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Global diversity of cumaceans & tanaidaceans (Crustacea: Cumacea & Tanaidacea) in freshwater

D. Jaume · G. A. Boxshall

Abstract Cumacea and Tanaidacea are marginal groups in continental waters. Although many euryhaline species from both groups are found in estuaries and coastal lagoons, most occur only temporarily in non-marine habitats, appearing unable to form stable populations there. A total of 21 genuinely non-marine cumaceans are known, mostly concentrated in the Ponto-Caspian region, and only four tanaids have been reported from non-marine environments. Most non-marine cumaceans (19 species) belong in the Pseudocumatidae and appear restricted to the Caspian Sea (with salinity up to 13‰) and its peripheral fluvial basins, including the northern, lower salinity zones of the Black Sea (Sea of Azov). There are nine Ponto-Caspian genera, all endemic to the region. Only two other taxa (in the family Nannastacidae) occur in areas free of any marine–water influence, in river basins in North and South America. Both seem able to survive in waters of raised salinity of the lower reaches of these fluvial systems; but neither has been recorded in full salinity marine environments. The only non-marine tanaidacean thus far known lives in a slightly brackish inland spring in Northern Australia. The genus includes a second species, from a brackish-water lake at the Bismarck Archipelago, tentatively included here as non-marine also. Two additional species of tanaidaceans have been reported from non-marine habitats but both also occur in the sea.

Keywords Freshwater · Global assessment · Species richness · Peracarida · Crustacea

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Freshwater Animal Diversity Assessment

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Introduction

Comprising about 1,300 and 900 marine species, respectively, the Cumacea and Tanaidacea are only marginal groups in continental waters. Although many euryhaline species in both taxa are found in estuaries and coastal lagoons, most occur only temporarily in non-marine habitats, appearing unable to form stable populations there. Only 21 genuinely non-marine cumaceans are known, most of which occur in the Ponto-Caspian region, whereas just four tanaids have been reported in non-marine habitats. Both groups are orders of peracarid crustaceans that are mainly adapted to a fossorial life-style in non-consolidated marine sediments, especially in deep

waters, although they can appear regularly in night-time plankton hauls in shallow waters.

The characteristic body form of a cumacean consists of a large, variably inflated cephalothorax incorporating the first 3 (of 8) thoracic somites, plus an elongate, narrow abdomen terminating in a pair of long and slender uropods. The cephalothorax displays a pair of frontal extensions, the pseudorostral lobes, which converge medially in most instances, whereas its lateral portions act as paired branchial chambers accommodating the respiratory epipodites of the first maxillipeds (see below). All thoracopods except the first, second and eighth are primitively biramous. The first pair (=first maxillipeds) is characteristic, possessing a respiratory coxal epipodite provided with digitiform extensions in addition to a narrow frontal extension, which together with the corresponding cephalothoracic pseudorostral lobe, forms a branchial siphon (exhalant canal) for the corresponding branchial chamber. The abdomen comprises six free pleomeres and a free telson, although in some families the latter is incorporated into the sixth pleomere forming a pleotelson. Apart from the uropods on the last pleomere, there are up to five pairs of pleopods in males, but a maximum of only one pair in females. Reduction in number of pairs of pleopods is common. All these limbs are originally biramous, with a 2-segmented exopod and a unisegmented endopod; the endopod of the uropod can be up to 3-articulate. Cumaceans are primarily deposit feeders, although some are apparently predators of foraminifers and other crustaceans. Most live half-buried in soft sediments.

General morphological characteristics for the order Tanaidacea include: a small cephalothorax incorporating the first two thoracic somites, six free thoracic somites, five abdominal somites bearing pleopods, and a pleotelson with a pair of uropods. All thoracopods except the third (=first pereiopod) of most apseudomorphs, and some other pereiopods of the manca stages of the genus *Kalliapseudes*, are uniramous. The maxillipeds (=first thoracopods) possess a respiratory coxal epipodite, which is concealed under the lateral margin of the cephalothorax (branchial cavity). The second pair of thoracopods is prehensile, displaying a chelate distal portion ("chelipeds"). The pleopods and uropods are basically biramous with 2-segmented exopods and unisegmented endopods, although both rami of the uropods can be multi-articulate, due to the display of cuticular annulations. Tanaidaceans are primarily tube or tunnel dwellers, and are generally considered to be deposit feeders.

