

Introduction

The Order Cumacea is a relatively small one, much smaller than either the Order Amphipoda, or the Order Isopoda. Even so, over 1032 described species were listed in the order up to 1992 (Băcescu 1988, 1992), and this number has continued to swell. Indications are that most areas of the globe contain many undescribed species. If we use a multiplier based on the percentage of undescribed taxa known from the NEP, the world cumacean fauna would be expected to reach well above 1800 eventually. It's members are relatively uniform in size and external form, all looking like small balls or tubes on a stick. This structure results from the presence of a more or less globose carapace (which can become considerably flattened) combined with a tapering thoracic region, and a long narrow abdomen terminating in the two uropods. The flavor of the group is well presented by Stebbing (1893), which while rich in detail, is very readable. Cumaceans are relatively important members of the benthic community, being the second most abundant group of crustaceans retained on a 1mm screen (Barnard and Given 1961).

Definition

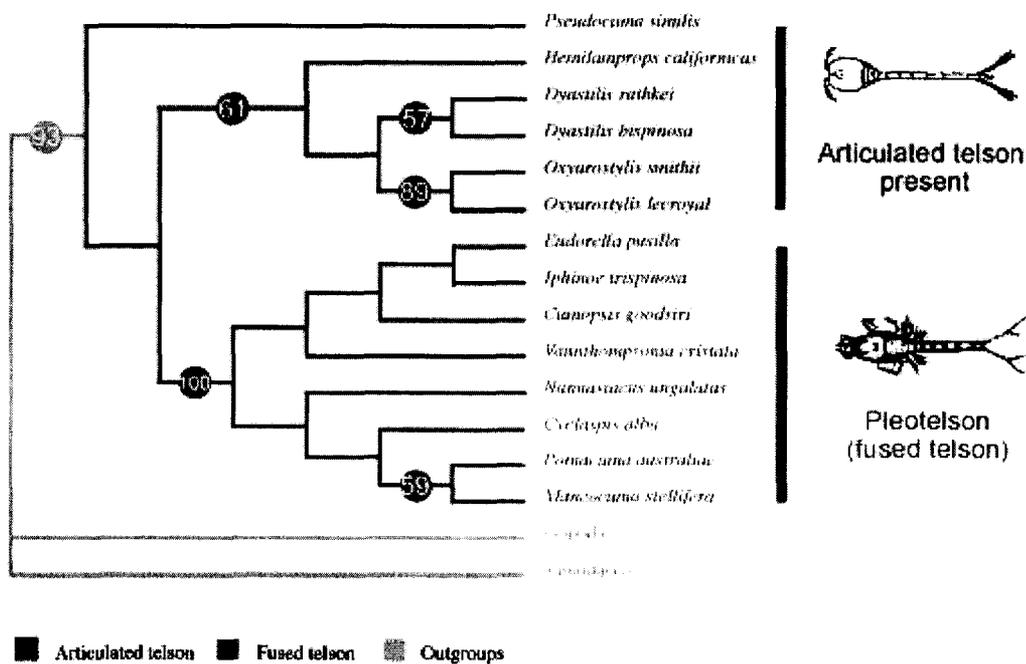
The definition of the order from Schram (1986) is: "Carapace short, fused to at least first three thoracomeres, can fuse with up to six, laterally enclosing a branchial cavity, with lateral lappets that extend anteriorly and medially to form a pseudorostrum; eyes generally fused, located on an anterior occasionally bell-shaped lobe; mandibles without palps; anterior three thoracopods as maxillipedes, the first with elaborately lobed branchial epipod and exopod extending forward under pseudorostrum as siphon, the second with fused coxae from which arise elongate endopods; posterior thoracopods often biramous; pleopods generally absent on females and sometimes reduced or absent on males; telson may be either free or fused with the sixth pleomere."

Relation to other Arthropods

Relationships with other groups are not settled, as is the case with all higher level arthropod systematics. Discussion of these issues are virtually endless, but useful reviews and analyses are provided by Schram (1986), Watling (1981, 1983), Wheeler et al (2004), and Schram and Koeneman (2004). It is likely that the closest relationship with extant groups is with the Tanaidacea. Bousfield (1995) presents an explicit classification which includes the extinct early forms (interpretation of which has severely complicated arthropod phylogeny), placing the Cumacea, along with the Tanaidacea, the Mictacea, and the Speleogriphacea in the superorder Hemicaridea.

Cumacean Phylogeny

The molecular phylogeny of the order has been preliminarily explored using CO1 gene sequences. The results largely conform to the morphology based expectations. The analysis placed the Pseudocumatidae as the sister group to all other cumaceans, with the remaining families split into two primary clades. The first, with articulated telsons, contains the Lampropidae and Diastylidae, the second, with the telson fused to the last abdominal somite, contains the Leuconidae, the Bodotriidae, and the Nannastacidae.



Families with no members sampled for this analysis are presumed to follow the trend shown by the sampled taxa, with the Gynodiastylidae joining the first clade, and the Ceratocumatidae joining the second. The taxon sampling of the analysis was limited, and the results are probably subject to refinement. Bodotriids were much more heavily sampled than other families, and showed evidence of polyphyly. The three subfamilies of the Bodotriidae were divided between the two major subclades of clade 2, with the Vaunthompsoniinae joined with the Leuconidae, and the Mancocumatinae joined with the Nannastacidae. The bodotriid subfamily Bodotriinae had representatives split between the two subclades. This initial analysis needs to be repeated, with either a broader sampling of taxa (also more evenly distributed among families), and/or use of information from other molecules.

History of Investigation

Information on this group is very scattered. The older literature has been analyzed (Băcescu 1973), but since then no similar compilation is available. A useful resource is provided by Băcescu in the Cumacea sections of the Crustaceorum Catalogus (1988, 1992) which covers all taxa described to that point. Investigations of cumacean taxonomy and ecology have, at best, been infrequent in North America. S. I. Smith worked on the eastern seaboard on cumaceans late in the 19th century. No other work was done by researchers here until 1912, when Calman evaluated the holdings of the U.S. National Museum. Additional work was done by Zimmer, another European, somewhat later (1936, 1943). Not until the 1930's did an indigenous researcher appear, Josephine Hart in Canada. Her early papers described a number of forms. Western North Pacific and Arctic forms were investigated by Russian workers, with Natalie Lomakina (1958) providing a most useful monograph (in Russian) covering that fauna. Not long after,

Sigeo Gamô began a long series of investigations of the Japanese fauna, some of which have relevance to NEP taxa.

This set the stage for a young student looking for a subject; Robert Given, who pursued research into the cumaceans of California as his thesis work at USC. This was at the time of considerable ferment in peracarid systematics and ecology lead by Robert Menzies and J. Laurens Barnard, which centered on USC. The strenuous efforts of Olga Hartman in investigating the polychaete annelids from this area paralleled and augmented the crustacean investigations. Shortly after Given submitted his thesis, enactment of the Clean Water Act jump-started environmental sampling in the nation's nearshore waters. The growth of environmental consulting firms which derived from this fueled further investigations of cumaceans. My mentors, Bruce Benedict and Brad Myers, both then at Marine Biological Consultants, identified and prepared capsule descriptions and drawings of many undescribed species from California waters encountered during environmental monitoring surveys. They utilized the information in Givens thesis, and expanded upon it. Early on (in 1974) they created a sort of handbook of the provisional cumacean taxa they had encountered. This was widely distributed and led to the stabilization of much of the nomenclature of local cumaceans. Many of their provisional names are still in use, although some have been superceded by formal description of cumacean taxa. Other than the forms described by Given (1961, 1964), Lie (1969, 1971) and Gladfelter (1975), the known fauna persisted as provisional species until Watling and McCann (1997) described a number of common local species. While species have been formally described often in recent years, the number of undescribed provisional species remains high, and grows whenever underexplored habitats are investigated. Of the six families which occur in the NEP, there are three where described forms outnumber provisionals, one where they equal them, and two in which provisionals outnumber described forms. Of the species listed below nearly half remain to be described.

General Morphology, Sexual Dimorphism, Ontogeny

Morphology of cumaceans is fairly uniform. A standard introduction, such as that of Stebbing (1913) or Schram (1986) should be consulted for description of the features of the group, although Watling and McCann (1997) also provide a good summary of their morphology. The cumacean website (<http://nature.umesci.maine.edu/cumacea.html>) can also be reviewed. In nearly all Cumacea there is substantial sexual dimorphism in external morphology. For this reason most new species descriptions provide descriptions of both males and females, and it is important to understand how to differentiate the sexes. There are some consistent trends which can be relied upon in interpreting specimens: males are usually larger than females, male carapaces are usually less inflated, and consequently longer for their diameter, than female carapaces; males and females will differ in the number of thoracic appendages bearing epipods; males in some families have pleopods lacking in the female; antenna two is greatly enlarged in sexually mature males, and goes through a series of elongations during the juvenile preparatory molts.. There is also considerable difference related to growth. A good discussion of the changes which occur with successive molts is given by Bishop (1982).

The attainment of sexual maturity leads to difference in appearance from both the molts that precede, and those that follow the reproductive molt. Secondary sexual characters will tend to be undeveloped until one or two molts prior to the reproductive

molt. In these last pre-adult forms, morphology will be in transition with the secondary sexual characters developing, but not fully formed. This is particularly evident in those families where males have pleopods. For several molts prior to the reproductive molt the juvenile males will be developing pleopods; first as peduncles only, then with both peduncles and rami, and finally with fully developed setose pleopods. Similar development is seen in the transition from juvenile male to fully adult male in size and relative development of the epipods of the thoracic limbs, and in the length and setosity of antenna two. After the reproductive molt there may be one or more post-reproductive molts. In these the males tend to develop gerontic conditions of overornamentation, with development of elaborate setal diversity and accentuated sculpture of the carapace and abdomen. The setal diversity is particularly well developed on the uropods, where a gerontic male may boast five or six different types of setal elaboration on the peduncles and rami. These can be quite misleading as they alter the overall appearance of the animal considerably. Such gerontic individuals must be carefully evaluated to understand what species they actually represent.

Ecology of Cumaceans

Cumaceans are for the most part detritivores, filtering fine organic particulates from interstitial or bottom boundary layer waters, or from resuspension of bottom sediments during forward burrowing. Zimmer (1933) reports on the life position of several species in sediments. In the examples he used, the animals maintained a connection with the sediment surface, with the pseudorostrum and the siphon formed between it and the maxillipeds open to the bottom waters. The rest of the animal was buried beneath the surface of the sediments. Animals in sandy sediments may be more completely buried in the sediments, with only the tips of the uropods and the tip of the pseudorostrum exposed (Hale 1943). This difference is probably related to the greater abundance and oxygenation of water in coarse sand sediments than in muddy bottoms. A subset of the group, including many of the bodotriids, are not detritivores, but micrograzers. They pick up individual grains of sand and rotate them in the mouthparts, licking off the associated microflora and fauna with mouthpart setae (Hale 1943).

In their turn cumaceans are fed upon by predators of many types, including polychaete worms, nemerteans, other arthropods, and fishes. According to Băcescu and Lima de Quieroz (1985), who surveyed the previous literature on consumption of cumaceans by fishes, they form an important portion of the gut contents of several species of rays, in addition to the flatfishes, gadids, and acipenserids previously reported from European waters (Zimmer 1941). Personal observations on the contents of light traps show that both isopods (cirolanids) and ostracods (cypridinids) will eat cumaceans while confined in the collection container. They tend to consume the carapace and thorax, and leave the abdomen behind (like eating a popsicle and tossing the stick).

Nicotheid copepods (genus *Sphaeronella*) are about the only organisms reported to parasitize cumaceans. Hansen (1920) reported five species of *Sphaeronella* brood parasites from various cumaceans.

Swimming is very common in cumaceans, particularly in males (Champalbert and Macquart-Moulin 1970). Females also take off from the bottom on excursions into the water column, but these are generally of shorter duration (Fage 1945). Males and females may also swim at different times, with only a brief overlap when both are in the

water column. Different groups segregate themselves by preferred swimming time (Hale 1953) during the hours of darkness.

Movements on and in the bottom are of several types. Burrowing can be either downward or backward into sandy sediments, depending on species (Hale 1943). Such motions are extremely rapid and hard to observe. In muddy sediments, forward motion may be undertaken with the gradual loosening and resuspension of sediments by movements of the maxillipeds during deposit feeding, followed by slow movement forward into the cavity created. Hale (1943) observed some bodotriids “hopping” across the surface of the sand. I have observed such hopping or springing behavior in the nannastacid *Cubanocuma* in shallow dishes. They will sit quiescent on the bottom for a minute or two, then “pop” into the water column, probably by a strong flexure of the abdomen and uropods, and swim about in a frenzied manner.

Constituent Families

The order contains eight recognized families: Bodotriidae, Ceratocumatidae, Diastylidae, Gynodiastylidae, Lampropidae, Leuconidae, Nannastacidae, and Pseudocumatidae. All but the Gynodiastylidae and Ceratocumatidae are represented in the NEP. Off and on other families have been suggested, most frequently the removal of the Campylaspinae from the Nannastacidae and its elevation to family status, but these are not currently recognized. Stebbing (1913) for instance, treated many of the groups now at the subfamily level as families, recognizing 26. Băcescu introduced a ninth family, the Archaeocumatidae (see Băcescu 1988) and included it in the Crustaceorum Catalogus. It has not achieved wide acceptance and is viewed as part of the Lampropidae here.

Key to the Families of Cumacea present in the NEP (modified from Watling and McCann (1997) and Gamô (1967))

- 1a. With ~~freely articulated~~ telson.....2
- 1b. Without ~~freely articulated~~ telson.....4
- 2a. Telson with 0 or 2 terminal setae.....3
- 2b. Telson with 3 or more terminal setae.....Lampropidae
- 3a. Endopod of uropods 1 segmented; males with 5 pleopod pairs.....
.....Pseudocumatidae
- 3b. Endopod of uropods 2-3 segmented; male with 2 pairs of pleopods.....
.....Diastylidae
- 4a. Uropod endopod uniarticulate.....Nannastacidae
- 4b. Uropod endopod biarticulate.....5
- 5a. Male with 0 or 2 pairs of pleopods; female with exopods on pereopods 1-3
.....Leuconidae
- 5b. Male with 5 pairs of pleopods; females with exopods only on pereopod 1
or on pereopods 1-4.....Bodotriidae

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The bodotriids are primarily shallow water sand associated forms, although a few such as *Bathycuma* and *Cyclaspoides* have penetrated the deep-sea. At least 24 species in 6 genera are known from the NEP from Panama to the Arctic. It is likely that additional undetected species remain uncollected, especially from sandy sediments in the south. Three of our local provisionals are known only from the very coarse iron-stained relict red sands found off Imperial Beach south of San Diego. The family was not represented in the collection described by Watling and McCann (1997), and is consequently not discussed there. Only four species in this family are listed by McLaughlin et al (2005) as from the Pacific coast of North America. Bodotriids are more diverse in the Western North Pacific, with 21 species in 8 genera described by 1967 (Gamô 1967). Although there is considerable known NEP diversity in the genus *Cyclaspis*, most of it remains to be described. In the list provided below 5 described and 12 undescribed forms are placed in *Cyclaspis*. Materials from a light trap collected in Bahia Kino in the Gulf of California by Todd Haney have provided 3 apparently undescribed species in this genus, as well as material of several provisional forms previously collected by Donath – Hernández on the Gulf side of Baja California. Two new species described from Pacific Costa Rica (Petrescu and Heard 2004) are included, although one of them is known only from the female. Similarly large diversity in the genus is known from the western coast of South America (Pilar Haye, personal communication), and numerous additional undescribed species in the genus have been collected from the Caribbean.

