Amphipoda of the Northeast Pacific (Equator to Aleutians, intertidal to abyss): XVII. Synopioidea: a review Donald B. Cadien, LACSD
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Preface

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

Introduction to the Synopioidea

Like the pardaliscoids the synopioids are represented in the North East Pacific by few families. To all intents there is really just the one as the second, the Argissidae, is formed of a single genus (*Argissa*) which is currently monotypic. Even the original description of that was as a *Syrrhoe*, a speciose and broadly distributed genus in the Synopiidae.

As first conceptualized by Bousfield (1977), the synopioid group contained the Synopiidae, the Argissidae, the Sebidae and also the Liljeborgiidae and Salentinellidae. This has been revised (Bousfield 1979) to include only the current complement of two families; the other three being included in a separate superfamily, the Liljeborgioidea. These two superfamilies, along with the Pardaliscoidea, form the core of the Infraorder Liljeborgida in the analysis of Schram (1986).

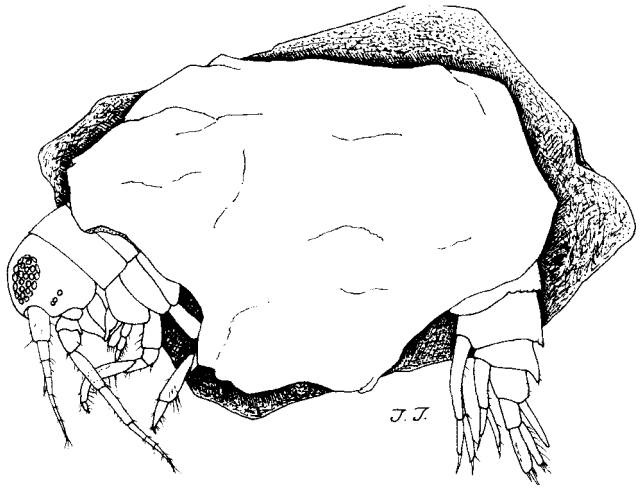
Diagnosis of the Synopioidea

"*Plesiomorphic, rostrate, abdominally processiferous, epibenthic and pelagic gammarideans, having dimorphic terminal male stage; conjoint flagellar segment of antenna 1 and elongate peduncle of antenna 2 bear brush setae; calceoli lacking; accessory flagellum strong; eyes subrotund, often dorsally confluent, large; mouthparts basic, upper lip with shallow median notch, lower lip broad, inner lobes variously developed; mandibular molar strong, palp usually with reduced segment 3; inner plates of maxillae setose, outer plate of maxilla 1 with 9-11 spine teeth; maxilliped plates and palp well developed; coxal plates medium deep, 4th excavate; coxae 5-7 posteriorly lobate; peraeon segments short, abdomen (pleon) large; gnathopods 1 and 2 non-amplexing, sub- similar, subchelate or simple; peraeopods 5-7 essentially homopodous, bases posteriorly expanded; brood plates medium broad; coxal gill on peraeopod 7; pleopods normal to powerful; uropods 1 and 2 lanceolate, apices spinose, rami unequal; uropod 3 lanceolate, foliaceous, outer ramus 2-segmented; telson large, lobes distally separated (narrowly) or fused completely, apices with small notch and spine.*" (from Bousfield 1979).

Ecological Commentary

Information on aspects of synopiids other than their taxonomy seems quite sparse. Many do swim, especially those from deeper waters. *Syrrhoe crenulata* was found to be a major constituent of the uppermost suprabenthic amphipod community in the Western

North Atlantic (Sainte Marie and Brunel 1985). Even shallow water forms swim, however, and male synopiids can form a sizeable proportion of the peracarids taken at night-lighting stations (pers. obs. based on samples from California, the Caribbean, and the Gulf of California). The galeate heads and laterally compressed smooth bodies (in a subset of the genera) suggest that these animals may dive into the surface of the sediments. The absence of strongly spinose appendages would not support sand swimming in the sense of phoxocephaloids, but synopiids may seek safety from predators under the sediment surface. The shortened modified dactyls of the last three legs in the genus *Metatiron* have been observed to be used to carry protective shell debris "shields" (Just 1981).



Metatiron bellairsi carrying shell debris with modified dactyls of P5-7
(Drawing Jean Just from Just 1981)

Conlan (1991) in her review of precopulatory behaviour in amphipods found no evidence to place synopiids as either mate-guarding or non-mate guarding. Trends in the distribution of secondary sexual characters can support a choice of strategy where no observational data exists. Bousfield (1982), based on such evidence, suggested that synopioids are pelagic non-mate guarders, with male swimming excursions in search of sexually receptive females. In light-trap samples examined to date, the sex ratio of animals caught is heavily male skewed, also supporting a non-mate guarding strategy for synopiids (Cadien, unpublished obs.).

Virtually no observational data is available on reproductive periodicity for synopiids, although the smallest juveniles of Syrrhoe crenulata were observed in July, suggesting spring spawning for that species (Wesławski and Legezynska 2002).

Key to NEP Synopioid genera (modified from J. L. Barnard 1972)

1. Gnathopods simple, sixth articles elongate.....2
   One or both gnathopods subchelate, sixth articles short.....4
2. Rostrum with sharp apex, eyes present, uropod 1 reaching apex of uropod 2.....3
   Rostrum with blunt apex, eyes absent, uropod 1 not reaching apex of uropod 2..
   .....*Pseudotiron*
3. With mandibular palp, dactyls of P5-7 elongate.....*Tiron*
   Lacking mandibular palp, dactyls of P5-7 prehensile.....*Metatiron*
4. Gnathopodal palms transverse or nearly so.....5
   Gnathopodal palms oblique.....6
5. Coxae 3-4 pelagont (adze-shaped).....*Syrrhoe*
   Coxae 3-4 not pelagont.....*Garosyrrhoe*
6. Telson cleft one-third or more.....7
   Telson cleft one-fifth or less, or telson entire.....8
7. At least one pereonite bearing mid-dorsal tooth.....*Syrrhoites*
   Mid-dorsal teeth only on pleon and urosome.....*Austrosyrrhoe*
8. Telson elongate, not basally broadened, gently tapered distally.....9
   Telson short, basally broadened, strongly tapering distally.....*Bruzelia*
9. Telson entire.....*Priscosyrrhoe*
   Telson cleft one fifth or less.....*Ileraustroe*

NEP Synopioidea from McLaughlin et al. (2005) supplemented by known provisionals
*=Taxon on the SCAMIT Ed. 9 list (Cadien and Lovell 2014). Valid taxa **bolded**, synonyms not.