Species diversity, distribution and historical processes

Non-marine cumaceans belong to two of the eight recognised families: Pseudocumatidae Sars and Nannastacidae Bate. Most non-marine species (19) are pseudocumatids and their distribution is focused around the Caspian Sea (maximum salinity 13‰) and its peripheral fluvial basins, including the northern, lower salinity zones of the Black Sea (Sea of Azov) (see Tables 1 and 3; Fig. 1). They represent nine genera, all endemic to the region, although the taxonomic status of some genera is equivocal (e.g. *Charsarocuma*; see comments by Sars (1914: 32) on its presumed synonymy with *Schizoramphus*) and their validity should be tested. The natural distribution of these taxa within the Ponto-Caspian region is difficult to ascertain since dispersal via artificial canals and reservoirs, by shipping, or even by deliberate introduction as fish food, may have had a profound effect (see Băcescu & Petrescu, 1999, and references therein). *Stenocuma graciloides* has recently been reported from the Gulf of Finland (Baltic Sea), where it may have been transported by ships passing through the Volga-Baltic waterway from its North Caspian home (Antsulevich, 2005). The presumed deliberate introduction of *Stenocuma gracilis*, *Pterocuma pectinata* and *Schizorhamphus scabriusculus* into the Aral sea, to serve as fish food (Karpevitch, 1960; quoted in Băcescu & Petrescu, 1999), seems not to have succeeded (Nikolay Aladin, pers. comm.). Apart from these Caspian pseudocumatids, only two other taxa (from the Nannastacidae) occur in areas free of any marine-water influence, in river basins in North and South America. Both seem able to survive in waters of raised salinity of the lower reaches of these fluvial systems (see Tables 1 and 3; Fig. 1), but neither has been recorded in full salinity marine environments. These two monotypic genera are endemic to their respective river basins.

Sars (1914) considered that the Caspian Cumacea were derived from a single ancestral form originating from the Mediterranean, probably belonging to the

Table 1 Global diversity of non-marine Cumacea (distribution of Ponto-Caspian taxa after Băcescu (1992) and Antsulevich (2005))

Order Cumacea	Distribution
Family Pseudocumatidae G. O. Sars, 1878	
Genus *Carinocuma* Mordukhai-Boltovskoi & Romanova, 1973	
C. birsteini Mordukhai-Boltovskoi & Romanova, 1973	Caspian Sea
Genus *Caspiocuma* G. O. Sars, 1900	
C. campylaspoides (G. O. Sars, 1897)	Caspian Sea; Volga, Don, Bug and Dniestr river basins
Genus *Charsarocuma* Derzhavin, 1912	
C. knipowitschi Derzhavin, 1912	Caspian Sea; pre-delta region of Volga
Genus *Hyrcanocuma* Derzhavin, 1912	
H. sarsi Derzhavin, 1912	Caspian Sea
Genus *Stenocuma* G. O. Sars, 1900	
S. gracilis (G. O. Sars, 1894)	Caspian Sea; Volga
S. graciloides (G. O. Sars, 1894)	Caspian Sea; Estuaries of Volga, Don, Dniestr and Danube; Black Sea (Azov); Gulf of Finland (Baltic Sea)
S. tenuicauda (G. O. Sars, 1894)	Caspian Sea; Volga
S. diastyloides (G. O. Sars, 1897)	Caspian Sea
S. cercarioides G. O. Sars, 1894	Caspian Sea; Volga, Don, Bug and Dniestr river basins; Black Sea
S. laevis (G. O. Sars, 1914)	Caspian Sea
Genus *Pterocuma* G. O. Sars, 1900	
P. pectinata (Sowinski, 1893)	Caspian Sea; Volga, Danube and Dniestr river basins; Black Sea
P. rostratum (G. O. Sars, 1894)	Caspian Sea; Volga; estuaries of Dniepr, Bug and Danube; Black Sea
P. sowinskyi (G. O. Sars, 1894)	Caspian; Volga; delta of Don; Black Sea
P. grandis G. O. Sars, 1914	Caspian Sea
Genus *Schizorhamphus* Băcescu, 1992	
S. bilamellatus (G. O. Sars, 1894)	Caspian Sea; Volga
S. eudorelloides (G. O. Sars, 1894)	Caspian Sea (up to 264 m depth); river mouths of Danube, Dniestr and Prut; Black Sea
S. scabriusculus (G. O. Sars, 1894)	Caspian Sea; Danube, Dniestr, Bug and Dniepr rivers
Genus *Strauchia* Czerniavsky, 1868	
S. taurica Czerniavsky, 1868	Caspian Sea
Genus *Volgocuma* Derzhavin, 1912	
V. telmatophora Derzhavin, 1912	Caspian Sea; Volga; Black Sea
Family Nannastacidae Bate, 1866	
Genus *Almyracuma* Jones & Burbanck, 1959	
A. proximoculi Jones & Burbanck, 1959	Intertidal freshwater springs at Cape Cod, and limnetic zone of Lower Hudson river (latter 1–30‰; Simpson et al., 1985), NE U.S.A.
Genus *Claudicuma* Roccatagliata, 1981	
C. platense Roccatagliata, 1981	Río de la Plata (Argentina), from Buenos Aires (0.5‰) to Punta del Indio (1.8–7.0‰) (Roccatagliata, 1991)