Despite good diversity of *Cyclaspis*, other genera with numerous species in other areas are not represented in our fauna. These include the genera *Bodotria*, *Iphinoe*, *Sympodomma*, and *Eocuma*. The genus *Glyphocuma*, which is unrepresented in the NW Pacific, has two quite similar undescribed species in our area. The genus is otherwise only known from Australian waters, where it was erected by Hale. Bodotriids in general are well-represented in Australia, and this is probably the area of origin of the family, although this remains to be determined. The genus *Coricuma* was placed in the Bodotriidae when originally proposed, but was later transferred to the Leuconidae (Watling 1991b). The family is distributed worldwide, and has endemic genera in many areas (Băcescu 1988). It is divided into three subfamilies, the Bodotriinae, the Mancocumatinae, and the Vaunthompsoniinae, based on combinations of numbers of pereopods bearing epipods, and number of pleopods in the male.

Secondary sexual characters in this group are relatively easy to see in most cases. The male pleopods, in particular, are usually prominently displayed. In a few species, however, among them *Cyclaspis nubila*, the adult male holds the pleopods tight against the underside of the abdomen. As the abdomen is slightly concave in these species, the pleopods are effectively hidden in lateral view. Subadult male pleopods are considerably easier to see. The marsupium of the female is also relatively easy to see, if developed, even prior to the carrying of a brood. While the elongation of the male second antennae is very noticeable, the antennae themselves are often not. Under most circumstances they are carried along the underside of the carapace, thorax and abdomen, tightly appressed to the main body. They can usually be found, but it may take concerted looking to ferret them out. Only in the full adult will they sometimes be long enough to show near the last

abdominal segment, even while hidden from lateral view. Even if the antennal flagellum is not readily evident, the males have strongly enlarged antennal peduncles, which must be muscular and more robust than those of the females to handle these long antennae. Examination of the antennal peduncle is usually easier than finding the rest of the antenna.

Determination of sex is as important in bodotriids as in any other cumacean. The pattern of sexual dimorphism characteristic of the group as a whole holds for this family; females are smaller than males, but usually by 30% or less in total length. They also have more inflated carapaces posteriorly, which typically slope more towards the eyelobe than in the male. Where only a single sex is known, the appearance of the other can be partially predicted by these trends, which seem to vary little within the family. For instance, the two described species from the Gulf of California, *C. bituberculata* and *C. conceptionis* were initially believed to also occur in the Bahia Kino material. Only males of “*C. bituberculata*” were found however, which were undescribed by Donath-Hernández. The males at hand proved to be several times the length of the females they were believed to belong to. This is so contrary to the established pattern that it was concluded that this was a closely related but different species, and not the males of the described species. Similarly both males and females which bore good resemblance to *C. conceptionis* were taken in Bahia Kino. Again, they were substantially larger (3 times the size indicated in the original description) and cannot belong to the same taxon. They are now treated as another undescribed species with close affinity to *C. conceptionis*.

A key to the California bodotriids was prepared in 1996 for SCAMIT presentation. This is updated below, with the addition of the Donath-Hernández species, two Costa Rican species, three provisional forms from the Gulf of California, and *Glyphocuma sp LA1* first taken in 1998. A key to all genera in the family world-wide is provided by Jones (1969, pp. 102-103).

NEP Bodotriidae from McLaughlin et al (2005) augmented by known provisional taxa.
*= Taxa on the SCAMIT Ed 4 list + addenda. Valid taxa bolded, synonyms not.

Family Bodotriidae

Bathycuma longicaudatum Calman 1912 – Mediterranean, Japan, NEP to San Diego, Chile; 1174-3950m

Cyclaspis bituberculata Donath-Hernández 1988 – Laguna Ojo de Liebre, outer coast of Baja California to Bahia Bocochibampo, Sonora, Mexico; shallow

Cyclaspis breedyae Petrescu and Heard 2004 – Gulf of Nicoya, Costa Rica; 1-2m

Cyclaspis conceptionis Donath-Hernández 1988 – Bahia Concepción, Gulf of California; shallow

***Cyclaspis nubila** Zimmer 1936 – SCB to Bahia Kino, Gulf of California; 0- 27m

Cyclaspis vargasae Petrescu and Heard 2004 – Los Islas Murcielagos, Costa Rica; 35m

***Cyclaspis sp A** SCAMIT 1995§ - Pt. Conception to Bahia Kino, Gulf of California; 0-48m

***Cyclaspis sp B** SCAMIT 1989§ - Oxnard to La Jolla; 8-18m

- ***Cyclaspis sp C** SCAMIT 1986§ - Pt. Conception to La Jolla; 5-15m
Cyclaspis sp D Cadien 1996§ - Huntington Beach; 0-1m
Cyclaspis sp E Cadien 1996§ - Imperial Beach; 20m
Cyclaspis sp F Cadien 1996§ - Imperial Beach; 20m
Cyclaspis sp G Cadien 1996§ - Imperial Beach; 20m
Cyclaspis sp J Cadien 2005§ - Bahia Kino, Sonora, Mexico; 1-10m
Cyclaspis sp K Cadien 2005§ - Bahia Kino, Sonora, Mexico; 1-10m
Cyclaspis sp N Cadien 2005§ - Bahia Kino, Sonora, Mexico; 1-10m
Cyclaspis sp 3 Donath-Hernández 1985§ - Puerto Peñasco and Bahia Kino, Gulf of California; 1-10m
Cyclaspis sp 4 Donath-Hernández 1985§ - Bahia de Los Angeles and Bahia Kino, Gulf of California; 1-10m
Cyclaspoides sp BAP1 Cadien 2001§ - Baja California; 3880-3950m
***Glyphocuma sp A** SCAMIT 1989§ - San Miguel Id. to San Diego; 71-108m
***Glyphocuma sp LA1** SCAMIT 2000§ - Santa Rosa Id.; 84m
***Leptocuma forsmanni** Zimmer 1943 – SCB to Bahia Kino, Sonora, Mexico; 1-10m
Vaunthompsonia cristata Bate 1858 – South Africa, Mediterranean, N. Atlantic; Indonesia; Japan to Puget Sound; 0-36m
***Vaunthompsonia pacifica** Zimmer 1943 – NWP to Puget Sound; SCB?; 0-96m

Key to the Bodotriidae of the NEP from the (Modified from Cadien 1996 to include all currently recognized provisional and described species known from the equator to the Arctic Circle in the Eastern Pacific)

- 1a. Exopods on only the first pair of pereopods.....2
1b. Exopods on more than one pair of pereopods.....19
2a. First three pedigerous segments fused with carapace.....*Cyclaspoides sp A*
2b. All five pedigerous segments free.....3
3a. Carapace with one or more teeth on the dorsal midline.....4
3b. Carapace lacking teeth on dorsal midline.....5
4a. Carapace with a single pair of ridges extending from dorsal midline to join the ventral margin below the level of the antennal notch; eyes divided into 11 ommatidea.....*Cyclaspis breedyae*
4b. Carapace with a single pair of ridges extending from the dorsal midline forward to the back of the eyelobe; eye undivided into separate lensed ommatidea.....
..... *Cyclaspis sp A*
5a. Antennal sinus absent; both margins of uropodal peduncle setose in female.....
.....*Cyclaspis sp D*
5b. Antennal sinus evident; peduncle of uropods lacking setae along both margins in female (but inner margin may be serrate).....6
6a. Carapace smooth, without pits, tubercles, surface ornament, or anteriodorsal depressed areas in either sex.....7

- 6b. Carapace strongly pitted and/or sculptured, with or without depressions anteriodorsally in both sexes.....8
- 7a. Paired horn-like tubercles dorsally on last two thoracic segments....*Cyclaspis sp 3*
- 7b. Thoracic tubercles lacking.....*Cyclaspis sp B*
- 8a. Carapace bearing lateral ridge(s) extending from mid-dorsal carina towards base of the carapace.....9
- 8b. Carapace lacking lateral ridge(s) extending down from the mid-dorsal carina....12
- 9a. Carapace bearing a single lateral ridge extending from the dorsal carina about 2/3 the distance to carapace base which forms the posterior boundary of a complex anterior-dorsal sinus.....*Cyclaspis sp G♂*
- 9b. Carapace bearing two or more lateral ridges.....10
- 10a. Mid-dorsal carina very strong on anterior half of carapace, weak posteriorly; two strong lateral ridges; carapace with stellate purple pigment spots..*Cyclaspis sp F♂*
- 10b. Mid-dorsal carina moderately strong on entire carapace; 3-6 delicate lateral ridges on carapace.....11
- 11a. Carapace lacking definite spots of pigment in juveniles, but both sexes increasingly pigmented with age; with 5-6 thin sloping ridges running obliquely across the carapace.....*Cyclaspis sp 4*
- 11b. Carapace with a few indistinct non-stellate pigment spots posteriodorsally; 3 delicate lateral ridges on carapace.....*Cyclaspis sp. E♀*
- 12a. Carapace with well marked anteriodorsal depression extending from dorsal carina to base of eyelobe in both male and female.....13
- 12b. Carapace lacking anteriodorsal depression in either sex.....14
- 13a. Carapace with smooth trough-like depression extending obliquely back from the antennal sinus in both sexes.....*Cyclaspis sp C*
- 13b. Carapace lacking smooth trough-like depression behind the antennal sinus in both sexes.....*Cyclaspis nubila*
- 14a. Carapace lacking either obtuse or acute anteriolateral tubercles.....15
- 14b. Carapace bearing one pair of large anteriolateral tubercles, either obtuse or edged with an acute ridge, between eyelobe and antennal sinus.....17
- 15a. Carapace strongly pitted, but lacks longitudinal strigillate sculpture.....*Cyclaspis vargasae*
- 15b. Carapace with strigillate longitudinal sculpture on sides of carapace.....16
- 16a. Uropodal exopod longer than endopod and both rami lacking long terminal spines on rami in both sexes; mature at about 7mm.....*Cyclaspis sp J*
- 16b. Uropodal rami subequal, both tipped with long (1/3 ramal length) terminal spines; mature at less than 2.5mm.....*Cyclaspis conceptionis*
- 17a. Carapace surface sculpture alveolate; anterior tubercles either obtuse or edged by an acute ridge.....18
- 17b. Carapace surface sculpture not alveolate; anterior tubercles obtuse; mature at less than 3mm.....*Cyclaspis bituberculata*
- 18a. Dorsal flanges present on thoracic somites T2 and T5; anterior tubercles edged with a sharp ridge; ventral margin strongly flared below the antennal sinus, and edged with another sharp ridge; mature at less than 2.5mm.....*Cyclaspis sp N*
- 18b. Dorsal surface of all thoracic somites lacking lobes or flanges; anterior tubercles obtuse, not edged by acute ridge; ventral margin not flared below antennal sinus;

- mature at 7+mm.....*Cyclaspis sp K*
- 19a. Carapace lacking teeth or denticles dorsally.....20
- 19b. Carapace bearing at least one, and usually many denticles or teeth on carina.....21
- 20a. Lateral margins of 3rd (♀) or 4th (♂) thoracic segment overlapping those of adjacent segments.....*Leptocuma forsmanni*
- 20a. Lateral margins of 3rd or 4th thoracic segments not overlapping those of adjacent segments.....*Vaunthompsonia* and *Glyphocuma* (♂♂) 25
- 21a. Abdominal somites ridged laterally.....*Bathycuma longicaudata*
- 21b. Abdominal somites not ridged laterally.....22
- 22a. Dorsal teeth or denticles in two parallel rows flanking carapace midline.....23
- 22b. Dorsal teeth in a single row along midline.....*Glyphocuma* ♀ and juvenile ♂ 24
- 23a. Eyelobe lacking denticle pair distally; carapace evenly rounded dorsally.....
.....*Vaunthompsonia pacifica*♀
- 23b. Eyelobe bearing denticle pair distally; carapace slightly excavated dorsally just before posterior margin.....*Vaunthompsonia cristata*♀
- 24a. Dorsal crest with well marked denticles; anterior ventral carapace border finely serrate.....*Glyphocuma sp A*
- 24b. Dorsal crest with only one or two poorly marked denticles; anterior ventral carapace border lacking serrations.....*Glyphocuma sp LA1*
- 25a. Anteriorly projecting lobe at the distal end of the basis of the third maxilliped.....
.....*Glyphocuma* (adult males of both local species unknown)
- 25b. Lacking lobe distally at end of third maxilliped basis.....*Vaunthompsonia* (adult males unknown for both reported species in the genus from the NEP)

Bathycuma – Only eight species are described in the genus (Băcescu 1988), to which a ninth must now be added (Mühlenhardt-Siegel 2005a). One additional undescribed form is known from the hadal zone of the Bougainville Trench (Wolff 1970). Only one species is from the NEP, the remainder are from the North Atlantic, South Atlantic, or Indian Oceans. Only two specimens are known from off our area; the type, from off San Diego, at 1174-1218m, and one in my possession from the Baja Abyssal Plain at 3880-3950m. It has also been taken from off Japan, and Gamô (1967) describes and illustrates it well, and the description and illustrations of Petrescu (1995) should also be consulted. Day (1975) provides a key to the genus up to that time, which includes all but the one recently described species (Mühlenhardt-Siegel 2005a) and Wolff's hadal provisional.

Cyclaspis – An extremely large genus of shallow-water (predominantly) bodotriids, with species found worldwide. Well over one hundred species are currently described, and many forms await formal description, at least in the Western Hemisphere. Over 60 years ago Hale recognized a large number of forms from around Australia, and a single species from the NEP (Hale 1944a). Since then a number of additional species have been described world-wide (Băcescu lists 93 in 1988). If the diversity evident in the Australian region is echoed elsewhere in the world, the eventual number of described *Cyclaspis* species may reach nearly 200. This sort of large genus, while not unprecedented, fairly easily lends itself to subdivision. At a minimum one would expect

that a series of subgenera would be erected, each housing a more manageable subset of the total. It is also possible that the genus will be exploded, with the description of a number of genera from this large one. There is ample morphological diversity in carapace shape (see Hale 1944a) to support such subdivision, but boundaries may prove elusive. In several faunas I have examined similar species exist in several size ranges, I suppose related to the diversity of different sized sediments the animals must burrow through. A large muscular species would be required to move large sand sized particles, while more gracile and smaller forms might occupy more uniform fine sands, or perhaps live among grains in coarse well-mixed sediments with shell debris or other biogenic components.



