
Neomysis mercedis

A mysid, or opossum shrimp

Phylum: Arthropoda, Crustacea
Class: Malacostraca
Order: Mysidacea
Family: Mysidae

Taxonomy: *Neomysis awatschensis*, *N. intermedia*, and *N. mercedis* were considered three different species (with distinct morphology) from the western Pacific, northwestern Pacific and northeast Pacific coasts (Tattersall 1951; Holmquist 1973; Brand et al. 1993), but have since been synonymized as *N. mercedis* (Moldin 2007).

Description

Size: Adults range in size from 11 to 17 mm in length (Banner 1948b). The illustrated specimens (from the Columbia River estuary) were up to 17 mm long.

Color: Clear body with black chromatophores, although an individual caught on eelgrass was yellow green (Banner 1948b).

General Morphology: Mysids are shrimp-like crustaceans that are occasionally called opossum shrimp due to the female marsupium or brood pouch, which is composed of oostegites. Like other Peracarida (e.g., cumaceans, isopods, amphipods, tanaids), their bodies are elongated and composed of an anterior **cephalon** and **pereon** (thorax, covered by a **carapace**), and a **pleon** (abdomen). At the posterior end, they have a **telson** and **uropods**. Among the Mysidacea specifically, the carapace is attached to the thorax by anterior segments only and the posterior dorsal edge is free (Banner 1948a) (Fig. 1). Mysid eyes are stalked, antennules are biramous, antennae have a long scale (or squama), pleopods are often reduced, thoracic legs bear swimming exopodites and uropods are lamellar and form tail fan. Mysids are easily distinguished from other Peracardia by the presence of a statocyst on the uropod endopods (see Plate 220, Moldin 2007; Vicente et al. 2014; Fig. 1, Meland et al. 2015).

Cephalon:

Carapace: Not attached dorsally at posterior edge. Anterior lateral angles acute (Figs. 1, 3).

Rostrum: A short triangle with obtusely pointed apex, and rounded, “flanged” corners (Tattersall and Tattersall 1951). A medial depression obscures the pointed apex (Holmquist 1973). In total size, rostrum is only as long as bases of eyestalks (Tattersall and Tattersall 1951) (Figs. 1, 3).

Eyes: On movable stalks and about 1.5 times as long as broad and with corneas that are expanded, but not separated into two portions (Fig. 3).

Antennae: Long, slender, and multi-articulate (Fig. 1).

Antennae Scale: (= squama) Long, narrow, about eight times longer than wide (Banner 1948b; Brandt et al. 1993). The size of the scale, however, may vary among individuals (Holmquist 1973). The scale is setose all around and is with pointed apex pointed (*Neomysis*, Tattersall 1933; Moldin 2007) and an articulated tip (Fig. 3).