Synopiidae

Austrosyrrhoe ilergetes J. L. Barnard 1964 (see Ileraustroe ilergetes)
Austrosyrrhoe ilergetes inconstans J. L. Barnard 1967 (see Ileraustroe ilergetes)
Austrosyrrhoe priscis J. L. Barnard 1967 (see Priscosyrrhoe priscis)
Austrosyrrhoe rinconis J. L. Barnard 1967 – outer coast of Baja California, Mexico: 1095-1205m
Bruzelia ascua J. L. Barnard 1966 – California: 1687-1720m
Bruzelia inlex J. L. Barnard 1967 – Cascadia Abyssal Plain, Oregon to outer Coast of Baja California, Mexico: 1720-2398m
Bruzelia popolacan J. L. Barnard 1972 – Pacific coast of Nicaragua: 3777-3950m
Bruzelia tuberculata Sars 1866 – Arctic and Northeast Atlantic, North Pacific to SCB: 121-2385m
Bruzelia sp A Dickinson 1976§ - Cascadia Abyssal Plain to San Diego Trough: 1200-2809m
Bruzelia sp 1 Thomas 1992§ - Gulf of the Farallones, Central California: 2385-3085m

***Garosyrrhoe bigarra** (J. L. Barnard 1962) – SCB to outer coast of Baja California, Mexico: 5-60m

Garosyrrhoe disjuncta J. L. Barnard 1969 – Bahia de Los Angeles, Gulf of California, Mexico: 1-24m

Ileraustroe ilergetes (J. L. Barnard 1964) – Mediterranean, Eastern Pacific from the outer coast of Baja California, Mexico to mid Chile: 1363-5690m

***Metatiron tropakis** (J. L. Barnard 1972) – Western Atlantic from Virginia to Brazil, Gulf of Mexico; Eastern Pacific from SCB to Peru: 3-357m

Priscosyrrhoe priscis (J. L. Barnard 1967) – outer coast of Baja California, Mexico: 791-1720m

Pseudotiron coas J. L. Barnard 1967 – Baja Abyssal Plain, Mexico: 2667-2706m

Pseudotiron longicaudatus Pirlot 1934 – Indonesia; Eastern Pacific from San Diego Trough to Panama: 835-3563m

Pseudotiron pervicax J. L. Barnard 1967 – Cascadia Slope, Oregon to outer coast of Baja California, Mexico: 732-1205m

Pseudotiron sp A Dickinson 1976§ - Cascadia Abyssal Plain: 2800-2828m

Pseudotiron sp 1 Thomas 1992§ - Gulf of the Farallones, Central California: 2385-3085m

Syrrhoe crenulata Goes 1866 – Boreal North Atlantic to Boreal North Pacific, east and west sides of both oceans, to Oregon: 40-2385m

***Syrrhoe longifrons** Shoemaker 1964 – British Columbia to SCB, 10-150m

Syrrhoe oluta J. L. Barnard 1972 – Eastern Pacific from Oregon to Colombia: 2798-3251m

***Syrrhoe sp A** SCAMIT 1987§ - Pt. Buchon, Central California to Coronado Submarine Canyon, Baja California, Mexico: 168-206m

Syrrhoe sp A Dickinson 1976§ - Cascadia Abyssal Plain to San Diego Trough: 1200-2820m

Syrrhoe sp B Dickinson 1976§ - San Diego Trough: 1229-1238m

Syrrhoe sp CS1 Cadien 2004§ - Cascadia Slope, Oregon: 1372m

Syrrhoites bigarra J. L. Barnard 1962 (see Garosyrrhoe bigarra)

Syrrhoites cohasseta J. L. Barnard 1967 – Cascadia Slope, Oregon to outer coast of Baja California, Mexico: 1205-1748m

Syrrhoites columbiae J. L. Barnard 1972 – Cascadia Slope, Oregon: 732-800m

Syrrhoites cu J. L. Barnard 1972 – Pacific coast of Colombia; 3025-3251m

Syrrhoites dulcis J. L. Barnard 1967 – outer coast of Baja California, Mexico: 1095-1205m

Syrrhoites pantasma J. L. Barnard 1972 – Pacific Panama to Ecuador: 1369-2853m

Syrrhoites redox J. L. Barnard 1967 – outer coast of Baja California, Mexico: 1720-1748m

Syrrhoites silex J. L. Barnard 1967 – outer coast of Baja California, Mexico: 842-1205m

Syrrhoites terceris J. L. Barnard 1964 – Gulf of Panama: 1609-1746m

Syrrhoites trux J. L. Barnard 1967 – Cascadia Slope, Oregon to outer coast of Baja California, Mexico: 842-1372m

Syrrhoites sp A Dickinson 1976§ - Cascadia Abyssal Plain to San Diego Trough: 1215-2820m

Syrrhoites sp B Dickinson 1976§ - Cascadia Abyssal Plain: 2800-2809m

Syrrhoites sp C Dickinson 1976§ - Cascadia Abyssal Plain: 2787m

Syrrhoites sp CS2 Cadien 2004§ - Cascadia Slope, Oregon: 732m

Syrrhoites sp 1 Thomas 1992§ - Gulf of the Farallones, Central California: 2385-3085m

***Tiron biocellata** J. L. Barnard 1962 – Monterey Bay, Central California to Bahia San Cristobal, outer coast of Baja California, Mexico: 1-180m

Tiron tropakis 1972 (see Metatiron tropakis)

Argissidae

***Argissa hamatipes** (Norman 1869) - Cosmopolitan, probably in error:4-1096m

Syrrhoe hamatipes Norman 1869 (see Argissa hamatipes)

Comments by Family

Syrrhoe nodulosa, a sub Antarctic species
(photo Martin Rauschert, from afg.biodiversity.aq)

<u>Family Synopiidae</u> –

A relatively small family of 16 genera, nine of which occur in the NEP. Fortunately the family was monographed by J. L. Barnard in 1972. He treated all the known taxa worldwide. Only two new genera have been added since his monograph; *Metatiron* Rabindranath 1972 and *Telosynopia* Karaman 1986. While the first is widespread, the latter is restricted to austral waters. His basic characterization of the family was one whose primary radiation was in deep cold waters, although he suspected it had originated in shallow waters. Rather than attempt to better the discussion of the family offered by him I merely refer you to it (pp. 1-13).

Even though this monograph is 42 years old, there have been no developments locally since, other than the transfer of *Tiron tropakis* to the genus *Metatiron* based on the absence of a mandibular palp (McLaughlin et al 2005). There are a number of additional undescribed species among deep water materials from Oregon and southern California

basins which are included here, but no additional NEP synopiids have been described in the interim. There is also a provisional species (*Syrrhoe sp A*) taken at shelf depths in the Southern California Bight. A more recent extensive treatment of the family was provided by Lörz and Coleman (2013) based on collections from New Zealand and adjacent waters. They treated those genera which occurred in New Zealand waters, and provided updated worldwide keys to most.

Regional provisionals included among forms reported from the NEP are, for the most part, "ghost taxa". They were erected during either consulting examinations (Blake et al 1993) or in thesis related taxonomic analysis (Dickinson 1976). The specimens and/or voucher sheets prepared for these animals are not available, and their existence is based on taxonomic listing. It is not known, for instance, if *Syrrhoe* sp A or B or C of Dickinson, or *Syrrhoe sp* 1 of Thomas are equal to *Syrrhoe* sp CS1 of Cadien. The last provisional is represented by specimens, but no comparisons may be made with the others. They may all be different, or one animal may bear up to three different provisional designations. It is not possible to decide. It is highly unlikely that any of these provisionals, all based on deep water collections, are equivalent to *Syrrhoe* sp A SCAMIT from shelf depths in the SCB.

While the specimens on which Thomas' provisionals were based may eventually become available for examination, the materials of Dickinson do not appear to be locatable. His intent was to publish descriptions of all these animals himself eventually, but he ceased publications of taxonomic papers following treatment of the ampeliscids (Dickinson 1982, 1983). While the distribution and some ecological information is available for his taxa (Dickinson 1978, Dickinson and Carey 1978), their identity cannot be defined.