A small undescribed *Cyclopsid* from Caribbean Panama

Zimmer (1944) described *C. dolera* from material ostensibly taken in Salinas Bay on the Pacific coast of Costa Rica. The species was known to be distributed through the tropical Western Atlantic, but has not been seen since on the Pacific Coast. Based on the reasoning provided by Roccatagliata (1986) the species is now thought to be found only in the Atlantic, with the original labeling being an error for Salinas, Puerto Rico. It is not included here for this reason.

A small subset of the *Cyclopsid* species are deep-water animals, but the vast majority are found on sandy bottoms in the intertidal, and shallow sublittoral zones. We only take them at our shallowest stations, and then only a few individuals of two species (*C. nubila* and *C. sp A*). A broader spectrum is found in the relict red sand deposits off the coast south of San Diego, where four more provisional forms are currently known. These are all rare, however, and several are known from single specimens.

Cyclopsoides – A small deep-sea genus, with two described species listed by Băcescu (1988), and additional species described by Petrescu (1995) and Mühlenhardt-Siegel (2005a). At least two undescribed species are also known, our provisional from

off Baja California, and a provisional known only from a single specimen off the Philippines (Calman 1905). The fusion of the thoracic segments with the carapace which characterize this genus makes it easy to separate from other deepwater bodotriids. Despite having few members, the genus is widespread, ranging from the deep North Atlantic, to the South Atlantic off Angola, the Indian Ocean off South Africa, the Philippines, Ecuador, and the NEP.

Glyphocuma – Hale (1944b) erected the genus and placed four species in it, three new. All were from the southern part of Australia. Since then Greenwood & Johnson (1967) have described a fifth species from Queensland in the north. They did not provide a key to the genus including their new species, preferring to differentiate it from the type in a table. Hale (1944b) provides a key to the four species known at that time. The two forms from the NEP are both provisionals, and are the only species in the genus known from outside Australia. The pattern of differences in carapace ornamentation is one of the primary differences between the two local provisional species. Since both sexes are not known for the species, the identification of the as yet uncollected sex remains problematic.

Leptocuma – Ten species are known in the genus (Băcescu 1988) only one from the NEP. Most members are austral, although several are known from the North Atlantic. Hale (1944b) provides a key to six species from Australia, which may point out some characters of interest in the taxonomy of the species. No comprehensive key to the members of the genus exists. This genus is much more elongate than other shallow-water bodotriids found in the NEP, and the overlapping of the thoracic pleura is a distinctive feature. While there is diversity in the genus in the SW Atlantic (Roccatagliata 1993), as yet only a single species is known from the NEP, with populations from temperate and tropical waters indistinguishable.

Vaunthompsonia – A widely distributed, if not large, genus of bodotriids. Eleven described species (one with two subspecies), and two provisionals are known (Băcescu 1988). The genus is predominantly shallow, with some members deeper on the shelf. A few species are known to occur more deeply. Surprisingly broad bathymetric distributions are ascribed to some species, particularly *V. cristata*, which is normally taken at 0-36m, but has one record at 2338m (Băcescu 1988). In another case, with a species similar to *V. cristata*, he suggests that the record (from 6475-6571m in the Kurile-Kamtschatka Trench) is either a misidentified *Bathycuma*, or an animal taken from the plankton incidentally (Băcescu 1988). In tropical climates the genus can occur quite shallowly, with *V. minor* taken amongst intertidal algae in Belize (personal collection). Neither of the two reported NEP taxa occur much south of the Arctic, penetrating into the boreal region as far as Puget Sound. Reports of these animals have been made previously (a number were identified in the BLM studies in the SCB), but these have proven to be erroneously identified *Glyphocuma* specimens. Remaining records of *V. pacifica* specimens in the SCB are questionable, and need to be verified.

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The Diastylidae is a relatively large family (17 genera and over two hundred species, Băcescu 1992; now grown to 21 genera, Mühlenhardt-Siegel 2003) which is quite common in the NEP, especially in its Arctic and Boreal areas. Eight of these genera occur in the NEP, and are discussed below. A key to the genera in the family is provided by Jones (1969), but genera from couplet 16 on in that key are now considered to belong in the family Gynodiastylidae (see Day 1980). As one of three families bearing articulated telsons, its members are most often confused with members of the other two, Gynodiastylidae and Lampropidae. This confusion extends to even knowledgeable workers, with some describing lampropids as diastylids (see Gladfelter 1975). The family key provided in the first part of this series should allow appropriate allocation of specimens to families.

More of NEP diastylid species are described than was the case with the last family, the bodotriids. Of the 38 diastylids reported from the NEP, only 7 belong to provisional taxa. This is perhaps due to the relatively shallow distribution of bodotriids, into habitats frequently unsampled, while diastylids are commonly found further offshore where they can be easily taken by dredge, core, and trawl. The family also has more affinity for cold waters than does the Bodotriidae, with many of the NEP forms of only Arctic or boreal distribution. Lastly, diastylids tend to be larger than bodotriids, with some of the largest species of cumaceans in the family. At least some of the members can be brightly pigmented in life. *Anchicolurus occidentalis*, for instance, is pale pink with scarlet markings in fresh material (the color fading in preservation to bone white).

Sexual dimorphism in the diastylids is generally less pronounced than in the bodotriids, but still substantial. Again the males tend to have carapaces which are not inflated posteriorly, or are inflated less than in the female. Natural history of *Diastylis stygia* was described by Blake and Watling (1994).

NEP Diastylidae from McLaughlin et al (2005) augmented by known provisional taxa.
*= Taxa on the SCAMIT Ed 4 list + addenda. Valid taxa bolded, synonyms not.

Family Diastylidae

- ***Anchicolurus occidentalis** (Calman 1912) – Oregon to SCB; 13-64m
Colourostylis (?) occidentalis see *Anchicolurus occidentalis*
- Diastylis abbotti** Gladfelter 1975 – Dillon Beach; 13.5m
- Diastylis alaskensis** Calman 1912 – Japan to Puget Sound; 0-196m
- Diastylis aspera** Calman 1912 – Kuriles to Puget Sound; 95-1150m
- Diastylis bidentata** Calman 1912 – Arctic to Puget Sound; 9-1000m
- Diastylis calderoni** Donath-Hernández 1988 – Head of Gulf of California; 0-5m
- ***Diastylis californica** Zimmer 1936 – Humboldt Bay to So. Coronado Island;
19-88m
- ***Diastylis crenellata** Watling and McCann 1997 – Fort Bragg to Coronado Sub-
marine Canyon; 11-606m
- Diastylis dalli** Calman 1912 – Arctic to Puget Sound; 24-2350m
- Diastylis newberryi** Gerken 2005 – SCB to Baja California; 15-536m

- Diastylis nucella** Calman 1912 – Arctic to Puget Sound; shallow
Diastylis obfuscatus see *Lamprops obfuscatus* in *Lampropidae*
- Diastylis paraspinulosa** Zimmer 1926 – Arctic to Puget Sound; 12-440m
 ***Diastylis pellucida** J. F. L. Hart 1930 – Vancouver to SCB; 12-829m
Diastylis quadriplicata Watling and McCann 1997 – Eureka to Gaviota; 123-366m
Diastylis rathkei (Krøyer 1841) – Arctic to Puget Sound; shallow
 ***Diastylis santamariensis** Watling and McCann 1997 – Puget Sound to San Diego; 6-204m
 ***Diastylis sentosa** Watling and McCann 1997 – Puget Sound to San Diego; 41-500m
Diastylis triserrata see *Lamprops triserrata* in *Lampropidae*
- Diastylis umatillensis** Lie 1971 – SE Alaska to Puget Sound; 20-60m
Diastylis sp BAP1 – Cadien 2001§ - Baja Abyssal Plain; 3880-3950m
 ***Diastylis sp C** Myers & Benedict 1974§ - SCB; 197-576m
Diastylis sp CS1 Cadien 2004§ - Cascadia Slope; 1150-1372m
Diastylodes pacifica Gerken 2005 – Baja California; 2385m
Diastylopsis dawsoni S. I. Smith 1880 – Alaska to Pt. Conception; 2-35m
 ***Diastylopsis tenuis** Zimmer 1936 – SCB; 3-60m
 ***Leptostylis abditis** Watling and McCann 1997 – Central California to San Diego; 11-954m
 ***Leptostylis calva** Watling and McCann 1997 – Fort Bragg to San Diego; 8-198m
Leptostylis villosa G. O. Sars 1869 N. Atlantic, Puget Sound; 22-195m
 **Leptostylis* sp B see *Diastylis newberryi*
Leptostylis sp CS1 see *Leptostylis* sp F
Leptostylis sp F MBC 1985§ - Cascadia Slope and Abyssal Plain to Tanner Basin; 732-2800m
Makrokylindrus (Adiastylis) abyssi Lomakina 1955 – NWP to Arctic; 3940m
Makrokylindrus (Adiastylis) americanus Băcescu 1962 – Gulf of Panama; 1748m
Makrokylindrus (Adiastylis) menziesi Băcescu 1962 - Galapagos; 3469-3493m
Makrokylindrus (Adiastylis) sp CS1 Cadien 2006§ - Cascadia Slope; 1372m
Makrokylindrus (Adiastylis) sp TB1 Cadien 2006§ - Tanner Basin; 1150+m
Makrokylindrus (Adiastylis) sp TB2 Cadien 2006§ - Tanner Basin; 1150+m
 ***Oxyurostylis pacifica** Zimmer 1936 – Morro Bay to SCB; 13-76m
 ***Oxyurostylis tertia** Zimmer 1943 – San Diego to Baja California; 10m
Vemakylindrus costaricanus Băcescu 1961 – Pacific Costa Rica; 3718m
Vemakylindrus hystricosa Gerken 2002 – Monterey to Baja California; 1150-1880m
Vemakylindrus sp TB1 see *Vemakylindrus hystricosa*

Since so many of the members of this family in the NEP are in the genus *Diastylis*, a separate key to those species will be presented later. Other NEP diastylids are keyed below to species. The species *Diastylis newberryi* serves to intergrade the genera *Diastylis* and *Leptostylis*, and is consequently keyed below among the *Leptostylis*, and

later in the *Diastylis* generic key as well. If you get to *Diastylis*, move to the key to that genus. More provisional species of *Diastylis* and/or *Makrokyllindrus* may be identified in samples from the Cascadia Abyssal Plain currently under evaluation.

Key to the known NEP Diastylidae (modified from Jones 1969) – dbcadien 31
October 2006

- 1a. Mandibles broad at base, truncate basally.....*Diastylodes pacifica*
- 1b. Mandibles tapering to base, subacute basally.....2
- 2a. Telson lacking both lateral and terminal spines and/or setae (although ♂ has a pair of ventral setae at the end of the telson)*Anchicolurus occidentalis*
- 2b. Telson bearing either lateral or terminal (or both) spines and/or setae3
- 3a. Pseudorostrum as long as or longer than carapace.....*Vemakylindrus* 4
- 3b. Pseudorostrum much shorter than carapace.....5
- 4a. Pseudorostrum as long as remainder of carapace, horizontal; carapace covered with several sizes of large spines.....*Vemakylindrus hystricosa*
- 4b. Pseudorostrum longer than rest of carapace, upturned; carapace with a few small spines and many spinules.....*Vemakylindrus costaricanus*
- 5a. Thoracic somites 3 and 4 much wider basally than dorsally in both sexes (5-10X)*Diastylopsis* 6
- 5b. Thoracic somites 3 and 4 only 1-3x as broad basally as dorsally in both sexes.....7
- 6a. Thoracic sternite 5 with a pair of denticles or teeth.....*Diastylopsis dawsoni*
- 6b. Thoracic sternite 5 with a single denticle or tooth.....*Diastylopsis tenuis*
- 7a. Telson shorter than or equal to last abdominal somite in length8
- 7b. Telson at least 1.25 length of last abdominal somite.....11
- 8a. Outer ramus of uropod only about ½ length of inner.....*Leptostylis abditis*
- 8b. Outer and inner rami of uropod subequal.....9
- 9a. Female with rudimentary epipods on 3rd and 4th pereopod bases; males with well developed and evident pleopods for several molts; carapace smooth or variously setose, gray or tan, matte, not shiny.....10 (NOTE TRIPLET)
- 9b. Female completely lacking rudimentary epipods on 3rd and 4th pereopod bases; pleopods poorly developed in all but final male molt (2 reduced articles), carapace globular, smooth, translucent or white, shiny.....*Leptostylis sp F*
- 10a. Carapace with a few scattered setae.....*Leptostylis calva*
- 10b. Carapace quite hirsute.....*Leptostylis villosa*
- 10c. Carapace lacking setae.....*Diastylis newberryi* (see also in *Diastylis* key)
- 11a. Terminal spines lacking, telson tapers to sharp point.....*Oxyurostylis* 12
- 11b. Terminal spines present on telson.....13
- 12a. Carapace with row of small spinules along dorsal midline, along anterior dorsal border, and on ocular lobe.....*Oxyurostylis tertia*
- 12b. Carapace minutely villose, but lacking spinules along dorsal midline, along anterior dorsal border, or elsewhere.....*Oxyurostylis pacifica*
- 13a. Pre-anal telson elongate, tubular, generally much longer than post-anal portion; lateral setal pairs few or lacking, restricted to post-anal telson (pre-anal telson may bear lateral teeth or denticles however).....*Makrokyllindrus* 14
- 13b. Pre-anal telson not tubular; quadrate, subquadrate, or tapering; length generally

- shorter than post-anal portion, but occasionally equal to or longer; lateral telsonic setal pairs usually four or more, occasionally one or two; may extend to pre-anal telson, but generally on post-anal only.....*Diastylis*
- 14a. Post-anal portion of telson more than half length of pre-anal portion.....15
- 14b. Post-anal portion much less than ½ length of pre-anal portion.....17
- 15a. Post-anal telson distally patulous, bluntly rounded.....*Makrokyllindrus abyssii*
- 15b. Post-anal telson distally tapering, pointed.....16
- 16a. Carapace with a curved serrate ridge extending from pseudorostrum to base; last thoracic and first abdominal somites lacking spines.....*Makrokyllindrus* sp CS1
- 16b. Carapace lacking ridges; last thoracic and first abdominal somites bearing a pair of posterior (T5) or posteriodorsal (A1) spines..... *Makrokyllindrus* sp TB2
- 17a. Basal 2/3 of pre-anal telson laterally dentate.....*Makrokyllindrus menziesii*
- 17b. Pre-anal telson lacking lateral teeth.....18
- 18a. With strong denticles on ventral carapace margin between obsolete antennal sinus and posterior margin of carapace; a second row of strong teeth extending rearward and slightly down from the level of the pseudorostrum; a pair of small tubercles dorsally near tip of pseudorostrum.....*Makrokyllindrus* sp TB1
- 18b. With strong denticles on ventral carapace margin from antennal sinus to postero-ventral corner of carapace, not extending onto posterior margin; only scattered small spinules elsewhere on carapace; no tubercles on pseudorostrum
.....*Makrokyllindrus americanus*

Anchicolurus – monotypic, containing only the local *A. occidentalis*. This is a large robust animal with heavily calcified carapace. It is readily recognized among other shallow water diastylids in the SCB by its prominent antero-ventral carapace corners, which give a quadricuspedate frontal margin; and the enlarged pleura of the thoracic segments. No other diastylid occurring in the NEP has such a short telson, or one lacking any lateral spines or setae.