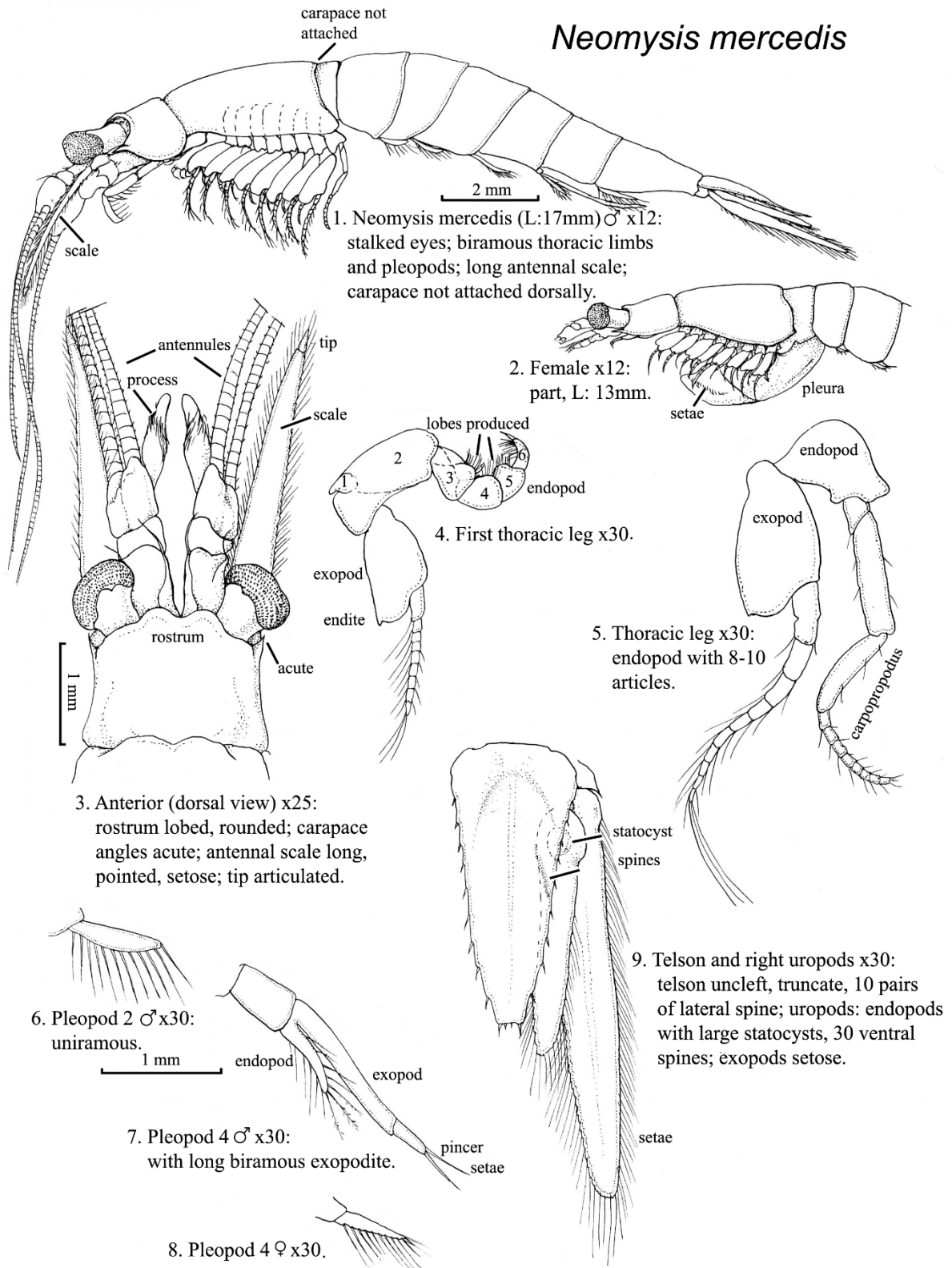
Mouthparts: For general mouthpart morphology for the Mysida see Fig. 3, Meland et al. 2015. In *N. mercedis*, the labrum is normal (i.e. not produced posteriorly as a cleft plate, and with anterior sharp point, Tattersall 1933). Anterior is pointed, but not with long sharp spine (Holmquist 1973). The mandibles are without expanded cutting lobe (Banner 1948a).

Pereon: Anterior pereonites attached to carapace.

Pereopods: First pereopod with endite of basipodite well developed (Banner 1948b). The endopod has a maxilliped-like feeding structure. The second, third and fourth articles have enlarged lobes (Fig. 4) (Banner 1948b). Legs 3–8 are similar, but third leg is not copulatory (Banner 1948). Endopods with 8–10 articles (Fig. 5).

Pleon:

Neomysis mercedis



Pleopods: In males, the first and second pleopods are rudimentary, and the second is uniramous (Banner 1948a) (Fig. 6). pleopod is short and slightly curved in *N. mercedis* (Holmquist 1973; Moldin 2007), with shortened, uniarticulate endopodite, long exopodite consisting of two articles, and with two terminal pincer setae (Banner 1948b) (Fig. 7). The fifth pleopods are rudimentary. In females, all pleopods are small, uniarticulate, and rudimentary (Fig. 8).