Description: "***Head*** *free, not coalesced with peraeonite 1; exposed; as long as deep, or longer than deep; rostrum present, long; eyes present, well developed or obsolescent, or absent; coalesced, or not coalesced; 1 pair, or 1 pair plus small accessory patch; not bulging. Body laterally compressed; cuticle smooth.*

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

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

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

Coxae 1-7 well developed, none fused with peraeonites. Coxae 1-4 longer than broad, overlapping, coxae not acuminate. Coxae 1-3 not successively smaller, coxae 1-2 vestigial. Coxae 2-4 none immensely broadened.

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

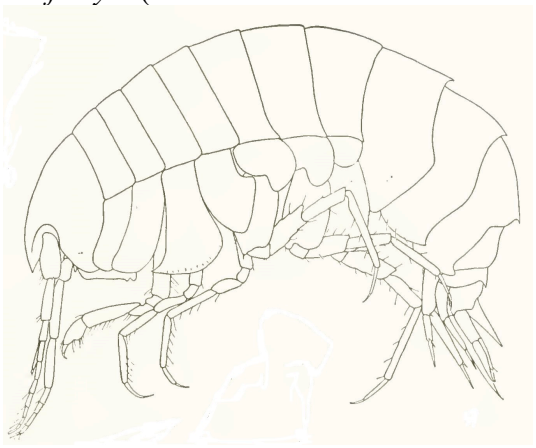
Peraeopods heteropodous (3-4 directed posteriorly, 5-7 directed anteriorly), none prehensile. Peraeopod 3 well developed. Peraeopod 4 well developed. 3-4 not glandular; 3-7 without hooded dactyli, 3-7 propodi without distal spurs. Coxa well developed, longer than broad or broader than long or expanded distally; carpus shorter than propodus or longer than propodus, not produced; dactylus well developed. ***Coxa smaller than coxa 3****, acuminate ventrally or not acuminate, with well developed posteroventral lobe; carpus not produced. Peraeopods 5-7 with few robust or slender setae; dactyli without slender or robust setae.* ***Peraeopod 5*** *well developed; shorter than peraeopod 6;* ***coxa*** *smaller than coxa 4 or larger than coxa 4,* ***with ventrally produced posterior lobe****; basis expanded or slightly expanded, subovate, with posteroventral lobe or without posteroventral lobe; merus/carpus free; carpus linear; setae absent. Peraeopod 6 shorter than peraeopod 7, or subequal in length to peraeopod 7; merus/carpus free; dactylus without setae. Peraeopod 7 with 6-7 well developed articles; longer than peraeopod 5; similar in structure to peraeopod 6; with 7 articles; basis expanded, without dense slender setae; dactylus without setae.*

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

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

Austrosyrrhoe – A small genus of deep sea synopiids, only one of the five species occurring in the NEP. The remaining species are distributed in the Northeast Atlantic (2), South Africa (1), and New Zealand (1). *Austrosyrrhoe* is similar to *Syrrhoites*, but lacks dorsal pereonal teeth. Lörz and Coleman (2013) provide a key to the genus worldwide.

Diagnosis**: "***Head not protuberant, lateral cephalic lobe not sharp; eyes absent; molar of medium size and not dominating mandible, weakly to strongly triturative; antenna 1 peduncle articles 1–2 either basic or article 2 elongate; coxa 1 apically rounded; coxae 3–4 not pelagont or weakly so; gnathopods typically subchelate, palms acute and bearing one serrate robust seta and one prominent additional robust seta; dactylus of gnathopod 2 normal; pereopods 5–7 elongate, dactyli elongate, article 2 of pereopod 7 expanded, rounded or truncate ventrally; pleonites 1–3 lateral margin not serrate; uropod 3 not grossly exceeding uropods 1–2, peduncle elongate; telson of medium length and cleft halfway*." (From Lörz and Coleman 2013)

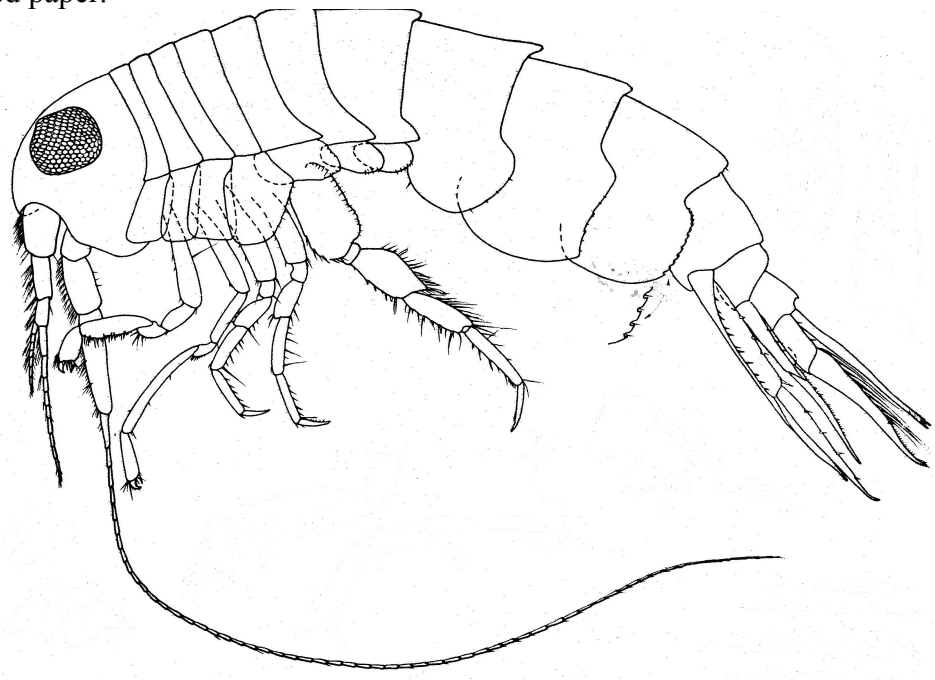


Austrosyrrhoe rinconis (From J. L. Barnard 1967)

Bruzelia – A moderately sized genus of 13 described species, four of which occur in the NEP. Two provisional species are also reported from the area, but are without descriptions and so remain unidentifiable. A key to the described worldwide species, including all those known from the NEP, is provided by Lörz and Coleman (2013). These animals are more robust than those of *Tiron* and *Syrrhoe*, which tend to be slender. *Bruzelia*, along with *Garosyrrhoe* and *Syrrhoites* usually have a wider body, more body ornamentation, and a heavier integument. They probably do not swim as much or as well as their more gracile counterparts in other genera. Since *Bruzelia* are typically found in deeper waters with little or no light penetration (although *B. tuberculata* does reach into shelf depths in the Arctic, and *B. australis* is from shelf depths), they are probably less exposed to visual predation than shelf species such as the members of *Tiron,* or *Synopia*. The genus is broadly distributed, with representatives in the western Caribbean, the Mediterranean, the Northeast Atlantic, South Africa, Australia, and New Zealand as well as in the southeast Pacific/Magellanic region.