Diastylis – A large genus, largest in the family. Băcescu (1992) lists 84 species, to which the four species of Watling and McCann must be added along with additional more recent species (i.e. Gerken and Watling 1998). The description of *Diastylis newberryi* (Gerken 2005) complicated separation of *Diastylis* from *Leptostylis*. The species intergrades with *Leptostylis* in the structure of the telson, but is differentiated by the length of the antenna in the male, and by the lack of inflation in the peduncle of the male antennule which characterizes *Leptostylis*. In consequence, this animal is included in the above key to non-*Diastylis* members of the family, where it keys with members of the genus *Leptostylis*. It has also been included below in the key to the NEP *Diastylis*. A number of the forms reported from the NEP are only known from Arctic or boreal waters. None-the-less I provide below a key to the species known from the NEP, since no comprehensive key currently exists. Watling and McCann (1997) provide a key to some of the more common species of the genus from our area, but it is not comprehensive.

Key to known NEP species of *Diastylis* – dbcadien, 5 November 2006

- 1a. Carapace lacking ornamentation of either ridges or spines; smooth.....2
- 1b. Carapace ornamented with either ridges, spines, or a combination.....5
- 2a. Carapace with numerous setae, hirsute; eyelobes poorly defined.....3

- 2b. Carapace with few or no setae; eyelobes well defined.....4
- 3a. Eyelobe bear a pair of minute spinules; carapace minutely villose; ventral margin serrate, with large recurved pointed teeth; telson with 4 lateral setal pairs
.....*Diastylis sp CS1*
- 3b. Eyelobe lacking spinules; carapace smooth, not minutely villose; ventral margin smooth, lacking large teeth; telson with 8-9 setal pairs.....*Diastylis umatillensis*
- 4a. Carapace lacking hump in carapace behind eyelobe and without sulcus around ocular lobe; post-anal telson shorter than pre-anal; one pair of lateral setae on telson.....*Diastylis newberryi*
- 4b. Carapace with eyelobe followed by a large hump, both set off by a sulcus similar to that of *Hemilamprops californicus*; post-anal telson longer than pre-anal; four pairs of lateral setae on telson.....*Diastylis sp C*
- 5a. Carapace ridges ending in large spurs.....*Diastylis calderoni*
- 5b. Carapace with either spines or ridges, but not both.....6
- 6a. Carapace with spines, but no ridges.....7 (NOTE TRIPLET)
- 6b. Carapace with ridges, but no spines.....8
- 7a. Spinules or small spines present on carapace along dorsal midline, but no large spines present; post anal telson much longer than pre-anal; lateral setal pairs numerous.....*Diastylis rathkei*
- 7b. Large spines present on carapace in one horizontal row; post anal telson much longer than pre-anal; lateral setal pairs numerous.....*Diastylis paraspinulosa*
- 7c. Large spines present on carapace in four horizontal rows; post anal telson equal to pre-anal; with four lateral setal pairs.....*Diastylis sentosa*
- 8a. Carapace with serrate, crenulate or castellate ridges.....9
- 8b. Carapace ridges smooth, lacking serrations, crenulations, or castellations.....13
- 9a. Pre-anal telson about ½ length of post anal.....*Diastylis nucella*
- 9b. Pre and post anal telson sections subequal in length.....10
- 10a. Carapace with a single ridge which is castellate anteriorly, but smooth posteriorly; telson very short, only about 1/3 of uropodal peduncle length; one lateral setal pair, or lateral setae lacking.....*Diastylis sp BAP1*
- 10b. Carapace with multiple ridges; telson ½ or more uropodal peduncle length; two or more pairs of lateral telsonic setae.....11
- 11a. Telson only about ½ length of uropodal peduncles in both sexes; bearing 2-6 pair of lateral setae.....12
- 11b. Telson subequal to uropodal peduncle in length; bearing about 9 pairs of lateral setae.....*Diastylis aspera*
- 12a. Three transverse ridges across carapace; ridges not separated by smooth sulci, all three ridges parallel, not anastomosing; telson with 5-6 pairs of lateral setae
.....*Diastylis pellucida*
- 12b. Carapace with two ridges which join behind and below the anterior lobe of the carapace; the anterior ridge runs transversely across the carapace; the posterior ridge is separated into curving sections on either side of the dorsal midline which extend posteriorly at the start then downward and back forward to join the anterior ridge; where they join, the posterior ridge bifurcates and its ventral branch meets the ventral margin; between the two ridges dorsally are crescentic sulci on both sides of the carapace midline; telson with 2-4 lateral setal pairs

-*Diastylis crenellata*
- 13a. At least one ridge bearing a tooth on each side of the carapace.....14
- 13b. No teeth on carapace ridges.....15
- 14a. One tooth on the second carapace ridge; post-anal telson nearly three times length of pre-anal part; 10 lateral telsonic setal pairs.....*Diastylis bidentata*
- 14b. Two teeth on the first carapace ridge, one lateral to the frontal lobe, and a second above the frontal lobe; pre-anal telson longer than post-anal; 4-5 lateral telsonic setal pairs.....*Diastylis californica*
- 15a. Pre and post-anal portions of telson subequal.....16
- 15b. Post-anal portion of telson longer than pre-anal.....18
- 16a. Telson and uropodal peduncle subequal in length.....17
- 16b. Uropodal peduncle 1/3 longer than telson.....*Diastylis alaskensis*
- 17a. Oblique carapace ridges reaching the ventral margin; telson with 2-3 setal pairs laterally.....*Diastylis abbotti*
- 17b. Oblique carapace ridges extend forward at the base, not reaching ventral margin; telson with 6 setal pairs laterally.....*Diastylis quadriplicata*
- 18a. Post-anal telson twice the length of pre-anal; 8-9 lateral setal pairs on telson; the carapace ridges not anastomosing into polygons mid-dorsally.....*Diastylis dalli*
- 18b. Post-anal telson 1 1/2 times the length of pre-anal; 5 lateral setal pairs on telson; carapace ridges forming polygons mid-dorsally.....*Diastylis santamariensis*

Diastylodes – A small genus of seven described species worldwide (Băcescu 1992) to which an eighth must now be added (Gerken 2005). The only species known from the NEP is the newly described *D. pacificus*, from deep-water off Baja California. Reyss (1974) provides a key to the genus except for *D. pacificus*. *Diastylodes pacificus* is most similar to *D. atlanticus* (Gerken 2005) and should key with that species in Reyss' key.

Diastylopsis – The genus is easy to recognize because of its long cylindrical carapace. It occurs in relatively shallow sands, but in some areas has been reported as deep as 60m. This seems rather atypical, but the members of the genus cannot be confused with any other present in the NEP, and so these deep records are regrettably and suspiciously accepted. There seems to be a good separation between the two taxa which occur in the area, with *D. dawsoni* occurring north of Pt. Conception, and *D. tenuis* occurring south of that biogeographic divider in the SCB. There is some overlap, however, and specimens taken in the area bounded by Pt. Conception and Morro Bay should be carefully examined; *D. tenuis* does occasionally occur there. I know of no substantiated reports of *D. dawsoni* within the SCB, however. Barnard and Given (1962) state that they had been unable to find intergradation (I assume this to mean hybridization) between the two taxa, despite examination of a great deal of material. They illustrate the male of *D. tenuis*, which was not known to Zimmer when he described the species (Zimmer 1936). The two species can be distinguished by their sternal tooth formulae (ventral teeth on thoracic and abdominal somites). In males it is T2 (1), T3 (1), T4 (0), T5 (1), A1 (1), A2 (1), A3 (0) for *D. tenuis* and T2 (0), T3 (0), T4 (0), T5 (2), A1 (1), A2 (1), A3 (1) in *D. dawsoni*. For females the formulae are T5(1), A1(0) in *D. tenuis* vs. T5(2), A1 (1) in *D. dawsoni*.

Leptostylis – As discussed by several authors (i.e. Day 1980, Gerken 2005, Gerken and Watling 1998, Watling and McCann 1997) the genus tends to intergrade with *Diastylis* and *Makrokylindrus*. Previous seemingly clear distinctions in telson structure are now blurred, so that determination of *Leptostylis* is no longer straightforward. Problems continue to make themselves apparent. With the provisional *Leptostylis sp F* for instance, the males do not bear pleopod primordia until they are in the pre-reproductive molt, and then they are rudimentary (only two small articles). No males with fully developed pleopods have yet been found, but one which shows the rudiments of two pleopods is known from the Tanner Basin. As is often the case, the problem did not appear until sufficient material was available for full characterization of the taxon. Since the pleopods are so little developed, sexing the animals depends on the count of epipods on the pereopods: 1-4 in the male, and 1-2 in the female. It is possible that this species never fully develops setose pleopods in the male; we will keep looking for additional material to answer that question. Day (1980) used male pleopod number as a distinguishing factor in the separation of the Diastylidae and Gynodiastylidae. She defined the Gynodiastylidae as lacking pleopods in the male, and the Diastylidae as bearing two pleopods in the male. Difficulty with male pleopods was already apparent in the description of *Atlantistylis* by Reyss (1975), a genus lacking pleopods in the male, but retained in the Diastylidae by Day (1980) without comment on the disparity. It has recently led to erection of new genera of diastylids similar to *Leptostylis*, but with a single pleopod in the adult male (*Ehtonodiastylis*, Gerken et al 2000; *Divastylis*, Mühlenhardt-Siegel 2003).

Makrokylindrus – Six representatives of this genus are found in the NEP, two provisionals from the Tanner Basin, one from the Cascadia Slope; two described species from considerably to the south, in deep-water of the Gulf of Panama and off the Galapagos (Băcescu 1962), and one in Bering Sea waters (see Lomakina 1958), all in the sub-genus *Adiastylis*. Members of the subgenus *Makrokylindrus* ss occurs sparingly (3 spp.) in the NW Pacific, but is absent in the Eastern Pacific. Members of the subgenus *Adiastylis* are also present, and diverse, in the NW Pacific (6 species). The genus, including both subgenera, is distributed world-wide, with many representatives in the Atlantic, Indian, and Pacific Oceans, and a few in the polar seas. Băcescu (1992) lists 15 species in *Makrokylindrus* ss., and 40 in *Adiastylis*, but this number has certainly increased in recent years (i.e. Mühlenhardt-Siegel 1997). It is best separated from *Diastylis* by the relative lengths of the pre and post anal sections of the telson, but there is a tendency for this to intergrade in some forms.

Oxyurostylis – Băcescu (1992) lists only five species in the genus, and no additional ones have been described since. Two of these species occur in the NEP. The record of *Oxyurostylis sp.* (J. L. Barnard (1970) represent undeterminable specimens, since both *O. pacifica* and *O. tertia* were reported from the collections. Specimens of *O. tertia* are unlikely to occur much to the north of San Diego, although that remains a possibility during ENSO events with strong northward warm current flow. All *Oxyurostylis* are shallow water animals, and the 76m record for *O. pacifica* is unusual, most specimens being taken shallower. They frequent bays and estuaries, and were common components of several associations the benthos in Bahia San Quintin (J. L. Barnard 1970).

Vemakylindrus – Ten species in this genus were listed by Băcescu (1992), to which *V. hystricosa* Gerken 2002 must be added. A juvenile specimen of this species was taken in the Tanner Basin at around 1150m. While this initially appeared separable, the differences were, on further reflection, ascribed to ontogenic change, and the erected provisional was synonymized with *V. hystricosa*. Members of this genus seem to be very uncommon locally, with only five specimens known from California, three of them manca. No material identifiable as *Vemakylindrus* was recorded from the bathyal-abyssal collections made in the Gulf of the Farallones near San Francisco, and none has yet been located in materials from bathyal and abyssal depths off Oregon. Similarly the two species described from deep tropical waters in the Eastern Pacific (Băcescu, 1961) are known from a total of three specimens.

Additional References (see Part 1 for Main reference list)

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The cumacean family Lampropidae is the second of three families belonging to the clade of forms with articulated telsons. It, along with the families Diastylidae, and Gynodiastylidae form this clade. The Pseudocumatidae, the sister taxon to all other cumaceans, also has an articulated telson. The Lampropidae is smaller than the Diastylidae, which was previously covered, having only 58 species distributed among 13 genera in the Crustaceorum Catalogus treatment (Băcescu 1988). Additional forms have been described since. In the NEP only four genera of lampropids are known to occur, with 20 species; nearly a third of which are provisionals. Like the diastylids, the lampropids are primarily a cool water and/or deep water group (Day 1978). Most of the local lampropids are in the genus *Lamprops*, which is a generally shallow-water genus of the northern Hemisphere (Day 1978). The genus *Mesolamprops* is also primarily shallow-water, while *Hemilamprops* and *Paralamprops* are deeper dwelling. The family is sexually dimorphic along the lines of most cumacean families. Unfortunately, the taxonomy at the generic level is dominated by separations based on adult male morphology. This makes it impossible to accurately place females and juveniles of a species in the appropriate genus, although specific identity may be clear.

It should be noted that under ICZN Article 30.1.4.3. all generic group names ending in -ops are to be treated as masculine. In consequence, to retain agreement in gender, all species level names originally proposed as feminine or neuter must be recast in masculine. For species in this family, where most generic names end in -ops, the appropriate masculine ending for species level names is -us rather than -a. All names have been emended below to conform to this article.

NEP Lampropidae from McLaughlin et al (2005) augmented by known provisional taxa.
*= Taxa on the SCAMIT Ed 4 list + addenda. Valid taxa bolded, synonyms not.