Telson: Short, and about twice as long as broad. The tip is broadly triangular and not cleft (Brandt et al. 1993). The telson bears 12–15 pairs of lateral spines (Holmquist 1973) (10 in illustrated specimen). The tip has two pairs of spines, the outer pair long and the inner pair very small and not setose (Banner 1948b) (Fig. 9).

Uropods: Uropod endopods with about 30 close set spines along the inner, ventral edge, near the statocyst (Fig. 9). The exopods are undivided, and with setae only (no spines) on both outer and inner margins.

Statocyst: A balance and light organ found on the uropod endopod that is large, opaque, and white in preservation (Fig. 9).

Sexual Dimorphism: The fourth male pleopod is short, slightly curved and biramous. Mature females are recognizable by oostegites and two pairs of lamellae, or pleura. The anterior pair is with posterior "balancing lobe" to assist in aerating embryos and has a setose ventral edge (Fig. 2).

Possible Misidentifications

Mysidacea and Euphausiacea, being superficially similar in appearance, are often treated together (e.g. Banner 1948a; Mauchline 1980). (They were formerly combined as the Schizopoda.) Both are orders of the class Malacostraca, but euphausiids are in the group (i.e. superorder) Eucarida with the Decapoda (Martin 2007). Like the mysids, euphausiids differ from decapods in having biramous thoracic legs (Kasaoka 1974). Unlike the mysids, euphausiids have a carapace that is fused dorsally with all the thoracic segments. The mysid carapace is attached only to the first two or three thoracic segments. Furthermore, mysid females have oostegites, but euphausiids do not.

The third pleopod is more or less reduced and only the fourth is biramous (*Neomysis*, Banner 1948b). Furthermore, the fourth

Other orders of Peracarida include Isopoda, Tanaidacea, and Amphipoda, which are all fairly easily distinguished from Mysidacea. One order that might be confused is Cumacea, small crustaceans of up to ½ inch long, with an inflated, shrimp-like carapace (see *Cumella vulgaris*, this guide), a single compound recessed eye (except for some eyeless females of some species), and a flexible, tubular abdomen. Mysids characteristically have large, stalked, movable eyes, and well developed exopodites on their thoracic legs. Mature females have oostegites forming a marsupium. Additionally, northeast Pacific mysids lack thoracic gills, have reduced pleopods in females (and sometimes in males). They also have a statocyst on the inner ramus of the uropod.

The Mysidacea is divided into two suborders, the Mysida (approximately 1,200 species worldwide) and Lophogastrida (58 species worldwide) (Vicente et al. 2014; Meland et al. 2015). The former suborder comprises coastal and intertidal species while the latter includes mostly large, pelagic and deep-sea mysids. These suborders are easily differentiable by the presence of branchial gills, biramous pleopods and the lack of statocysts in Lophogastrida (branchia are absent, pleopods are reduced and statocysts are conspicuous in the Mysida) (Moldin 2007). *Neomysis mercedis* belongs to the Mysida, lacking gills or branchiae on the thoracic legs and having rather reduced female pleopods.

Within the Mysidacea locally, there are 15 species comprising the following genera: *Acanthomysis* and *Neomysis* (comprising three species and four species, respectively), and *Hyperacanthomysis*, *Alienacanthomysis*, *Columbiaemysis*, *Deltamysis*, *Exacanthomysis*, *Hippacanthomysis*, *Holmesimysis*, and *Archaeomysis* (each with a single species represented locally) (Moldin 2007).

Alienacanthomysis macropsis is recognizable by elongated eyestalks and *Deltamysis holmquistae* has spines on the lateral telson margins, but only distally, where other species have spines all over the telson

margins or in proximal groups.

Alienacanthomysis macropsis, has a broadly triangular rostrum with long acute lateral carapace spines and its telson has a fringe of small spines. It is abundant in San Francisco Bay and becomes rarer farther north (Holmquist 1979). It has been reported from Yaquina Bay to lower Columbia River and in Puget Sound in bays amongst *Ulva* and in plankton (Kozloff 1974).

Archaeomysis grebnitzkii has spines along the lateral margins of uropod exopods, which is not seen in other species. Of the species without lateral exopod spines, *Hippacanthomysis platypoda* has a flattened exopod of fourth pleopod (males).