Diagnosis: "*Head not protuberant, except in type species, lateral cephalic lobe not sharp; eyes absent; antenna 1 articles 1–2 either basic or article 2 elongate; molar greatly enlarged, dominating mandible, not triturative; mouthparts basic; coxa 1 ordinary; coxae 3–4 not pelagont, coxa 3 not strongly expanded distally except for acute anteroventral cusp and not posteriorly excavate, coxa 4 variable in size and shape, drawn out posteriormarginally (rarely weak); gnathopods typically subchelate, palms acute, defined by 1 serrate and 1 smooth robust seta; dactylus of gnathopod 2 normal; pereopods 5–7 weakly to strongly elongate, dactyli weakly elongate; pleonites 1–3 lateral margin not serrate; uropod 3 not exceeding uropods 1–2; telson elongate, always entire or minutely incised.*" (From Lörz and Coleman 2013)

Garosyrrhoe – A small genus of two species from the NEP, and a cognate of one of these from the Caribbean. Differentiation of *G. bigarra* and *G. disjuncta* in the NEP can be troubling as there is a tendency for some of the character states separating the two to vary, sometimes seeming to intergrade. This led at one point to *G. bigarra* being treated as a complex by SCAMIT members. Their synonymy has been suggested on occasion, and remains possible if genetic evidence can be gathered demonstrating it. The Caribbean *G. luquei* (Ortiz & Velado 1985) seems to be a cognate of *G. disjuncta* based on the dorsal spination of the 7th pereonite and pleonites 1 and 2. Note that the paper by Ortiz & Velado, while indicated as published in 1985 on the paper itself is indicated as 1988 in WoRMS. If not a typo, this may reflect a publication delay not evident from the published paper.



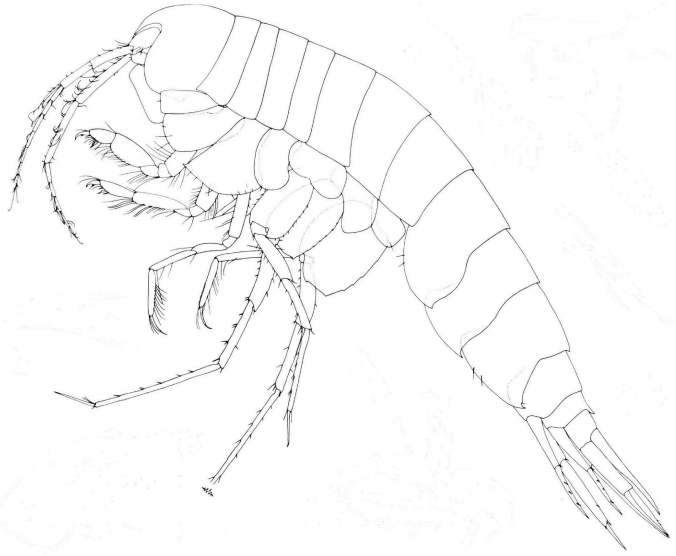
Garosyrrhoe bigarra male (From J. L. Barnard 1962

A key to the two species known at the time is provided by J. L. Barnard (1972). The following modified key based on that includes all three known species:

1. Accessory flagellum of 2 articles; article 2 a small cap on the elongate article 1……..……..……*G. luquei*
   Accessory flagellum multiarticulate, with basal article no more than twice the length of remaining articles…….……..2
2. Pleonites 1-2 and pereonite 7 each with a pair of dorsal teeth…….*G. disjuncta*
   Pleonites 1-2 and pereonite 7 each with a single dorsal tooth……....*G. bigarra*

Diagnosis: "*Forehead not protuberant; lateral cephalic lobe not sharp; mandible with palp, molar of medium size, weakly triturative or fuzzy; mouthparts basic; articles 1-2 of antenna 1 basic; coxa 1 ordinary; coxae 3-4 not pelagont, coxa 3 softly rectangular, posterior margin nearly parallel with anterior, and nonexcavate, coxa 4 expanded midposteriorly, posterodorsal margin sloping, not concave but appearing excavate, coxa*

4 larger than 3; gnathopods subchelate, palms nearly transverse, defined by large serrate spine giving hand chelate appearance; dactyl of gnathopod 2 normal; pereopods 3—5 elongate, dactyls elongate, article 2 of pereopod 5 rounded posteroventrally; pleonites 1-3 not denticulate or very weakly so; uropod 3 not exceeding uropods 1-2, peduncle elongate; telson elongate, deeply cleft." (From J. L. Barnard 1972)



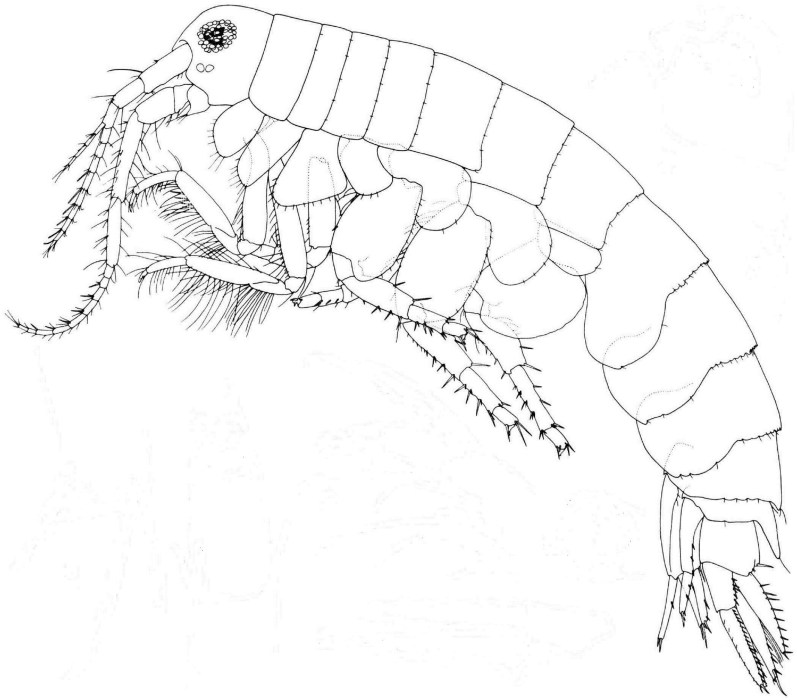
Ileraustroe ilergetes (From J. L. Barnard 1972)

Ileraustroe – A small genus of three described species, one reported from the NEP. Of these only the recently described *I. neumannae* from New Zealand has a coherent distribution. Both of the others are reported from widely disparate areas; *I. ilergetes* from the Mediterranean and the Eastern Pacific, and *I. torpens* from South Africa and the Caribbean. Such distributions seem unsupportable for peracarids, and will perhaps prove illusory based on additional material and new investigation. The Eastern Pacific form has been treated as a subspecies *I. ilergetes inconstans* by J. L. Barnard 1967 (as *Austrosyrrhoe).* Lörz and Coleman (2013) key these species.