Lampropidae

***Hemilamprops californicus** Zimmer 1936 – Japan, Puget Sound to San Diego;
13-177m

Hemilamprops gracilis J. F. L. Hart 1930 - Alaska to Puget Sound; 120-200m

***Hemilamprops sp A** MBC 1985§ - Oregon to Huntington Beach;
305-798m

Hemilamprops sp B Paquette 1985§ - Oregon to Anacapa Island; 185-732m

Lamprops augustinensis Gerken 2005 – Cook Inlet, Alaska; 0-1m

Lamprops beringi Calman 1912 – Arctic Alaska to Puget Sound; 0-129m

***Lamprops carinatus** J. F. L. Hart 1930 – Arctic Alaska to SCB; 18-120m

Lamprops fuscatus G. O. Sars 1865 – No. Atlantic; SE Alaska to Puget Sound;
2-121

Lamprops krasheninnikovi Derzhavin 1926 – NW Pacific to Puget Sound;
0-12 m

Lamprops obfuscatus (Gladfelter 1975) – Tomales Bay; 18m

***Lamprops quadriplicatus** S. I. Smith 1879 – NW Pacific; Alaska to Oxnard; 0-
104m

- Lamprops serratus** J. F. L. Hart 1930 – Puget Sound; 20-95m
Lamprops tomalesi Gladfelter 1975 – Tomales Bay; 6m
Lamprops triserratus (Gladfelter 1975) – Tomales Bay to Oxnard; 7-16m
Lamprops sp D MBC 1985§ - SCB; 69-197m
Lamprops sp E MBC 1985§ - off Pt. Arguello; 951m
Lamprops sp F MBC 1985§ - off Pt. Arguello to Tanner Basin; 954-1150+m
***Mesolamprops bispinosus** Given 1964 – Pt. Conception to San Diego;
 30-100m
Mesolamprops dillonensis Gladfelter 1975 – Tomales Bay; 13-21m
Paralamprops sp BAP1 Cadien 2001§ - Baja Abyssal Plain; 3880-3950m

Key to the NEP Lampropidae (modified from Jones 1969) – dbcadien 6 November 2006

- 1a. Males with pleopods.....2
 1b. Males lacking pleopods.....*Lamprops* (see key to genus)
 2a. Male with two pleopods.....*Mesolamprops* 3
 2b. Male with three pleopods.....4
 3a. Uropodal exopod shorter than endopod; telson with two pairs of lateral setae or spines; carapace lacking incised sulcus around ocular lobe and pseudorostrum, smooth.....*Mesolamprops bispinosus*
 3b. Uropodal exopod as long as endopod; telson with 3-6 (usually 4-5) pairs of setae or spines laterally; carapace with incised sulcus around ocular lobe and pseudo-rostrum as in *Hemilamprops californicus*.....*Mesolamprops dillonensis*
 4a. Basal article of uropodal exopod subequal to or longer than distal article; basis of third maxilliped distally widened*Hemilamprops* 5
 4b. Basal article of uropodal exopod much shorter than distal article; basis of third maxilliped not distally widened.....*Paralamprops* sp. BAP1
 5a. Carapace with incised sinus enclosing pseudorostrum and eyelobe extending ½ carapace length then curving to dorsal midline.....*Hemilamprops californicus*
 5b. Carapace lacking incised sulcus, but with other carapace sculpture.....6
 6a. Carapace with serrate mid-dorsal crest on anterior ½.....*Hemilamprops* sp A
 6b. Carapace lacking mid-dorsal crest.....7
 7a. Carapace with a single horizontal carina extending from position of antennal sinus posteriorly which sweeps up to the dorsal midline at the posterior carapace margin telson with three subequal terminal spines, and 4 pairs of lateral telsonic spines or setae.....*Hemilamprops gracilis*
 7b. Carapace with series of anastomosing ridges which divide it into several irregular polygons of various sizes on each side of carapace; telson with three subequal terminal spines, and 2 pairs (♂) or 8-9 pairs (♀) of lateral setae or spines.....
*Hemilamprops* sp B

Hemilamprops – *Hemilamprops californicus* is very common at shallow shelf depths in the SCB. It can be confused with individuals of *Mesolamprops bispinosus*, particularly in the female. Close attention must be paid to the number and position of the lateral setal pairs on the telson to distinguish females and juvenile males of these two taxa. Adult males can easily be distinguished by the number of pleopods; 2 in *Mesolamprops*, 3 in *Hemilamprops*. The condition of the carapace also differs in the two, with the cephalic shield (termed an incised sulcus in the above key) better developed and more defined in *H. californicus* than in *M. bispinosus*. The two taxa can co-occur, so species identity is specimen dependant, and not based on the identity of the males in the sample. *Hemilamprops gracilis* is known only from boreal seas to the north in the NEP, but could range further south than current reports indicate under La Niña oceanographic conditions.

The two provisional taxa in the genus locally are very different, and only one is known to range into the SCB. *Hemilamprops* sp A was taken several times in B'03 sampling at bathyal depths, and from the L.A. 3 Dump Site off Newport Beach. It was originally taken in Central California as part of the MMS Santa Maria Basin Study, and has since been recorded on the Cascadia Slope off Newport, Oregon. There are similarities to several described species (*taseiana* described from Sagami Bay, Japan; and *normani* from the North Atlantic), but the species is still deemed separable. It is the only member of the genus in the NEP with a serrated dorsal crest.

Hemilamprops sp B was originally noticed in one of the BLM RIP samples from near Anacapa Island reexamined during the MMS Santa Maria Basin Study. A single juvenile male was present at Station 24844 at 185m on the island shelf between Anacapa Island and the mainland. A female of the species was taken at 492m off Pt. Sal in Central California. These remained the sole known representatives of the species until examination of samples from the Cascadia Slope in 2002 revealed the species was quite common at one 732m station (over 260 specimens of juveniles, adult males, and adult females). Sexual dimorphism is relatively strong in this species. Both males and females have the same base arrangement of three longitudinal ridges running obliquely forward on the carapace, but the pattern of anastomosing secondary ridges is very different in the two sexes, and more complex in the female. The telsons also differ markedly. In the female the telson bears 8-9 pairs of lateral setae, while in the male there are only two. The female telson is also somewhat longer relative to the uropodal peduncles than is that of the male.

Lamprops – This is the major genus in the family in the NEP, with 10 described and three provisional members. The occurrence of two provisional species in the vicinity of Pt. Arguello at nearly 1000 m depth is unusual. Both taxa are known from single specimens, however, and additional material may show that they belong in other genera in the family, *Leucon* being a predominantly shallow shelf genus. The number of species in the genus in the small area of Tomales Bay suggests that there is much hidden diversity in the NEP fauna, and that lampropids are locally underdescribed. Records of *Lamprops quadriplicatus* and *Lamprops krasheninnikovi* from the NEP may be difficult to unravel. *L. krasheninnikovi* was originally described as a subspecies of *quadriplicatus*, and it is not certain which form is referred to in earlier records of *L. quadriplicatus* from the area. Lomakina (1958) presents the forms as subspecies, providing a table for their

separation. Lie (1969) repudiated his earlier reports of *L. quadriplicatus krasheninnikovi* (Lie 1968), citing the observations of Given (1965) on Arctic material which suggested that the forms separated by Derzhavin were no more than variations, and not worthy of subspecific or specific separation. Hart (1987), however, continues to record *L. krasheninnikovi*, and no longer reports *L. quadriplicatus* from the Puget Sound area. McLaughlin et al (2005) do not offer a solution to this dilemma, listing *L. quadriplicata* only from the Atlantic, and not listing *L. krasheninnikovi* at all. In contrast Gerken (2005) expressed the belief that all the forms united under *L. quadriplicata* were probably separate species, as was the *L. quadriplicata longispina* identification of Gamô (1965) from Japan. Until the issue is further resolved, both taxa are presented here as being valid at the species level. They are, however, keyed together below. The provisional form *Lamprops* sp F is known only from females, so cannot be accurately placed in the absence of information on male pleopod count. Since the pseudorostrum is long and acute, and the telson is about equal in length to the urosomal peduncle, this may actually be a member of the genus *Pseudodiastylis*. Accurate placement awaits males, and it is retained in *Lamprops* pending their collection.

Key to known NEP members of the genus *Lamprops* – drcadren 6 November 2006

- 1a. Telson armed with terminal spines, but lacking lateral setae or spines.....2
- 1b. Telson armed with terminal spines and one or more pairs of lateral setae or spines
.....5
- 2a. Carapace with dorsal carina or keel for at least ½ length.....3
- 2b. Carapace lacking dorsal carina or keel.....4
- 3a. Thoracic somites T1-T3 each with anterior tooth on dorsal midline.....
.....*Lamprops triserratus*
- 3b. Thoracic somites T1-T3 lacking teeth on dorsal midline.....*Lamprops carinatus*
- 4a. Terminal telsonic spines with middle spine and outer pair subequal in length,
intermediate pair only half as long.....*Lamprops obfuscatus*
- 4b. Terminal telsonic spines with middle spine and inner pair subequal in length,
outer pair shorter (about 2/3 length of central 3).....*Lamprops tomalesi*
- 5a. Telson bearing a single pair of lateral setae.....*Lamprops* sp F
- 5b. Telson with 2 or more pairs of lateral setae.....6
- 6a. Telson with 5-6 pairs of lateral setae.....*Lamprops beringi*
- 6b. Telson with 2-4 pairs of lateral setae.....7
- 7a. Carapace lacking carinae or ridges..... *Lamprops* sp D
- 7b. Carapace bearing one or more ridges or carinae.....8
- 8a. Carapace with single horizontal or mid-dorsal carina.....9
- 8b. Carapace with multiple oblique ridges.....12
- 9a. Carapace with a single horizontal carina extending from the antennal sinus 2/3 of
the distance to the posterior carapace edge.....*Lamprops* sp E
- 9b. Carapace with a mid-dorsal carina.....10
- 10a. Median telsonic terminal spine only about ½ length of the other four.....
.....*Lamprops fuscatus* (♂)
- 10b. Median telsonic terminal spine subequal in length to intermediate pair.....11

- 11a. Median telsonic terminal spine and intermediate pair subequal and about 2/3 the length of outer spine pair.....*Lamprops serratus*
- 11b. Outer terminal spine pair slightly longer than median three spines.....*Lamprops fuscatus* (♀)
- 12a. Carapace bearing partial ridges between the four major oblique carapace ridges; eyelobe reaching nearly to edge of pseudorostrum.....*Lamprops quadriplicatus* and *Lamprops krasheninnikovi*
- 12b. Carapace lacking partial ridges between the four major oblique carapace ridges; eyelobe separated by ½ its length from the pseudorostral margin.....*Lamprops augustinensis*

Mesolamprops - Băcescu (1988) lists only four species in this genus, two of which occur in the NEP. The bathymetric distribution of these taxa is peculiar. Both of the local species are inner to mid shelf animals, while the Mediterranean *M. denticulatus* is upper bathyal, and *M. abyssalis* from the Tropical West Atlantic is abyssal (Băcescu 1988). Gladfelter (1975) provides a useful character table for the separation of the two local species in the genus, and adds *Hemilamprops californicus*, which can be confused with *M. dillonensis*. There should be little difficulty in applying this table in the SCB, as *M. dillonensis* is not known to occur south of Central California. While the cephalic shield is better expressed in *Hemilamprops californicus* males than in females, it is well-enough marked that separation of *H. californicus* from *M. bispinosus* females can be based on the carapace alone. It is wise, however, to also check the number of lateral setal pairs on the telson, which will also separate the two forms. As mentioned under *Hemilamprops*, the two species can and do occur together, with males of each species found with females of either.

Paralamprops - The characters used in the above key to lampropids are those of the genus, and do not serve to separate *P. sp* BAP1 from others in the genus. Currently only one species in the genus is known from the NEP. The genus is composed of at least 15 species worldwide, distributed primarily in the Atlantic and Antarctic. While the majority of the species are known from bathyal depths, they also occur at abyssal and hadal depths (Băcescu 1988). Most of these taxa are keyed in Day (1978), but the three species of Reyss (1978), and that of Mühlenhardt-Siegel (2005a) are missing as is the local provisional. The local species is, like much of the genus, large. The single known specimen being a mature male over 2 cm long. *Paralamprops sp* BAP1 differs in carapace morphology from all other members of the genus, not fitting either half of couplet one in Day's key. It bears a single pair of dorso-lateral ridges, which are not marginal. It also has a very prominent crest like hump behind the obscure ocular lobe, The dorso-lateral ridges and the post-ocular hump are both rounded. Thoracic somites T1-T5 all bear flattened lateral alae which are largest on T2. The lobe on T5 is not a flattened alar plate as are those on the preceding segments, but a short lateral swelling of the somite. The telson is nearly as long as the uropodal peduncles; the pre-anal portion very short, and the post-anal portion linear and not tapering.

Additional Literature Cited (see Part 1 for Main reference list)

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The Leuconidae is a moderately sized family (96 species in 1988, with a number described since, i.e. Mühlenhardt-Siegel 2005b) distributed primarily in polar and/or cold waters (Băcescu 1988). In the NEP the family is represented by 26 taxa distributed among 6 genera, one with 5 subgenera. Barysheva (1984) gives a useful account of cumacean distribution in the eastern Bering Sea, which deals for the most part with members of this family. A major revision of the entire family was performed by Watling (1991) who erected several new genera and subgenera. SCAMIT members generally avoid use of subgenera, except for a few groups where they appear to have utility in local waters. This is one of those groups. The genus *Leucon* has local members in five of the six available subgenera. In addition to the five subgenera listed by Watling (1991), Watling and McCann (1997) established the subgenus *Diaphonoleucon* (which remains monotypic), based on the local *Leucon declivis*, formerly *Leucon* sp H. Boundaries of the subgenus *Epileucon*, which was originally proposed as a full genus (Jones 1969), appear to have been stabilized by Watling (1991). The locally occurring *Leucon bishopi* was originally placed in *Epileucon*, but was transferred to *L. (Crymoleucon)* upon its creation by Watling (1991). The genus *Coricumma*, originally placed in the Bodotriidae (Watling and Breedy 1988), was transferred to the Leuconidae as part of the revision (Watling 1991). Emended diagnoses of all genera and subgenera known at the time are provided by Watling in his family revision. Keys to females of each of the genera and subgenera are also provided. These will be modified to accommodate the additional provisional species known from the NEP.

Leuconids are not particularly abundant where they occur, but *Leucon (Leucon) falcicosta* (as *Leucon* sp A) was identified as a member of the recurrent group associated with *Amphiodia urtica*; key species in the most widely distributed community in southern California (Jones 1969). In the same analysis *Eudorella pacifica* (as *Eudorella* sp A) was associated with recurrent group III, a group consisting entirely of small crustaceans, which occurred along the entire coast of the SCB.

Despite the efforts of Given (1961) and of Watling and McCann (1997) the family has many undescribed provisional forms in the NEP. Since it is known to exhibit strong patterns of sibling replacement by depth along continental margins (see Bishop, 1982), the occurrence of numerous species in any geographic area is not unexpected. In the NEP most of the genera and subgenera in the family are apparently well-described, with no known provisionals in *Alloeoleucon*, *Eudorella*, *Eudorellopsis*, *Leucon (Crymoleucon)*, *Leucon (Diaphonoleucon)*, *Leucon (Epileucon)*, *Leucon (Macrauloleucon)* and *Nippoleucon*. Only in *Leucon (Leucon)* are there known but undescribed forms (5 of 11). It is likely that additional work with existing deep-water materials will indicate additional provisional taxa, at least in the genus *Eudorella*. Cadien provided a key to the species of *Leucon* known from southern California at a SCAMIT meeting in February of 1986.

Sexual dimorphism is variable in the family, with some species having males and females virtually identical in all respects except secondary sexual characters of antennal length, pleopod number, and epipod development. In others the non-sexually based morphology diverges significantly between males and females, usually in details of the

carapace and the uropod. Members of multiple species within a genus are seldom found in the same grab samples (epibenthic sled samples and other distance-integrating devices usually do have more than one species present), but one cannot immediately assume that males and females taken from a single grab or core are conspecific. Within the genus *Leucon* in local waters the only species where males and females are nearly always taken together is *Leucon (Leucon)* sp G. Virtually all collections of this animal have included both males and females where more than a single specimen was caught.

