Maxilla 1: inner plate with 1-4 medial setae, palp long, article 1 short. Maxilla 2: inner plate broader but not longer than outer, outer plate narrow, inner plate without facial row of setae and few other medial setae. Maxilliped: inner plate not relatively long, outer plate slightly or greatly longer than inner; palp of 4 articles, 4 shorter than 3, 3 unlobed, 4 not spinose along inferior margin. Coxae very short, coxa 1 strongly produced anteriorly or expanded ventrally, coxa 4 without or with weak posterior lobe, excavate or not. Gnathopods alike, large, subchelate, weakly eusirid, carpus of both much shorter than large ovate propodus, with strong posterior lobe extending distad, numerous posterior setae, spines on palms of gnathopods thin or inconspicuous. Pereopods 3-7 elongate, simple, dactyls simple, article 2 not anteriorly lobate. Epimeron 3 serrate, or rarely smooth. Outer rami of uropods 1-2 shortened or not; rami with lateral and dorsal spines. Uropod 3 ordinary, not extended beyond uropod 1, peduncle without large process, rami lanceolate. Telson elongate, cleft, .incised, emarginate, or entire, triangular or linguiform, without long apical armaments*." (from J. L. Barnard and Karaman 1991)

Bousfield & Hendrycks (1995) present a key to the described members of the genus in the NEP. Lörz (2010) provides a more recent key that includes these species as well as others. Ten provisional species of *Rhachotropis* have been proposed for the region, six of which are undocumented. These were erected by Dickinson (1976) in his thesis and were divided between the San Diego Trough in the SCB, and the Cascadia Abyssal Plain off Oregon. While information on their occurrence and distribution, and even their ecology in some cases, was offered, these species remain undefined, and without available vouchers for examination and description by others. They are included as an indication of the level of diversity in the genus regionally, although it is likely that one or more are the same as the documented provisionals proposed by others. Such may be the case with the *Rhachotropis* sp 28 from off Southern California reported by Lörz et al (2012).

Key to the NEP *Rhachotropis* (modified from Bousfield & Hendrycks 1995) with Arctic and NWP species excluded – D. Cadien 15 April 2006 (revised 20 Jan 2015)

1. Pigmented eyes present.....2
   Pigmented eyes lacking.....10
2. Telson long, distally notched.....3
   Telson long to medium, cleft 40% or more.....4
3. Pleonite 3 dorsally with 3 ridges, but lacking teeth; urosomite 1 with a large dorsal tooth.....***barnardi*** Bousfield & Hendrycks 1995
   Pleonite 3 dorsally with 3 ridges terminating in teeth; urosomite 1 with 3 ridges, the central one bearing a tooth.....***boreopacifica*** Bousfield & Hendryckx 1995
4. Pereonite 7 with posteriodorsal cusp or tooth.....5
   Pereonite 7 lacking posteriodorsal cusp or tooth.....7

5. Pleonite 3 bearing both teeth and ridges dorsally.....6
   Pleonite 3 ridged but lacking teeth.....***minuta*** Bousfield & Hendrycks 1995
6. Pereonite 7 bearing a small cusp on posterior margin.....**sp A** Velarde 1987§
   Pereonite 7 bearing a large tooth on posterior margin.....***oculata*** Hansen 1888
7. Pleonite 3 dorsally unornamented, lacking cusps, ridges or teeth.....8
   Pleonite 3 bearing cusps, ridges, or teeth.....9
8. Pleonite 1 with a single dorsal tooth; pleonite 2 with a dorsal tooth flanked by cusps.....***conlanae*** Bousfield & Hendrycks 1995
   Pleonite 1 with a dorsal tooth flanked by cusps; pleonite 2 with a single dorsal tooth.....***luculenta*** Barnard 1969
9. Pleonite 3 with a central ridge flanked by toothed ridges.....***inflata*** Sars 1882
   Pleonite 3 lacking teeth, but with 3 ridges, the 2 lateral ones serrate .....sp **SD1** Velarde 2006§
10. Pleonites 1 & 2 with a lateral tooth.....***gubilata*** Barnard 1964
    Pleonites 1 & 2 lacking lateral teeth.....11
    Pleonite 1 lacking dorsal or lateral teeth, Pleonite 2 with dorsomedian spine, but no lateral teeth.....sp CS1 Cadien 2004§
11. Telson long, distally notched.....12
    Telson medium to long, cleft 25% or more.....14
12. Urosomite 1 lacking dorsal tooth.....***natator*** (Holmes 1908)
    Urosomite 1 with dorsal tooth.....13
13. Pleonite 3 with 3 dorsal ridges; urosomite 1 tooth large.....***clemens*** Barnard 1967
    Pleonite 3 with dorsal tooth, but no ridges; urosomite 1 with a small tooth .....***distincta*** (Holmes 1908)
14. Pleonite 1 with dorsal ridges..... .....15
    Pleonite 1 lacking dorsal ridges.....17
15. Urosomite 1 with dorsal ridges; with or without teeth; coxa 1 with ventral notch or notches.....16
    Urosomite 1 toothed but lacking ridges dorsally; coxa 1 ventral margin entire, lacking notches.....***cervus*** Barnard 1955
16. Urosomite 1 dorsally ridged, but without tooth; coxa 1 with posteroventral notch.....***americana*** Bousfield & Hendrycks 1995
    Urosomite 1 with 3 dorsal ridges, the central one toothed; coxa 1 with both antero- and posteroventral notches.....**sp CS2** Cadien 2004§
17. Pleonite 1 with 3 small teeth; telson cleft 50%.....***multesimis*** Barnard 1967
    Pleonite 1 with a large tooth; telson cleft 30-35%.....17
18. Pleonite 2 with 3 dorsal teeth, the middle largest; pleonite 3 with 3 ridges, but no teeth.....***calceolata*** Bousfield & Hendrycks 1995
    Pleonite 2 with one small tooth; pleonite 3 with a posterior cusp, but lacking ridges.....***ludificor*** Barnard 1967



G1 of *Triquetrimana brevipalpa* (from Hendrycks & Conlan 2003)

**Triquetrimana** – Following the pattern of unique genera within this family, the genus is based on a single female specimen collected in a sediment trap at 3500m off Central California. The unique straight carpi and the triangular propods easily distinguish this animal from all other eusiroids in the world (Hendrycks & Conlan 2003).

**Diagnosis: "***Eye absent; rostrum short, rounded; antenna 1 slightly shorter than antenna 2, accessory flagellum one-articulate; mandibular palp feeble, shorter than mandible body, article 3 length 0.5×article 2; maxilla 2, inner plate wide, almost twice the width of outer plate; maxilliped palp, medial margin of dactylus spinose; coxa 1, not produced anteriorly; coxa 3 larger than 4, with a bluntly rounded, posteroventral lobe, posterior margin excavate; gnathopods 1–2, propodus triangular, equal in size, carpus elongated and non-lobate; peraeopods 5–6, basis expanded, rounded, subequal, merus expanded proximally; uropods spinose, rami broadened; telson elongate, cleft deeply."* (from Hendrycks and Conlan 2003

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