Diagnosis**: "***Head not protuberant, lateral cephalic lobe absent; eyes absent; molar slightly enlarged, smooth or weakly triturative; mouthparts basic; antenna 1 article 1 basic, article 2 slightly elongate; coxa 1 ordinary; coxae 3–4 pelagont, coxa 3 expanded distally and posterodorsal margin excavate, coxa 4 small; gnathopods typically subchelate, palms acute, defined by 1–3 serrate and usually one simple robust seta; dactylus of gnathopod 2 normal; pereopods 5–7 elongate, dactyli elongate, basis pereopod 7 expanded and serrate posteromarginally, subtruncate posteroventrally (except rounded in I. torpens); pleonites 1–3 lateral margin not serrate; uropod 3 not exceeding uropods 1–2, peduncle elongate; telson minutely cleft*." (From Lörz and Coleman 2013)

Metatiron – The genus was established by Rabindranath (1972) for the Indian *Tiron brevidactylus*. The other species in the genus were described after its erection. Of these, only *M. tropakis* occurs in the NEP. The genus and its constituent species have not been accepted by some workers, and controversy over its validity remains. The presence/absence of the mandibular palp is viewed as sufficient to define *Metatiron* (i.e. Thomas 1993, LeCroy 2011), or insufficient, with species lacking the palp included in

Tiron (i.e. Just 1981, Jazdzewski 1990, Lörz and Coleman 2013). In their generic key for the family Lörz and Coleman do not even employ absence of the mandibular palp as a key character. Instead they substitute the dorsal teeth of the first three pereonites as the separator of *Tiron* (without them) and *Metatiron* (with them). WoRMs seems to accept *Metatiron* as a valid taxon, but then places *Tiron triocellatus* and *Tiron tropakis* there with a question mark. Both species are also included under *Tiron*. J. L. Barnard and Karaman (1991) treat *Metatiron* as valid, but include only *M. brevidactylus* [the type] and *M. caecus*, relegating all others to *Tiron*. The basic problem seems to be what characters actually define the genus *Metatiron*? The generic diagnosis provided below is that of J. L. Barnard and Karaman (1991) which led them to include but two taxa in the genus. The question marks in their diagnosis seem to indicate they were unsure about what the limits of *Metatiron* were. Their diagnosis differs substantially from that of Rabindranath, adding characters not mentioned by him. A 'regional diagnosis' of the genus is provided by LeCroy (2011) with some character states in direct opposition to those in the J. L. Barnard and Karaman diagnosis. All these, however, utilize the absence of a mandibular palp and the reduction and specialization of the dactyls of P5-P7 as key characters of *Metatiron*. Using these points of agreement we can allocate the species of *Tiron*+*Metatiron* to the two genera unequivocally. *Metatiron* would include; *M. brevidactylus* [type], *M. bellairsi*, *M. bonaerensis*, *M. coecus*, *M. galeatus*, *M. ovatibasis*, *M. triocellatus*, and *M. tropakis*. *Tiron*, after the removals above, would consist of *T. altifrons*, *T. antarcticus*, *T. australis*, *T. biocellata*, T. *intermedius*, *T. spiniferus*, and *T. thompsoni*.

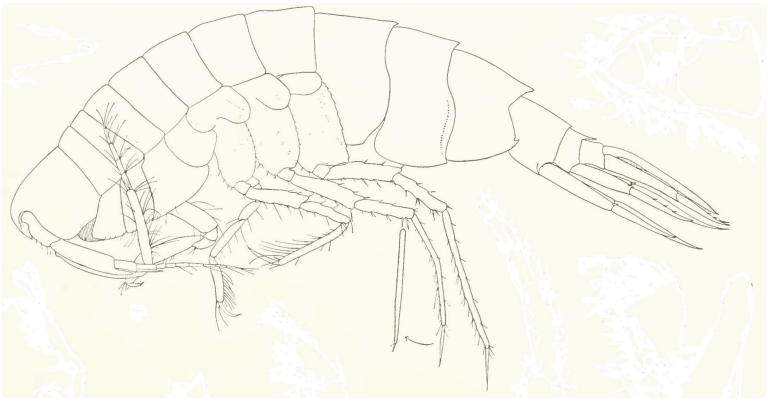


Metatiron tropakis (From J. L. Barnard 1972)

On that basis the genus contains eight species, one of which occurs in the NEP. The distribution of *M. tropakis* is suggestive of a species cluster rather than a single

taxon. It is likely that Caribbean and south Atlantic records of the species represent one or more undiagnosed sibling (and perhaps cognate) species.

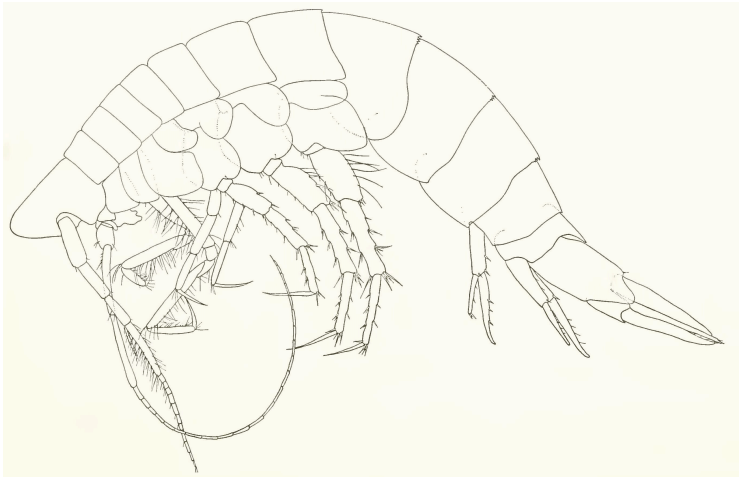
Diagnosis: " *Forehead [?not protuberant, lateral cephalic lobe ?not sharp, 'moderately produced']; eyes well developed, or absent, often with pair of segregated lateral cornea1 lenses on each side of head; mandible without palp, molar large, columnar, triturative; mouthparts basic; articles 1-2 of antenna 1 basic; coxa 1 ordinary, coxae 3-4 pelagont, coxa 3 oblong, weakly expanded apically, poorly excavate, coxa 4 small; gnathopods simple, propodus thin, spinose; dactyl of gnathopod 2 normal; pereopods 5-7 short, dactyls short, clawlike, bearing large inner wire-seta; article 2 of pereopod 7 posteroventrally rounded; pleonites 1-3 with mid-dorsal tooth; uropod 2 [?not shortened]; uropod 3 [?exceeding uropods 1-2, peduncle short]; telson elongate, deeply cleft.*" (From J. L. Barnard and Karaman 1991)



Priscosyrrhoe priscis (From J. L. Barnard 1967)

Priscosyrrhoe – A monotypic genus endemic to the NEP. The type and only species *P. priscis* was described from middle bathyal depths off the outer coast of Baja California (J. L. Barnard 1967). It is differentiated from other genera in the family by the characters in the key presented above.

Diagnosis: : "*Forehead weakly protuberant, lateral cephalic lobe not sharp; eyes absent; mandible with palp, molar small and not dominating mandible, triturative surface obsolescent; article 2 of antenna 1 elongate and bearing apicodorsal tooth; coxa 1 ordinary; coxae 3—4 weakly pelagont; gnathopods typically subchelate, palms oblique and bearing one large serrate spine; dactyl of gnathopod 2 normal; pereopods 3—5 elongate, article 2 of pereopod 5 weakly expanded and ventrally rounded; pleonites 1-3 not denticulate; uropod 3 not exceeding uropods 1-2, peduncle elongate; telson highly elongate, entire*." (From J. L. Barnard 1972)



Pseudotiron longicaudatus (From J. L. Barnard 1967)

Pseudotiron – A small genus of six described species, three known from the NEP. Two of these are endemic, but the third, *P. longicaudatus*, was originally described from the Arafura Sea south of Indonesia (Pirlot 1934), and has since been reported from several points in the NEP by several researchers. The type, *P. bouvieri*, is from the Mediterranean, and *P. golens* was described from abyssal South African waters. Recently another species, *P. livingstonae*, was added from New Zealand (Lörz and Coleman 2013). This broadly distributed genus is known only from deep water collections. There are two provisional species from the NEP in addition to the described forms, but neither has a description, and so they remain unidentifiable. Lörz and Coleman (2013) provide a comprehensive key to the described species.