NEP Leuconidae from McLaughlin et al (2005) augmented by known provisional taxa.

*= Taxa on the SCAMIT Ed 4 list + addenda. Valid taxa bolded, synonyms not.

Alloeoleucon santamariensis Watling and McCann 1997 – Central California; 92-410m

Coricuma nicoyensis Watling and Breedy 1988 – Gulf of Nicoya, Costa Rica; 0-1m

Epileucon sp B see *Leucon (Crymoleucon) bishopi*

***Eudorella pacifica** J. F. L. Hart 1930 – Puget Sound to San Diego; 20-732m

Eudorella redacticruris Watling and McCann 1997 – off Pt. Conception; 430m

Eudorella tridentata see *Eudorella pacifica*

Eudorella truncatula Bate 1856 – Mediterranean, No. Atlantic; NEP from Alaska to Central California; 410-2816m

Eudorellopsis biplicata Calman 1912 – NW Atlantic to NWP, Arctic Alaska; 20-1514m

Eudorellopsis integra (S. I. Smith 1879) – NW Atlantic, Arctic, NWP, NEP to SE Alaska; 1.5-1500m

***Eudorellopsis longirostris** Given 1961 – Puget Sound to San Diego; 11-606m

Eudorellopsis ushakovi Lomakina 1955 – NWP to SE Alaska; 85-412m

Hemileucon comes see *Nippoleucon hinumensis*

Hemileucon hinumensis see *Nippoleucon hinumensis*

***Leucon (Crymoleucon) bishopi** Băcescu 1988 – Oregon to Gulf of Panama; 477-930m

Leucon (Crymoleucon) savulescui Petrescu 1992 – Baja Abyssal Plain to Peru-Chile Trench; 3880-4723m

***Leucon (Diaphonoleucon) declivis** Watling and McCann 1997 – Oregon to Huntington Beach; 367-952m

Leucon (Epileucon) bishopi see *Leucon (Crymoleucon) bishopi*

Leucon (Epileucon) tenuirostris G. O. Sars 1886 – So. Atlantic; NEP to Peru-Chile Trench; 300-4116m

Leucon (Leucon) armatus Given 1961 – Pt. Sur, Central California to Mugu Submarine Canyon; 107-222m

***Leucon (Leucon) falcicosta** Watling and McCann 1997 – Crescent City to San Diego; 90-410m

Leucon (Leucon) fulvus G. O. Sars 1864 – No. Atlantic, NWP to Puget Sound; shallow subtidal

***Leucon (Leucon) magnadentatus** Given 1961 – Crescent City to Tanner/Cortez Banks; 109-953m

- Leucon (Leucon) nasica** Krøyer 1841 – No. Atlantic, NW Pacific, NEP to Puget Sound; 4-659m
- ***Leucon (Leucon) subnasica** Given 1961 – Morro Bay, Central California to SCB; 15-1372m
- Leucon (Leucon) sp G** MBC 1985§ - Pt. San Luis, Central California to Western Santa Barbara Channel; 366 – 954m
- Leucon (Leucon) sp I** MBC 1985§ - off Morro Bay, Central California; 592m
- Leucon (Leucon) sp J** MBC 1985§ - off Diablo Canyon, Central California; 396m
- Leucon (Leucon) sp L** Cadien 1986§ - Baja Abyssal Plain; 3880-3950m
- Leucon (Leucon) sp N** Cadien 1990§ - Prince William Sound, Alaska; shallow shelf
- Leucon (Macrauloleucon) spinulosus** Hansen 1920 – No. Atlantic, NWP; NEP from Cascadia Abyssal Plain to Baja Abyssal Plain; Peru-Chile Trench; 698-5841m
- Leucon sp A see *Leucon (Leucon) falcicosta*
- Leucon sp B see *Leucon (Crymoleucon) bishopi*
- Leucon sp H see *Leucon (Diaphonoleucon) declivis*
- Leucon sp K see *Leucon (Macrauloleucon) spinulosus*
- Leucon sp M see *Leucon (Crymoleucon) savulescui*
- Nippoleucon hinumensis** (Gamô 1967) – Japan, introduced to NEP bays, Puget Sound to San Francisco Bay; 2-40m

Key to the genera of Leuconidae in the NEP (adapted from Watling 1991) – dbcadien, 8 November 2006

- 1a. Distinct eye lens and/or pigment present.....*Coricum*
- 1b. Eye lobe without lens or pigment.....2
- 2a. Efferent orifice anterior or anterodistal.....3
- 2b. Efferent orifice distinctly dorsal, pseudorostral lappets bent posterad and directed dorsally.....5
- 3a. ♂ without pleopods; ♂ antenna 2 not reaching end of pereon (thorax).....4
- 3b. ♂ with 2 pairs of pleopods; ♂ antenna 2 extending along pleon (abdomen).....*Leucon*
- 4a. ♂ lacking strong setal brush on antennal peduncle; ♂ antennal flagellum not modified for grasping (mid to outer shelf).....*Alloeoleucon*
- 4b. ♂ with strong setal brush on antennal peduncle; ♂ antennal flagellum modified for grasping (polyhaline bays and estuaries).....*Nippoleucon*
- 5a. Antennule (Antenna 1) geniculate between articles 1 and 2.....*Eudorellopsis*
- 5b. Antennule (Antenna 1) geniculate between articles 2 and 3.....*Eudorella*

Alloeoleucon – The genus remains monotypic, containing only the local *A. santamariensis*. It seems closely associated with *Nippoleucon*, being distinguished from it only by details of the adult male antenna, although the two genera are found in two different habitats. Female *Alloeoleucon* cannot be distinguished currently from female *Leucon* at the generic level, and differences between species must be recognized to properly place them as *Alloeoleucon*.

Coricum - Another monotypic genus, housing only *C. nicoyensis* from Pacific Costa Rica on intertidal mud flats. This genus along with the genus *Ommatoleucon*, bear

pigmented eyes; lacking in all other leuconids. It was initially placed in the Bodotriidae, and intergrades with members of that family in some respects. Watling (1991) reweighed the evidence, finding an error in the original characterization of the mandible as tapering rather than truncate. Truncate mandibles are a characteristic of leuconids. This reinterpretation, along with the description of the genus *Ommatoleucon*, another eyed leuconid, prompted his removal of the genus from the Bodotriidae and a relocation to the Leuconidae.

Eudorella – There are three valid taxa in the genus present in the NEP. A fourth, *Eudorella tridentata*, which was erroneously listed as valid in McLaughlin et al (2005), was synonymized with *E. pacifica* by Barnard and Given (1961), a judgment followed subsequently (Watling 1991, Watling and McCann 1997), although Hart (1987) continues to view it as valid. Variability in the genus was explored by Barnard and Given (1961), who documented significant variation in carapace morphology leading to synonymization of *Eudorella tridentata*. The potential for such variation elsewhere within the family must be considered, especially in deep-water forms where often few individuals are known. Once the variability was determined to be strong, members of this genus have nearly all been pigeon-holed into *E. pacifica* locally. It was not until Watling brought his broader experience from the North Atlantic into play that *E. truncatula* was recognized as occurring in the NEP (Watling and McCann 1997). Although it was mentioned from the NWP by Lomakina (1958), it was not detected by Hart or Lie in boreal NEP materials. The peculiar *E. redacticruris* has not been taken subsequent to its initial description, nor has it been recognized in preexisting materials.

Species of the genus are common in samples from deeper waters of the NEP, and require a more complete examination to determine their identity. Materials from the Baja Abyssal Plain seem grossly to differ from *E. pacifica* and *E. truncatula* (more closely resembling *E. fallax*), but have not been thoroughly analyzed. Similarly there appear to be several forms present in materials from bathyal and abyssal depths off Oregon currently under evaluation. At least one form from the Cascadia Abyssal Plain is reminiscent of both *E. hispida* and *E. hirsuta*, being covered with fine setae. It may however, belong to neither. As yet uncharacterized provisional *Eudorella* are to be expected from deeper NEP waters in future, but there are currently no recognized provisionals in the fauna. With the broad geographic ranges of deeper dwelling cumaceans, some of the species reported from western South America (Petrescu 1991) may be detected in NEP material. Three species not otherwise known from the NEP are recorded by him from Vema collections in the Gulf of Panama; *E. bacescui*, *E. fallax*, and *E. gracilior*.

Despite the demonstrated variability of *E. pacifica*, it may prove to house undetected siblings within that variability. Genetic examination of a broad spectrum of materials from the NEP is needed to clarify the genus, and allow better separation of its local members.

All local *Eudorella*, with the exception of *E. redacticruris*, are represented in Watling's 1991 key to females of the genus (p. 579-580). The key could easily be modified to include *E. redacticruris* by inserting the following couplet as couplet 0, and then following the existing key:

- 0a. Fifth leg lacking*Eudorella redacticurris*
- 0b. Fifth leg present1

Eudorellopsis – An engagingly strange carapace morphology defines this genus, with the pseudorostrum and anterior carapace strongly upswept, and the carapace strongly sculptured and calcified in many species. Four species are known in the NEP, but only one appears to be endemic to the area, *Eudorellopsis longirostris*. *E. ushakovi* and *E. biplicata* are species of trans-Pacific distribution, known from both the boreal NWP and the boreal NEP. *E. integra* is circum-Arctic in distribution and extends into the boreal regions of both the North Atlantic and North Pacific. The species can all be separated by use of Watling’s key to the genus (1991, p.580). No provisionals in this genus are yet known from the NEP. Of these forms only *E. longirostris* has a distribution extending to the temperate waters of the SCB.

Key to species of *Leucon* in the NEP (based on keys in Watling 1991, but modified to include both sexes where known) – dbcadien, 13 November 2006

- 1a. Branchial siphon elongate, greatly exceeding pseudorostrum.....*Leucon (Macrauloleucon) spinulosus*
- 1b. Branchial siphon normal length, protruding only slightly beyond pseudorostrum or no longer than pseudorostrum.....2
- 2a. Pereonite 5 with ventral hook(s).....*Leucon (Epileucon) tenuirostris*
- 2b. Pereonite 5 without ventral hook(s).....3
- 3a. Antenna 1 accessory flagellum extending at least to midlength of main flagellum 1st article.....*Leucon (Crymoleucon) 4*
- 3b. Antenna 1 accessory flagellum minute to short.....5
- 4a. Carapace with paired spine rows posteriorly which join to form dorsal crest row on the anterior carapace.....*Leucon (Crymoleucon) savulescui*
- 4b. Carapace lacking dorsal crest spines.....*Leucon (Crymoleucon) bishopi*
- 5a. Pleopods of male reduced to short peduncle bearing nub-like rami; branchial siphon exceeding pseudorostrum, but not greatly longer than pseudorostrum*Leucon (Diaphonoleucon) declivis*
- 5b. Pleopods of male with normal peduncles and setose rami; branchial siphon not or only slightly exceeding pseudorostrum.....*Leucon (Leucon) 6*
- 6a. Carapace with only a single tooth or denticle mid-dorsally.....7
- 6b. Carapace bears several teeth along dorsal midline.....8
- 7a. Carapace lacking well defined dorsal carina; anterior margin of pseudorostrum oblique, finely serrate; no teeth or denticles on underside of pseudorostrum; anterior ventral border of carapace smooth.....*Leucon (Leucon) sp 1 ♂*
- 7b. Carapace with well defined dorsal carina; anterior margin of pseudorostrum vertical, not serrate; strong teeth on underside of pseudorostrum, anterior ventral border of carapace serrate.....*Leucon (Leucon) fulvus ♂*
- 8a. Pereopod 1 basis with spines or denticles on posterior (ventral) margin.....9
- 8b. Pereopod 1 basis at most setose, lacking spines or denticles on posterior (ventral) margin.....13
- 9a. Pereopod 1 basis with a single tooth distally.....10

- 9b. Pereopod 1 basis with multiple teeth.....11
- 10a. Pereopod 1 merus also bears a single distal tooth.....*Leucon(Leucon) nasica*
- 10b. Pereopod 1 merus lacking distal tooth.....*Leucon(Leucon) subnasica*
- 11a. Pereopod 1 basis with 3 large teeth.....*Leucon (Leucon) magnadentatus*
- 11b. Pereopod 1 basis with 5-6 teeth.....12
- 12a. Carapace bearing 2-3 spines laterally.....*Leucon (Leucon) sp L*
- 12b. Carapace lacking spines laterally.....*Leucon (Leucon) sp N*
- 13a. Uropodal endopods shorter than exopods.....14
- 13b. Uropodal endopods longer than exopods.....15
- 14a. Carapace bearing a tooth or denticle laterally below the dorsal crest spines; a well incised distinct curving ridge defining an anterior lateral carapace sulcus.....
.....*Leucon (Leucon) falcicosta*
- 14b. Carapace without lateral tooth below dorsal crest; no defined lateral carapace sulcus.....*Leucon (Leucon) sp J*
- 15a. Anterior margin of pseudorostrum smooth.....*Leucon (Leucon) sp G*
- 15b. Anterior margin of pseudorostrum serrate.....16
- 16a. Uropodal endopod basal article four times length of terminal article; pereopod 1 article 3 with a single tooth.....*Leucon (Leucon) armatus*
- 16b. Uropodal endopod basal article less than twice the length of terminal article; pereopod 1 article 3 lacking tooth.....*Leucon (Leucon) fulvus* ♀

Leucon (Crymoleucon) – Currently represented in the NEP by two species, *L. (C.) bishopi*, which was originally characterized as an *Epileucon*, and *L. savulescui*. Watling and McCann (1997) provide a description and discussion of the former (although you may also want to examine the illustrations in Jones 1969), while *L. savulescui* is described by Petrescu (1992). The name *bishopi* is a replacement name for *Epileucon pacifica* of Jones 1969, a homonym of *Leucon pacificus* Zimmer 1937 proposed by Băcescu (1988). *L. (C.) savulescui* was known only from material from the Peru-Chile trench (Petrescu 1992), until it was recognized as identical to the provisional *Leucon* sp M from the Baja Abyssal Plain.

Leucon (Diaphonoleucon) – The length of the branchial siphon in this subgenus is intermediate, not nearly as long as the rolled tube of *L. (Macrauloleucon)*, but longer than that of the remaining subgenera. It extends noticeably beyond the tip of the pseudorostrum. Only a single species is currently assigned to the subgenus, *L. (D.) declivis*, for which it was created (Watling and McCann 1997). The species appears to be adapted to low-oxygen conditions, and is distributed bathymetrically across the oxygen minimum zone of the NEP. It is possible that the longer branchial siphon aids in some way in increasing the efficiency of the respiratory current, allowing the species to utilize habitat difficult for other species. The species is relatively large for the group, perhaps reflecting a broader ambit in daily activities than in smaller congeners.