marine genus *Pseudocuma* Sars, 1865, which includes three Mediterranean species, one of which is also present in the Black Sea. The Caspian genus *Stenocuma* is considered to be a subgenus of *Pseudocuma* by some authors (Băcescu, 1992). Dumont (2000: 186) believed that Caspian cumaceans were derived from ancestral forms that lived in estuaries and tidal zones of rivers that discharged into

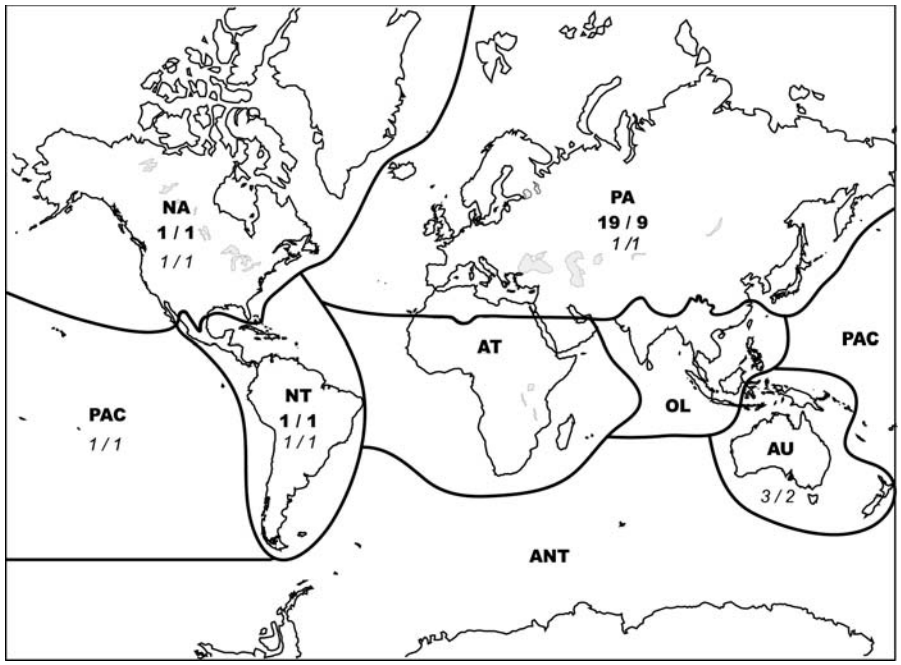

Fig. 1 Total species and genus numbers of Cumacea (Bold) and Tanaidacea (italics) per zoogeographic regions (Species number/ Genus number). PA: Palaearctic, NA: Nearctic, NT: Neotropical, AT: Afrotropical, OL: Oriental, AU: Australasian, PAC: Pacific Oceanic Islands, ANT: Antarctic

the (proto-) Mediterranean before the closure of the Sarmatian Basin, a vanished Miocene brackish lake that covered the entire Ponto-Caspian region from 14.5 to 8.3 Myr ago. Their osmoregulatory abilities would have preadapted them to life in the brackish Sarmatian lake.