Diagnosis**: "***Head protuberant or not, lateral cephalic lobe absent; eyes absent; molar of medium size, columnar and triturative; mouthparts basic; antenna 1 articles 1 and 2 basic or elongate; coxa 1 ordinary; coxae 3–4 pelagont except in P. coas; gnathopods simple, lacking distinctive robust setae; dactylus of gnathopod 2 normal; pereopods 5–7 typically elongate but short in P. coas; basis of pereopod 7 typically rounded posteroventrally or slightly truncate; pleonites 1–3 typically serrate dorsally but apparently smooth in P. golens; urosomite 3 elongate; uropod 3 greatly exceeding apices of uropods 1–2, peduncle short; telson elongate, deeply cleft*." (From Lörz and Coleman 2013)

Syrrhoe – One of the larger genera in the family, with 14 described taxa worldwide. There are also four provisional species reported from the NEP in addition to the three described species. Of these, two are not supported by either specimens or descriptions and will remain undeterminable. The remaining two have supportive documentation, and differ. Syrrhoe sp A SCAMIT 1987§ is from shelf depths from Central to Southern California, while Syrrhoe sp CS1 Cadien 2004§ is from mid-bathyal depths off Oregon. The genus is very broadly distributed with species also known from the Caribbean (1) and Mediterranean (1), the Northeast Atlantic (2, 1 also known from NEP), the southwest Atlantic (1), Antarctic (3), Australia (2), and New Zealand (2). These are keyed in Lörz and Coleman (2013). A key to the NEP species, including provisionals, is provided below:

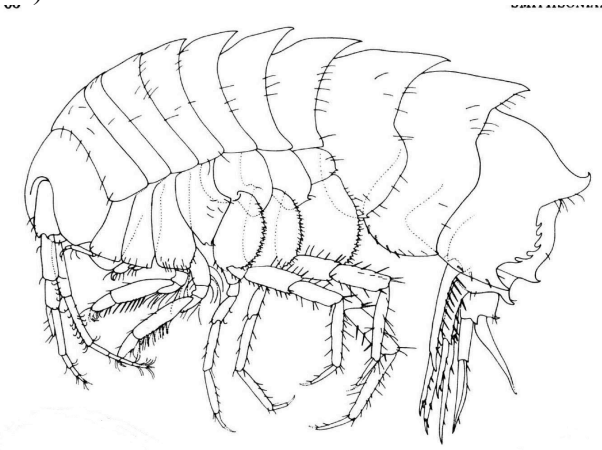
Syrrhoe crenulata (from www.marine species.org)

Key to NEP *Syrrhoe* (modified from Lörz & Coleman 2013)– dcadien 10Nov14

1. Head extended as a forehead, forming protrusive appearance……..…2
   Head with anterodistal margin curving hemispherically, dorsal and anterior margins of head nearly perpendicular……..4
2. Coxa 1 broad, distal margin about twice as broad as proximal margin……..
   ……..…….*S. oluta*
   Coxa 1 not broad, anterior and posterior margins nearly parallel……3
3. Telson long and cleft about ¾ length; P7 basis posteriorly subtriangular, with distinct ventral margin; antenna 1 with curved cusp on first peduncular article
   …….*S. longifrons*
   Telson long and cleft ¾ or more of its length; P7 basis posteriorly rounded, lacking distinct ventral margin, bearing large teeth; antenna 1 with curved cusps on peduncular articles 1-3…….….*S.* sp A SCAMIT
4. Posterior margin of pleonite 3 including both epimera fully serrate……..
   ….……..……..*S. crenulata*
   Posterior margin of pleonite 3 with gap in serrations between base of posterior lobe of epimeron and posterior margin of pleonite 3…….*S.* CS1

Diagnosis**: "***Head protuberant or not, lateral cephalic lobe rounded to acute; molar not enlarged, weakly triturative; mouthparts basic; antenna 1 article 1 bearing large distally curved tooth, peduncle slightly elongate (female); coxa 1 ordinary or enlarged; coxae 3–4 pelagont; gnathopods with transverse or subtransverse palms bearing enlarged serrate defining robust seta; dactylus of gnathopod 2 normal; pereopods 5–7 elongate, dactyli elongate, basis heavily serrate or not, basis of pereopod 7 typically rounded posteroventrally but in few species becoming truncate; pleonites 1–3" typically serrate dorsally and laterally but often smooth or bearing single dorsal*

tooth, uropod 3 peduncle short (except S. nodulosa); telson elongate, deeply cleft." (From Lörz and Coleman 2013)



Syrrhoites columbiae (From J. L. Barnard 1972)

Syrrhoites – Even larger than the last genus, *Syrrhoites* has 26 described species world-wide. Of these 9 are reported from the NEP, along with five provisional species, all but one of which are unsupported and indeterminate (and from abyssal depths). The single supported provisional is from the mid-bathyal off Oregon. Like other synopiid genera Syrrhoites has species world-wide; NEP (9+5 provisionals), Japan (1), New Zealand (5), Antarctica (1), South Africa (3), the North Atlantic (3), and the Mediterranean (4). Described species in the genus were keyed by Lörz and Coleman 2013. Other than the Japanese *S. pacifica*, which is a shelf species collected as shallowly as 20m, all *Syrrhoites* are bathyal or abyssal. Barnard (1972) introduced a provisional species he did not name, *Syrrhoites* sp A Barnard 1972, into the literature from bathyal depths off Chile. This was included in his key and also in that of Lörz and Coleman (2013). The provisional species *Syrrhoites* sp CS2 can be separated from other members in the NEP by having a third epimeron which is rounded posteriorly, lacking even the small ventral tooth of *S. cu*, and the larger but sometimes blunt posterior projections of *S. cohasseta, S. dulcis, S. redox, S. silex, S. trux*, or *S. pantasma*. It is also very different from the multiple posterior third epimeral teeth of *S. columbiae* (large) or *S. terceris* (small). Unfortunately the other NEP provisionals are undescribed and indeterminate.

Diagnosis**: "***Head not protuberant, sometimes with middorsal keel, lateral cephalic lobe not sharp; eyes absent; molar greatly enlarged, not triturative; mouthparts basic; antenna 1 articles 1–2 basic, article 1 with small medioterminal tooth; coxa 1 ordinary or distally expanded; coxae 3–4 not pelagont, coxa 3 rectangular, sometimes distally expanded, coxa 4 shorter or nearly as long as 3; gnathopods simple to subchelate, palms acute, defined by 1–2 robust setae but majority of species with palms obsolescent though distinguished by robust seta(e); dactylus of gnathopod 2 normal; pereopods 5–7 elongate, dactyls elongate, basis of pereopod 7 posteriorly serrate and rounded, ventrally usually rounded; pleonites 1–3 not serrate posteromarginally; uropod 3 not greatly exceeding other uropods, peduncle elongate; telson elongate and deeply cleft*." (From Lörz and Coleman 2013)

Tiron biocellata (from www.boldsystems.org)