Leucon (Epileucon) – Represented in the NEP only by the abyssal *L. (E.) tenuirostris* from the Arctic. Watling (1991) rediagnosed the subgenus based in part on the criteria established by Bishop (1981) in his reevaluation of *Epileucon* as a genus. Watling agreed with Băcescu that full generic status is not warranted, however, and reduced it to a subgenus of *Leucon*. *L. bishopi*, which was initially placed in *Epileucon*, was transferred to *L. (Crymoleucon)* by Watling.

Leucon (Leucon) – Contains the type of the genus *L. (L.) nasica*, as well as a number of species distributed in the NEP. Several, like the type, are apparently circum-borearctic, and are distributed in the colder waters of both the Atlantic and Pacific as well as the Arctic Ocean. A number of the NEP species are provisionals, placed here pending further assignment to other subgenera. Many will probably stay in *Leucon* ss., but a few will move to other subgenera, most probably *Leucon (Crymoleucon)* and *Leucon (Diaphonoleucon)*. As study materials become more numerous these reassessments should be increasingly possible. *Leucon* sp. M, initially placed here, has already been identified as *L. (Crymoleucon) savulescui* and removed. It is suspected that *Leucon* sp. N will eventually prove to be a *Diaphonoleucon*, but materials are not available for further study, leaving placement to be based on the original notes rather than specimens. Additional materials from deep water on the Cascadia Slope and Cascadia Abyssal Plain seem to contain several additional species, but most are likely to be placed in other subgenera and not *Leucon* ss., which is primarily distributed on coastal shelves. The local species are keyed in the *Leucon* key provided above. Important characters for specific determination are located on the carapace dorsal and ventral margins, on the pseudorostrum, on the maxilliped, on the basis of the first pereopod, and on the uropods.

Leucon (Macrauloleucon) – Originally established to receive three existing species by Watling (1991), the subgenus has grown considerably since to 8 described species (Ledoyer 1993; Mühlenhardt-Siegel 1994, 2005b). Mühlenhardt-Siegel (2005b) provides a character table comparing the eight described species, three newly described in the same paper. Most members of the subgenus are abyssal, but the two known Antarctic species are shelf to bathyal forms. It may be that the elongate tubular branchial siphon that characterizes this subgenus is helpful in the fine oozes which overlay abyssal plains and basins. There is considerable variability both between and within a sex of denticle and tooth counts and placement on the carapace. This is particularly true of the species recorded from the NEP, *L. (M.) spinulosus*. The variability was commented on by Hansen (1920) and later by Petrescu (1994). Two provisional species which differed slightly from the nominal pattern of *spinulosus* were created and later synonymized within a broader concept of that species' variability. The species has a very broad range, both in depth and zoogeographically. Subsequent comparisons of material may show that it is actually a complex of sibling species with higher endemism.

Nippoleucon - The genus *Nippoleucon* is known to be non-native in the NEP. It was introduced from Japan, with the local representative, *N. hinumensis*, becoming a major constituent of some disturbed bay/harbor benthic communities. This species, when initially taken in Newport Bay, Oregon in the 1980s, was believed to be *Hemileucon comes*, a native of New Zealand. *N. hinumensis* is a species tolerant of reduced salinities, and was originally described from oligohaline waters in Japan (Gamô, 1967). It has since spread both up and down coast to Puget Sound and San Francisco Bay. Some aspects of the ecology of this animal have recently been explored (Akiyama and Yamamoto 2004a,b) in populations within its home range. While males have distinctively modified antennae as well as differences in pleopod count, females cannot be distinguished from *Leucon* morphologically. *Nippoleucon* occur in different habitat from females of *Leucon* species, which are found nearly entirely on the open coastal shelf and slope.

Additional Literature Cited (see Part 1 for Main reference list)

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The nannastacids are a very diverse group, with Băcescu listing over 300 species in 20 genera (1992). This number of described species has continued to grow, and forms known locally also include a relatively large number of provisionals. Despite the diversity of genera known world-wide, there are only four present in the NEP, and only two of these are speciose: *Campylaspis* and *Cumella*. Both these genera are found from the deep-sea to the intertidal (Jones 1969). Both also have many representatives in shallow and deep waters, but periodic major descriptive works (i.e. Gamô 1964; Jones 1974, 1984; Petrescu and Iliffe 1992; Petrescu et al 1994) continually change the balance of deep vs shallow species.

The nominate genus *Nannastacus* literally means ‘tiny crayfish’. Attempting to recognize any similarity with crayfish in this genus quickly leads one to the conclusion that the original name was ill-conceived. Nannastacids are typically rather globose carapaced animals, usually higher posteriorly and sloping towards the pseudorostrum. There are, of course, no chelae or claws as might be suggested by the family name derivation. While most are small, a few of the *Campylaspis* are relatively large. *Cumella* species are nearly uniformly small.

NEP Nannastacidae from McLaughlin et al (2005) augmented by known provisional taxa.
*= Taxa on the SCAMIT Ed 4 list + addenda. Valid taxa bolded, synonyms not.

Family Nannastacidae

- ***Campylaspis biphlicata** Watling and McCann 1997 – Puget Sound to San Diego; 47-1372m
- ***Campylaspis blakei** Watling and McCann 1997 – Eureka to San Diego; 92-914m
- ***Campylaspis canaliculata** Zimmer 1936 – Fort Bragg to San Diego; 10-644m
- ***Campylaspis hartae** Lie 1969 – Puget Sound to San Diego; 7-207m
- ***Campylaspis maculinodulosa** Watling and McCann 1997 - Central California to San Diego; 25-154m (note: the synonymy of *C. sp B* Myers & Benedict with this species indicated in Watling and McCann is based on a misidentification. The two taxa differ in several respects)
- Campylaspis papillata** Lomakina 1952 – NWP, Oregon to SCB; 143-1150+m
- ***Campylaspis rubromaculata** Lie 1969 – Puget Sound to San Diego; 7-588m
- ***Campylaspis rufa** J. F. L. Hart 1930 - Vancouver Island to San Diego; 98-565m
- ***Campylaspis sp A** SCAMIT 1995§ - San Pedro Sea Shelf; 150-307m
- Campylaspis sp B** Myers & Benedict 1974§ - off Pt. San Luis, Central California to Los Angeles Harbor; 20-405m
- Campylaspis sp BAP1** Cadien 2001§ - Baja Abyssal Plain; 3880-3950m
- Campylaspis sp BAP2** Cadien 2001§ - Baja Abyssal Plain; 3880-3950m
- Campylaspis sp BAP3** Cadien 2001§ - Baja Abyssal Plain; 3880-3950m
- ***Campylaspis sp C** Myers & Benedict 1974§ - Sta. Cruz Island to San Diego; 12-27m

- Campylaspis* sp CS1 see *Campylaspis biplicata*
***Campylaspis* sp CS2** Cadien 2004§ - Oregon; 1372m
***Campylaspis* sp CS3** Cadien 2004§ - Oregon; 732-950m
***Campylaspis* sp CS4** Cadien 2004§ - Oregon; 1372m
***Campylaspis* sp CS5** Cadien 2004§ - Oregon to San Diego; 542-1372m
***Campylaspis* sp CS6** Cadien 2006§ - Oregon; 1372m
***Campylaspis* sp F** Myers & Benedict 1974§ - San Diego; 10m
***Campylaspis* sp J** Given 1970§ - SCB; shelf depths
***Campylaspis* sp N** MBC 1985§ - Oregon to San Gabriel Submarine Canyon; 107-950m
***Campylaspis* sp O** MBC 1985§ - Pt. Estero; 403m
***Campylaspis* sp TB1** Cadien 2004§ - Tanner Basin; 1150+m
Cumella bruinensis Gerken 2005 – Gulf of Alaska; 0-1m
****Cumella californica*** Watling and McCann 1997 – Soquell Submarine Canyon to Todos Santos Bay, western Baja California; 3-305m
Cumella morion Watling and McCann 1997 – Humboldt Bay to San Diego; 15-154m
Cumella vulgaris J. F. L. Hart 1930 – Vancouver Island to San Diego; 0-18m
****Cumella* sp B** Myers & Benedict 1974§ (see *Cumella morion*)
***Cumella* sp E** Phillips 1998§ - Santa Monica Bay;
***Cumella* sp F** MBC 1985§ - slope of San Pedro Sea Shelf; 305m
***Cumella* sp G** MBC 1985§ - Central California to San Pedro Sea Shelf; 102-197m
***Cumella* sp J** Paquette 1994§ - Goleta; 26-37m
Cumella (*Cumewingia*) sp 1 Donath-Hernandez 1985§ see *Cumella californica*
***Elassocumella* sp SD1** Nesler 2005§ - San Diego; 110-112m
***Platycuma* sp CS1** Cadien 2004§ - Oregon; 1372m
****Procampylaspis caenosa*** Watling and McCann 1997 – Cape Mendocino to San Diego; 11-200m
***Procampylaspis* sp CS1** Cadien & Martin MS – Oregon to Tanner Basin; 732-1150+m

Because so much of the NEP diversity of this family is in the genus *Campylaspis*, its members will be separately keyed. A key to genera occurring in the NEP, and to species in genera other than *Campylaspis* is provided below. If you arrive at the genus *Campylaspis* in the key, please proceed to the separate key to that genus which follows.

Key to Genera and non-*Campylaspis* species of Nannastacidae known from the NEP (based on Jones 1969)dbcadien – 17 November 2006

- 1a. Carapace flattened, plate-like; gut coiled.....*Platycuma* sp CS1
- 1b. Carapace rounded, tubular to bulbous; gut not coiled.....2
- 2a. Second maxilla dactyl strongly toothed, forming a rake; carapace invested in organic coat of sediment grains.....*Procampylaspis* 3
- 2b. Second maxilla not strongly toothed or rake-like; carapace not invested in organic coating, although may be strongly setose, retaining some debris.....4

- 3a. Second maxilla with two basal teeth of rake coalesced into an incised hump, followed by an elongate tooth, a very short tooth and the terminal tooth; ocular lobe bearing two spinules.....*Procampylaspis* sp CS1
- 3b. Second maxilla with first four teeth separate, and declining in length towards long strong terminal tooth; ocular lobe lacking spinules.....*Procampylaspis caenosa*
- 4a. Carapace bulbous (especially in females) and extending back over free thoracic somites; eye poorly developed or, if well developed, occurring as a single ocular group.....*Campylaspis* (see key to genus)
- 4b. Carapace flattened oval to tubular in both males and females, not covering any thoracic somite; eye(s) well developed, usually separated into a medial cluster of ocular elements (males with more, females with fewer).....5
- 5a. Females lacking exopods on third maxilliped and pereopods 1-3.....*Elassocumella* sp SD1
- 5b. Females with exopods on third maxilliped and on pereopods 1-3.....*Cumella* 6
- 6a. Uropodal peduncles shorter than last abdominal somite.....*Cumella* sp J
- 6b. Uropodal peduncles equal to or longer than last abdominal somite.....7
- 7a. Abdominal somites 1-4 with paired dorsal spines.....*Cumella* sp G
- 7b. Abdominal somites lacking paired dorsal spines.....8
- 8a. Uropodal peduncles more than twice length of last abdominal somite.....*Cumella* sp E ♂ (♀ unknown)
- 8b. Uropodal peduncles no more than 1 ½ length of last abdominal somite.....9
- 9a. Pseudorostrum anteriorly serrate.....*Cumella vulgaris*
- 9b. Pseudorostrum anteriorly smooth.....10
- 10a. Thoracic pleura laterally flaring.....*Cumella californica*
- 10b. Thoracic pleura not flared laterally.....11
- 11a. Carapace with strong mid-dorsal crest; females with inflated posterior carapace.....12
- 11b. Carapace lacking strong mid-dorsal crest; female with uninflated tubular carapace as in the male.....*Cumella* sp F
- 12a. Abdominal somites 1-4 with dorsally directed middorsal processes (but not paired spines).....*Cumella morion*
- 12b. Abdominal somites 1-4 without dorsal ornament.....*Cumella bruinensis*

Campylaspis – The genus *Campylaspis* has, if anything, too many bold characters on the carapace. The problems encountered in construction of descriptions and keys to these animals generally revolve around a non-standardized descriptive language for the types of ornamentation found on carapaces. Spines, bumps, pebbles, granules, tubercles, prickles, ridges, carinae, knobs, pits, troughs, grooves, sinuses, and setae (simple or plumose) are intertwined on the carapaces of these animals in a bewildering array of intergrading variations. Fortunately sexual dimorphism is not usually expressed in the types of ornamentation, although the strength of expression of individual features may vary between males and females of a species. In this genus the males are generally as large as or larger than the females, with a flatter more tubular carapace.

Jones (1974) gave a key to the 98 species known at that time, but subsequently added five additional species. Additional species have been described by others since,

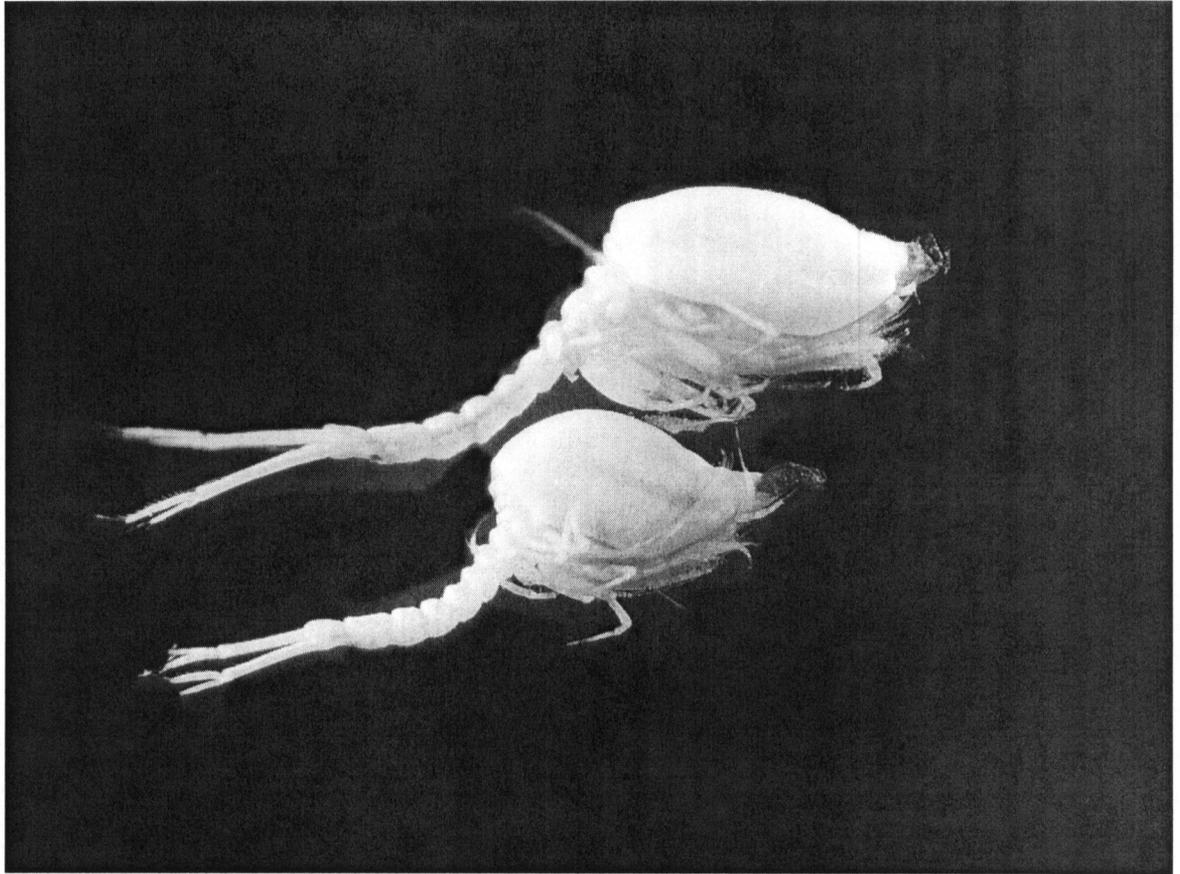
and there is no current key to the genus worldwide. We can adopt the six major species groups used by Jones (1974) in lieu of subgenera to help segregate these species into morphologically related clusters. They are as follows, with the NEP species belonging in them listed:

1. the *rubicunda* group

Members of this group have smooth carapaces, without lateral depressions, and with at most a pair of low rounded protuberances or with small granulations. Includes: *rufa*, sp BAP2, sp O, sp. CS5

2. the *sulcata* group

Members of this group have a depression on either side of the carapace (a sinus, groove, or trough). If distinct ridges are present they do not extend to the dorsal hind end of the carapace. Some spines or a few low protuberances may be present, but not conical, subcylindrical or rounded tubercles. Includes: *blakei*, *canaliculata*, sp B, sp F



Campylaspis canaliculata male and female: a member of the *sulcata* group

3. the *costata* group

These have one or more, usually two or three, distinct ridges running horizontally or obliquely backwards on either side of the carapace, of which at least one extends onto the dorsum. Depressions may be present between the

ridges, but they are not defined posteriorly. Tubercles are not present.
Includes: *biplicata*, *hartae*, sp. C, sp CS6

4. the *verrucosa* group
With moderate or large numbers of tubercles on the sides and dorsum of the carapace. These may or may not be organized into tuberculate ridges.
Includes: *maculinodulosa*, *rubromaculata*, *papillata*, sp BAP1, sp BAP3, sp CS3, sp CS4, sp. N, sp A
5. the *rostrata* group
A small group in which the pseudorostrum is prominent and enlarged. No currently known NEP species belong here.
6. the *spinosa* group
A residual group not fitting into any of the above clusters. Includes: sp CS2, , sp TB1, sp J

Despite their differences, *Campylaspis sp B* of Myers and Benedict and *Campylaspis biplicata* Watling and McCann are frequently confused. The former species is larger; both sexes of *C. biplicata* are mature at 2mm, while mature *C. sp B* are 3mm long. Females of *C. sp B* do not have the defined ridges shown by females of *C. biplicata*, but have the sulcus melding into the surrounding surface without a ridge at its margin. Uropodal peduncles of *C. sp B* are medially crenulate, those of *C. biplicata* are smooth. Males are more difficult to distinguish, but the sinus in *C. sp B* tapers anteriorly, while that of *C. biplicata* broadens anteriorly. Male uropodal endopods and peduncles are more strongly setose in *C. sp B*, only weakly setose in *C. biplicata*.

Many *Campylaspis* species have pigment, sometimes in chromatophore like spots or splotches on the carapace, thorax, abdomen, or appendages; sometimes as a tint or color diffused throughout the integument. Several of the local species have characteristic pigmentation, but it cannot always be relied upon. *Campylaspis rufa*, for instance, was described and named for its red integument. Unfortunately, specimens morphologically indistinguishable can be found in the same range which are pure translucent white. This same dichotomy is seen in *C. canaliculata*, which has both red and white forms.

Key to the species of *Campylaspis* known from the NEP – dbcadien 12December06

- 1a. Carapace smooth, without tubercles, ridges, or lateral depressions (sulci).....2
- 1b. Carapace ornamented with granules, ridges, tubercles, spines, or a combination of these features: if these are lacking, lateral depressions (sulci) are present.....5
- 2a. Carapace pyriform, low, setose, especially near eyelobe*Campylaspis sp CS5*
- 2b. Carapace globose, inflated, lacking setae, smooth.....3
- 3a. Uropodal rami and peduncle subequal in length.....*Campylaspis sp O*
- 3b. Uropodal peduncle much longer than rami.....4
- 4a. Uropodal peduncle tapered to base, distally flattened.....*Campylaspis rufa*
- 4b. Uropodal peduncle uniform width over length.....*Campylaspis sp BAP2*
- 5a. Carapace with ridges, tubercles, papillae, or spines.....9

- 5b. Carapace lacking ridges, tubercles (low granules may be present), or spines, but bearing lateral depressions (sulci) extending back from antennal sinus.....6
- 6a. Last two thoracic and first three abdominal somites bearing dorsolateral spikes
.....*Campylaspis blakei*
- 6b. Thoracic and abdominal somites lacking dorsolateral spikes.....7
- 7a. Carapace with two roughly parallel sulci laterally.....*Campylaspis sp F*
- 7b. Carapace with a single sulcus extending posteriorly from antennal sinus.....8
- 8a. Lateral sulcus long and narrow ($l/w=8+1$).....*Campylaspis canaliculata*
- 8b. Lateral sulcus broad ($l/w=4/1$).....*Campylaspis sp B*
- 9a. Carapace with lateral ridges, either smooth or tuberculate; may also bear tubercles or spines.....10
- 9b. Carapace lacking lateral ridges but bearing some combination of spines, tubercles granules, bumps; lateral sulci may also be present.....19
- 10a. Ridges form a reticulate anastomosis, not separable into individual ridges; ridges smooth, lacking tuberculations.....*Campylaspis hartae*
- 10b. Ridges separate, although two may join (or one bifurcate).....11
- 11a. Ridges smooth, lacking tuberculations.....12
- 11b. At least one ridge tuberculate or formed from a confluent row of tubercles.....15
- 12a. Two ridges on each side.....13
- 12b. Three ridges on each side.....14
- 13a. Pseudorostrum blunt, carapace blocky, not tapering anteriorly; lateral ridges barely raised above general surface, vertical, extending from ventral to dorsal over the carapace; no tubercles dorsally.....*Campylaspis sp CS2*
- 13b. Pseudorostrum pointed, not blunt; carapace inflated posteriorly and tapering to ocular lobe; lateral ridges sharply defined, raised considerably above general surface, oblique, extending from anterior to posterior of carapace; tubercles dorsally above lateral ridges..... *Campylaspis sp BAP3*
- 14a. With three ridges, all of which are of similar length and reach onto the dorsal carapace; thoracic somites without tubercles dorsally [shelf depths].....
.....*Campylaspis sp C*
- 14b. With three ridges, none of which reach the dorsal carapace; the first two much shorter than the third; thoracic somites bearing paired flattened granulate tubercles dorsally [bathyal depths].....*Campylaspis sp CS6*
- 15a. With 4 ridges, all reaching the dorsal carapace; body orange-red with darker spots and chromatophore clusters; uropodal peduncles quadrangular in cross-section
.....*Campylaspis sp A*
- 15b. With fewer than 4 ridges, integument not orange-red; uropodal peduncles either round, oval, or flattened in cross-section.....16
- 16a. With 3 tuberculate ridges, the middle one shorter.....*Campylaspis rubromaculata*
- 16b. With 2 ridges on each side.....17
- 17a. Ridges tuberculate in both male and female.....18
- 17b. Ridges tuberculate in female, smooth in male.....*Campylaspis biplicata*
- 18a. Last 3 thoracic and all abdominal somites with paired pointed dorsal tubercles; carapace strongly tuberculate, ridges with flattened tubercles; ivory white, with no pigmented chromatophores.....*Campylaspis sp CS4*
- 18b. Thoracic and abdominal somites lacking dorsal tubercles; carapace granulate to

- weakly tuberculate; ridges with low tuberculations only; carapace with numerous small reddish-purple chromatophores.....*Campylaspis maculinodulosa*..
- 19a. Carapace with a lateral sulcus as well as bearing tubercles dorsally; sulci short, not reaching more than ½ carapace length, curved.....*Campylaspis sp J*
- 19b. Carapace lacking lateral sulci; bearing spines, papillae, bumps, granules, or tuberculations.....20
- 20a. Pseudorostrum blunt, strongly upturned; carapace with paired rows of spines (sharply pointed tubercles) along dorsal margins.....*Campylaspis sp TB1*
- 20b. Pseudorostrum obtusely pointed, horizontal, not strongly upturned; carapace with surface ornament scattered over surface, not arranged in longitudinal rows along dorsal margin, lacking sharply pointed tubercles (spines).....21
- 21a. Carapace bearing very small low pimple-like tubercles scattered evenly over carapace surface; anterior ventral margin strongly dentate; uropods short, with relatively stubby rami.....*Campylaspis sp CS3*
- 21b. Carapace bearing larger bumps or papillae arranged in rows across or along length of carapace, but not defining dorsolateral carapace margins.....22
- 22a. Uropodal peduncle broad and flattened; broader than the combined width of the uropodal rami; carapace tuberculations somewhat flattened, not globose or conical eyelobe prominent.....*Campylaspis papillata*
- 22b. Uropodal peduncle not broad and flattened; narrower than the combined width of the uropodal rami; carapace ornaments either conical bumps or globose papillae, not flattened tubercles; eyelobe absent or obscure.....23
- 23a. Carapace bearing large globose papillae; no chromatophore concentrated pigment; posterior margin of abdominal somites bearing ring of 4-5 teeth on each; uropodal peduncle with 4-5 small spines on mesial margin.....*Campylaspis sp BAP1*
- 23b. Carapace bearing smallish conical bumps; red pigmented chromatophores scattered over carapace surface on and between bumps, and on abdominal somites; dorsal spines present on abdominal somites, but no posterior marginal teeth; uropodal peduncles bare mesially.....*Campylaspis sp N*

Cumella - The genus *Cumella* is particularly diverse, especially in the tropics and subtropics, with many species described recently from the tropical West Atlantic (Băcescu 1992, Băcescu and Iliffe 1991, Băcescu and Muradian 1977, Petrescu 1996, Petrescu and Heard 2004, Petrescu and Sterrer 2001). NEP diversity in this group remains poorly investigated, and many additional species are likely to be detected in temperate to tropical Eastern Pacific areas. All the members of the genus are very small, and this tends to complicate the detection and definition of species. Live collected material often has pigmentation cues for separation of closely related congeners (based on personal observations in the British Virgin Islands, where 13 *Cumella* species were separated based on live appearance), but these are immediately lost in preservation.

Another set of character states based on eye configuration can be separatory within a fauna. These states are sex specific, however, so must be used with caution, and with adequate material available to provide both sexes of encountered species. *Cumella* species are often quite abundant when their particular habitat is sampled, and frequently both sexes will be taken, allowing use of sex specific characters. Habitats for the

members of this genus are diverse, ranging from clean coarse coral sand, through fine silts to algal association. Sediment preferences in one local species have been investigated (Wieser 1956).



One of the undescribed *Cumella* species from Guana Island, British Virgin Islands. Unpreserved specimen to show pigment pattern of white dots and brown splotch on carapace, and rings of dark pigment on abdomen (Photo – Leslie Harris).

In at least one deep-water species a scavenging opportunist strategy is used by the organism to coverage on, and feast upon, food falls (Smith 1986). Similar behavior has not, to my knowledge, been observed in shallow water members of the genus. Mouthpart structure suggests that a more frequent nutritive mode is that of filtering deposit feeder.

Elassocumella – Was erected to house *Cumella micruropus* from the Tropical Western Atlantic. Aside from the shortness of the uropodal peduncles, the distinguishing character is the lack of exopods on either the third maxilliped or any of the pereopods of the female. This strongly distinguishes this genus from all others in the family. The local species is very similar to *Cumella californica* in most respects, but lacks the female exopods, placing it in *Elassocumella*. It is possible that this is a variable expression which is somehow related to growth or environmental parameters, and that the genus is consequently ill-founded.

Platycuma – The genus is primary known from the Atlantic (5 species listed in Băcescu 1992), the present provisional is the first known representative from the Pacific. The carapace is greatly flattened and plate-like in these species, all from deep bathyal to abyssal depths. The local provisional species, from the Cascadia Slope at 1372m, is known from a single specimen.

Procampylaspis – Like the preceding genus, nearly all species of *Procampylaspis* are known from bathyal and abyssal depths. Of our two local species, one is known from continental shelf depths (*P. caenosa*), and the other from the lower bathyal (*P. sp.* CS1). Most species in this genus, including the two local representatives, envelope themselves in an organic matrix filled with fine sediment grains. This forms an adherent coating which is very difficult to remove and obscures details of the carapace surface. The composition of this material and its method of formation are both unknown.

While generally like *Campylaspis* in carapace formation and external appearance, members of *Procampylaspis* all bear a specially modified clawlike dactylar rake as the

distal article of the second maxilliped. The spine formula of this differs between the species, and is diagnostic for the local forms. Stebbing (1913) considered this genus to form a family of its own.

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Comments on Cumacea for LH – Part 7. The Family Pseudocumatidae
dbcadien 14 December 2006

The family Pseudocumatidae is very poorly represented in the NEP. In European waters, however, and particularly in those of fluctuating or reduced salinity, the family is very abundantly represented and has numerous species. The current paucity of reports of these animals in the NEP may reflect deficiencies of sampling in estuarine and oligohaline waters, and may change in future. The single described species in the family in the NEP, *Pseudocuma lagunae*, is known only from the type, not having been seen since its collection near the turn of the last century. The other species, *Petalosarsia sp A* is an offshore species not uncommon in the SCB, but seldom taken in NPDES monitoring programs. The majority of the records of this animal are from the BLM studies of the late 1970's. The material resides at the Natural History Museum of Los Angeles County, where it has been examined by Tony Phillips (Hyperion).

The natural history of one *Pseudocuma* has been investigated (Corey 1969), but not the described NEP representative.

NEP Pseudocumatidae from McLaughlin et al (2005) augmented by known provisional taxa. *= Taxa on the SCAMIT Ed 4 list + addenda. Valid taxa bolded, synonyms not.

Family Pseudocumatidae

Pseudocuma lagunae Baker 1912 – Laguna Beach; 0-1m

****Petalosarsia sp A*** Diener 1985§ - SCB; shelf depths

The two genera can be separated on the condition of the first pereopod, which has articles 3 and 4 fused in *Petalosarsia*, and free in *Pseudocuma*. The fifth article of the same appendage is broad in *Petalosarsia*, and unexpanded in *Pseudocuma* (see generic key in Stebbing (1913, pg. 141).

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