The only truely non-marine tanaidacean known is *Pseudohalmyrapseudes aquadulcis* (Parapseudidae) which lives in a slightly brackish inland spring in Northern Australia (see Tables 2 and 3; Fig. 1; Larsen & Hansknecht, 2004). The genus includes a second species, *P. mussauensis*, from a brackish-water lake in the Bismarck Archipelago; this species is tentatively included here as non-marine, since the genus has not been recorded yet in fully marine environments, and Shiino (1965) was rather vague in his description of the salinity regime of the lake where the species was discovered (see Tables 2 and 3; Fig. 1).

Table 2 Global diversity of non-marine Tanaidacea

Order Tanaidacea	Distribution
Family Parapseudidae Gutu, 1981	
Genus *Pseudohalmyrapseudes* Larsen & Hansknecht, 2004	
P. aquadulcis Larsen & Hansknecht, 2004	"Freshwater spring" (but 1.93‰ in salinity), Australian Northern Territory
P. mussauensis (Shiino, 1965)	"Brackish lake", Bismarck Archipelago (Papua New Guinea)
Family Tanaidae Dana, 1849	
Genus *Sinelobus* Sieg, 1980	
S. stanfordi (Richardson, 1901)	Marine, plus freshwater, hypohaline and hypersaline inland waters of Galapagos, Japan, Hong Kong, New Zealand, Australia, Argentina, Kurile Islands, West Indies, Florida and Brazil (see Larsen & Hansknecht, 2004, and references therein)
Family Anarthruridae Lang, 1971	
Genus *Paraleptognathia* Kudinova-Pasternak, 1981	
P. longiremis (Lilljeborg, 1864)	Deep sea plus… Lake Baikal! (Kudinova-Pasternak, 1972) Record requiring confirmation

Table 3 Global and per biogeographic region diversity (species number) of non-marine Cumacea and Tanaidacea

	PA	NA	NT	AT	OL	AU	PAC	World
Nannastacidae		1 (1)	1 (1)					2 (2)
Pseudocumatidae	19 (9)							19 (9)
Total Cumacea	19 (9)	1 (1)	1 (1)					21 (11)
Anarthruridae	1 (1)							1 (1)
Parapseudidae						2 (1)		2 (1)
Tanaidae	1 (1)	1 (1)	1 (1)		1 (1)	1 (1)	1 (1)	1 (1)
Total Tanaidacea	2 (2)	1 (1)	1 (1)		1 (1)	3 (2)	1 (1)	4 (3)

In brackets, number of genera. No records of these groups exist from Antarctica. PA: Palaearctic, NA: Nearctic, NT: Neotropical, AT: Afrotropical, OL: Oriental, AU: Australasian, PAC: Pacific Oceanic Islands, ANT: Antarctic.

Larsen & Hansknecht (2004) suggest that *Pseudohalmyrapseudes* occupies an intermediate position between the euryhaline genus *Halmyrapseudes* Băcescu & Gutu, 1972 and *Longiflagrum* Gutu, 1995, although no phylogenetic analysis was performed to support this suggestion. The Australian species is inferred to have reached the spring it inhabits via the groundwater system, although the possibility of an upstream migration from the ocean cannot be ruled out.

Two other species of tanaidaceans have been reported from non-marine habitats, but both occur also in marine environments. *Sinelobus stanfordi* (Tanaidae), a widely distributed euryharine taxon, has been reported repeatedly from geographically scattered freshwater, hypohaline or hypersaline lakes (Tables 2 and 3; Fig. 1). In addition, there is a doubtful record of the deep-sea trench *Paraleptognathia longiremis* (Anarthruridae) from Lake Baikal (Kudinova-Pasternak, 1972; Tables 2 and 3; Fig. 1). This record requires confirmation and, as Larsen & Hansknecht (2004) point out, the conspecificity of the non-marine populations of these two taxa to their corresponding marine forms should be confirmed, suggesting that the current diversity of non-marine tanaidacean species is underestimated.

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