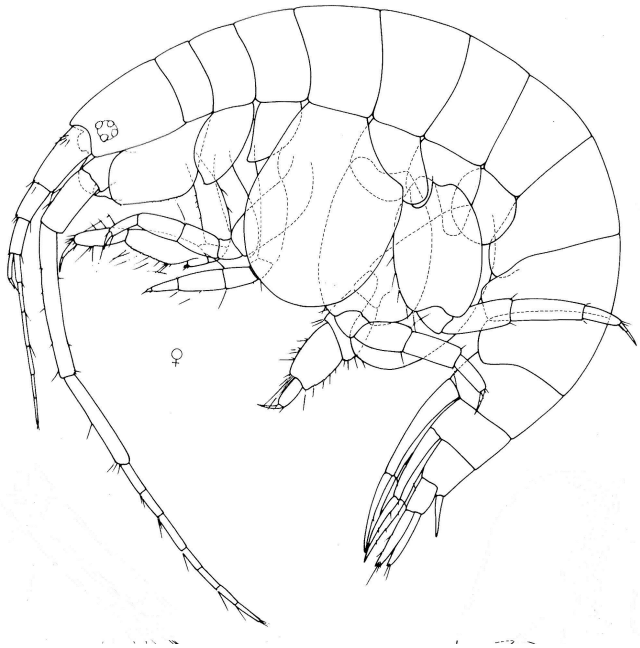
Tiron – The boundaries between this genus and *Metatiron* are in dispute. In the discussion under *Metatiron* a position is adopted which allows us to proceed with the two genera. *Tiron* (as discussed earlier) consists of seven taxa, only one of which occurs in the NEP. These tend to be shallow water coarse substrate species, and the NEP form is commonly taken on clean sand bottoms with admixtures of coarse material (gravel, shell hash). A worldwide key to the genus, including a series of species viewed here as belonging to *Metatiron*, is provided by Lörz and Coleman (2013). *Tiron spiniferus*, a Borearctic species known from the North Atlantic, has been reported from waters off Pt. Barrow at the boundary of the Chukchi and Beaufort Seas by Shoemaker (1955); just north of the end of coverage in the current review. Only *Tiron biocellata*, the common shelf form from the SCB, is known from the coverage area.

Diagnosis : "*Head sometimes protuberant, lateral cephalic lobe sharp or rounded; eyes present and accessory eyes usually present; molar of medium size, strongly projecting, columnar and triturative; antenna 1 articles 1–2 not elongate; coxa 1 ordinary (enlarged in T. galeatus), coxae 3–4 not pelagont or weakly so, coxa 3 softly rectangular, posterior margin almost parallel with anterior margin and not strongly excavate; coxa 4 shape variable, almost as long as coxa 3; gnathopods simple, lacking distinct robust setae; dactylus of gnathopod 2 normal; pereopods 5–7 very short, dactyls typically very short, clawlike and bearing large seta in inner curvature, but occasionally dactyls slightly elongate and poorly armed; basis of pereopod 7 posteroventrally rounded; pleonites 1–3 typically serrate dorsally but apparently smooth in some species; uropod 3 greatly exceeding apices of uropods 1–2, (except in T. brevidactylus), peduncle short; telson elongate, deeply cleft.*" (from Lörz and Coleman 2013)

<u>Family Argissidae</u> – Diagnosis: "*The body is smooth; urosome segment 2 has a sexually dimorphic posterodorsal process. The rostrum is very small. The eyes are small, few-faceted, and lateral. The accessory flagellum is short and two-segmented. The mandibular palp terminal segment is not short. Coxal plates 2 and 3 are much shorter than 1 and 4; all are rounded below. Peraeopods 3-7 are short; segment 6 and the dactyl are short. In peraeopods 5-7 the bases are deep-oval in outline; 6 usually is the smallest;*

segments 4 and 5 are somewhat expanded. In uropods 1 and 2 the rami are subequal, and 2 is not shortened. In uropod 3 the rami extend well beyond the deeply cleft telson." (from Bousfield 1982).

Argissa - The sole species is reputedly cosmopolitan (J. L. Barnard and C. M. Barnard 1983) at shelf and slope depths. This is *Argissa hamatipes* (Norman 1869). There are two other names in the older literature, both synonyms of *A. hamatipes* (*A. typica* of Boeck 1871 and *A. stebbingi* of Bonnier 1896). It is very likely that this "species" is actually a complex of related forms in different parts of the world ocean. Whether the two preexisting names can be used, or if they were appropriately synonymized with *A. hamatipes* remains for further investigation. The NEP representative is almost certainly an undescribed congener and not *A. hamatipes*. Characters on which members of this genus might be separated remain to be identified, and the name *A. hamatipes* will continue to be applied broadly until appropriate criteria for species separation can be determined.



Argissa hamatipes female, the male would have a toothed urosome
(From Bellan-Santini et al 1982)

The "species" is very easy to recognize. Argissids are swimmers, and while laterally compressed, are relatively compact. They are weakly rostrate, have an accessory flagellum on antenna 1, bear antennal brush setae posteriorly, and have a callynophore in the male. They are very characteristically eyed (although J. L. Barnard and C. M. Barnard 1983 indicate eyes may be lacking. I have never found this to be true in California [but a single specimen from 732m off Oregon seemed eyeless]. The eye is relatively large, and has four pairs of ommatidea arranged evenly around its rim. This has the appearance of being "four-eyes" since the ommatidea are more visible than the rest of the eye (although not dark colored). The condition is well illustrated in Bousfield 1973, as is the entire animal. His description and illustrations form a good basis for recognition of this species. Coxae 1 and 4 are enlarged, and the basis of P7 is very large

and noticeable. The telson is thin, tapering, and deeply cleft. Gnathopods are not dimorphic and are weak and simple.

Sexual dimorphism is expressed in the structure of the antennae (male callynophorate), and in the urosome. Both sexes have U3 dorsally toothed, but the male also has a long spike on U2.

The combination of the eye and the enlarged basis of P7 is normally what catches my eye and allows *A. hamatipes* to be pulled from among other laterally compressed small white amphipods. It is taken commonly, but not in large numbers...usually only one or two to a sample.

Literature Cited

Alonso de Pina, Gloria M. 1998. *Metatiron bonaerensis*, a new species (Crustacea: Amphipoda: Synopiidae) from the southwest Atlantic. *Proceedings of the Biological Society of Washington* **111**(3): 627-633.

Barnard, J. Laurens. 1962. Benthic marine Amphipoda of Southern California; 2. Families Tironidae to Gammaridae. *Pacific Naturalist* 3(2):73-115.

---------. **1964**. Deep-sea Amphipoda (Crustacea) collected by the R/V "Vema" in the Eastern Pacific Ocean and the Caribbean and Mediterranean Seas. *Bulletin of the American Museum of Natural History* 127(1):1-46.

———**. 1966**. Submarine Canyons of Southern California. Part V. Systematics: Amphipoda. *Allan Hancock Pacific Expeditions* 27(5): 1-166.

---------. 1967. Bathyal and Abyssal gammaridean Amphipoda of Cedros Trench, Baja California. *United States National Museum Bulletin* 260: 1-205.

---------. 1972. A review of the family Synopiidae (=Tironidae), mainly distributed in the deep sea (Crustacea: Amphipoda). *Smithsonian Contributions to Zoology* 124: 1-94.

---------, and Charline M. Barnard. 1983. Freshwater Amphipoda of the world, 1. Evolutionary patterns and II. Handbook and bibliography. Hayfield Associates, Mt. Vernon, Virginia, U.S.A. 830pp.

---------, and Gordan S. Karaman. 1991 The Families and Genera of Marine Gammaridean Amphipoda (except marine gammaroids). Records of the Australian Museum Supplement 13 (Parts 1 and 2): 1-866.

Bellan-Santini, Denise, Gordan S. Karaman, Gertraud Krapp-Schickel, Michel Ledoyer, Alan A. Myers, Sandro Ruffo, and Ulrich Schiecke 1982. The Amphipoda of the Mediterranean. Part 1. Gammaridea (Acanthonotozomatidae to Gammaridae). *Memoires de l'Institut Océanographique du Monaco* **13**(1): 1-364.

Blake, James A., JoAnn Muramoto, Brigitte Hilbig, and Isabelle P. Williams. 1983. July 1991 Survey (R/V Wecoma) Final Report. Benthic Biology and Sediment Characterization. Woods Hole, Massachusetts, U.S.A., Science Applications International Corporation**:** 130pp. + appendices.

Bousfield, Edward L. 1973. *Shallow-water gammaridean Amphipoda of New England*. Comstock Publishing Associates/Cornell University Press. Ithaca, New York, U.S.A. 312pp.

---------. 1977. A new look at the systematics of gammaroidean amphipods of the world. *Crustaceana* Supplement 4: 282-316.

---------. 1979. A revised classification and phylogeny of the amphipod Crustacea. *Transactions of the Royal Society of Canada* 4(14): 343-390.

---------. 1982. Malacostraca, Peracarida, Amphipoda. . Pp. 232-294 IN: Parker, Sybil P. (ed.). *Synopsis and Classification of Living Organisms*, Volume 2. McGraw Hill, New York, New York.

Cadien, D. B. and L. L. Lovell (eds.). 2014. A Taxonomic Listing of Benthic Macro- and Megainvertebrates from Infaunal & Epifaunal monitoring and research programs in the Southern California Bight. Los Angeles, California, USA**:** 186pp.

Conlan, Kathleen E. 1991. Precopulatory mating behavior and sexual dimorphism in the amphipod Crustacea. *Hydrobiologia* **223**: 255-282.

Dickinson, John J. 1976. Two zoogeographic studies of deep sea benthic gammarid amphipods. Ph. D. dissertation Department of Oceanography. Oregon State University, Corvallis, Oregon. 117pp.

---------. 1978. Faunal comparison of the gammarid Amphipoda (Crustacea) in two bathyal basins of the California Continental Borderland. *Marine Biology* **48**: 367-372.

---------. 1982. Studies on amphipod crustaceans of the Northeastern Pacific region. I. 1. The systematics and distributional ecology of the family Ampeliscidae (Amphipoda: Gammaridea) in the Northeastern Pacific Region. I. The genus *Ampelisca*. *National Museums of Canada, Publications in Biological Oceanography* (10): 1-39

---------. 1983. The Systematics and distributional ecology of the superfamily Ampeliscoidea (Amphipoda: Gammaridea) in the Northeastern Pacific region. II. The Genera *Byblis* and *Haploops*. National Museums of Canada, Publications in Natural Sciences **1**: 1-36.

---------. and Andrew G. Carey Jr. 1978. Distribution of gammarid Amphipoda (Crustacea) on Cascadia Abyssal Plain (Oregon). *Deep-Sea Research* **25**: 97-106.

Jazdzewski, Krzyzstof 1990. A redescription of *Tiron antarcticus* K. H. Barnard, 1932 (Crustacea: Amphipoda: Synopiidae) with an updated key to the species of *Tiron* Liljeborg, 1865. *Proceedings of the Biological Society of Washington* **103**(1): 110-119.

Just, Jean. 1981. *Tiron bellairsi* sp. n. (Amphipoda, Synopiidae) from coral sand in Barbados, with notes on behaviour. *Zoologica Scripta* **10**(4): 259-263.

Karaman, Gordan S. 1986. Contribution to the Knowledge of the Amphipoda. 155. *Syrrhoites barnardi*, new marine amphipod from the Mediterranean Sea, with remarks to genus *Synopia* Dana (Gammaridea, Synopiidae). *Studia Marina* **17 -18**(1): 159-178.

LeCroy, Sara E. 2011. An illustrated identification guide to the nearshore marine and estuarine gammaridean Amphipoda of Florida. Volume 5: Families Leucothoidae, Liljeborgiidae, Neomegamphopidae, Ochlesidae, Phliantidae, Phoxocephalidae, Platyischnopidae, Pleustidae, Podoceridae, Pontoporeiidae, Sebidae, Stenothoidae, Synopiidae and Talitridae. Tallahassee, Florida, U. S. A., Florida Department of Environmental Protection**:** pp. 615-816.

Lowry, James K., **and Roger T. Springthorpe (2001 onwards).** Amphipoda: Families and Subfamilies. Version 1: 1 September 2001. http://crustacea.net/.

Lörz, Anne-Nina, & Charles Oliver Coleman. 2013. The Marine Fauna of New Zealand and the Ross Sea: Amphipoda, Synopiidae (Crustacea). NIWA Biodiversity Memoir 127: 1-160, National Institute of Water and Atmospheric Research, Wellington, New Zealand.

McLaughlin, P. A., D. K. Camp, M. V. Angel, E. L. Bousfield, P. Brunel, R. C. Brusca, D. B. Cadien, A. C. Cohen, K. Conlan, L. G. Eldredge, D. L. Felder, J. W. Goy, T. A. Haney, B. Hann, R. W. Heard, E. A. Hendrycks, H. H. Hobbs III, J. R. Holsinger, B. Kensley, D. R. Laubitz, S. E. LeCroy, R. Lemaitre, R. F. Maddocks, J. W. Martin, P. Mikkelsen, E. Nelson, W. A. Newman, R. M. Overstreet, W. J. Poly, W. W. Price, J. W. Reid, A. Robertson, D. C. Rogers, A. Ross, M. Schotte, F. R. Schram, C.-T. Shih , L. Watling, and G. D. F. Wilson. 2005. *Common and Scientific Names of Aquatic Invertebrates from the United States and Canada - Crustaceans*. Bethesda, Maryland, U. S. A.: American Fisheries Society. 565pp.

Ortiz, M. and T. Veledo 1985. Una nueva especie de anfípodo del género *Garosyrrhoe* (Synopiidae, Gammaridea) de aguas cubanas. *Revista de Investigaciones Marinas* **6**(1): 14-18.

Rabindranath, P. 1972. Three species of gammaridean Amphipoda (Crustacea) from the Trivandrum Coast, India. *Zoologischer Anzeiger* **188**(1/2): 84-97.

Sainte-Marie, Bernard and Pierre Brunel 1985. Suprabenthic gradients of swimming activity by cold-water gammaridean amphipod Crustacea over a muddy shelf in the Gulf of Saint Lawrence. *Marine Ecology - Progress Series* **23**: 57-69.

Schram, Frederick R. 1986. *Crustacea*. Oxford University Press, Oxford, Great Britain. 606pp.

Shoemaker, Clarence R. 1955. Amphipoda collected at the Arctic Laboratory, Office of Naval research, Point Barrow, Alaska, by G.E. MacGinitie. *Smithsonian Miscellaneous Collections* **128**(1): 1-78.

---------. 1964. Seven new amphipods from the West Coast of North America with notes on some unusual species. *Proceedings of the United States National Museum* 115(3489): 391-430.

Thomas, James D. 1993. Identification Manual for the Marine Amphipoda : (Gammaridea). I. Common coral reef and rocky bottom amphipods of south Florida. Tallahassee, Florida, State of Florida Department of Environmental Protection, Division of Water Management, Bureau of Surface Water Management**:** 80pp.

Wesławski, Marcin and Joanna Legezynska 2002. Life cycles of some Arctic amphipods. *Polish Polar Research* **23**(3-4): 253-264.