Holmesimysis costata and *E. davisii* have distinctly segmented pleonites, the former has a broadly triangular telson while the latter has a telson that is sharply triangular.

Holmesimysis was extracted from *Acanthomysis* (Holmquist 1979). Its members have fourth male pleopods with only two segments and a tip that bears two spiny peg-like structures (Mauchline 1980).

Holmesimysis costata, the type species for the genus, has a short, bluntly rounded antennal scale.

Columbiaemysis, *Acanthomysis*, *Neomysis* and *Hyperacanthomysis* species have pleonites that are smooth and without distinct folds or segments. *Neomysis* species have a pointed distal tip of the antennal scale (Fig. 3) and members of the remaining genera have a distal antennal scale tip that is rounded (Tattersall 1951; Moldin 2007).

Columbiaemysis ignota has been described from female specimens only, and only from British Columbia. Its antennal scale is long, setose all around, and has a suture. Its telson is tongue shaped, with spines becoming dense at the tip, and two long spines at the rounded apex. There are four spines on the lower edge of the statocyst.

There are several northeast Pacific species in the genus *Neomysis* (all with pointed apex on the antennal scale, two pairs of female oostegites, statocyst on the uropod endopod, and male fourth pleopods biramous). *Neomysis japonica* is a Japanese species introduced and first collected from San Francisco Bay, California in 2004. It has a long antennal scale that is 10 times as long

as broad, an articulated distal tip, and a broadly triangular telson (Moldin 2007).

Neomysis integer is an Atlantic species that has also been found in plankton in Puget Sound (Kozloff 1974). It has a long pointed antennal scale, a long telson with a narrow, truncate apex and long dense lateral spines, there are about 15 spines near the statocyst.

Neomysis kadiakensis is a large species (20 to 23 mm long) (Banner 1948b), with over 40 spines near the statocyst. Its telson is long and narrow with 20 or more pairs of lateral spines (Banner 1948b), each spine is longer than the distances between their bases. The eyes have corneas larger than their stalks and the rostrum is bluntly triangular.

Neomysis kadiakensis ranges from British Columbia, Canada to San Francisco Bay, California. Although considered a neritic species, it is possibly more common inside bays and inlets than outside (Banner 1948b).

Neomysis rayii (= *franciscorum*, = *toion*) has a telson at least 2 ½ times longer than wide and the truncate telson tip is very narrow. There are 10 to 12 pairs of lateral telson spines present and, near the statocyst, are 20 to 50 spines. This is a large species (18 to 65 mm long, Banner 1948b). It ranges from Alaska to San Francisco Bay and occurs in the plankton in Puget Sound, Washington (Kozloff 1974) and has also been collected in Yaquina Bay and the lower Columbia River, Oregon. *Neomysis awatschensis* and *N. intermedia* have been synonymized with *N. mercedis* (Moldin 2007). None of the preceding aforementioned *Neomysis* species, has the short, curved male pleopod with its proximal article 4x the length of its distal article. Also distinctive in *N. mercedis* is the antennal scale, which is 8x longer than wide (Banner 1948b; Brandt et al. 1993).

Ecological Information

Range: Type locality and namesake presumably Lake Merced, California (Holmes 1897 in Tattersall 1951). Known range from Prince William Sound, southern Alaska, to San Francisco Bay area and possibly south to Pt. Conception, California (Orsi and Knutson 1979). Washington in Puget Sound and inland lakes. Oregon sites include Fletcher Lake, rivers and coastal waters and California sites at Lake Merced, Lake Merritt, and the

Sacramento-San Joaquin estuary (Holmquist 1973).

Local Distribution: Oregon coastal waters including lagoons, inlets, estuaries, and bays (Holmquist 1973). Planktonic in fresh water, but originated in shallow marine bays, from which it has also moved into fresh water lakes (Banner 1948b). Very sensitive to oxygen content and does poorly in water that has less than 8 ppm (Heuback 1969).

Habitat: Benthic and planktonic in brackish water and freshwater. Rarely found in strictly marine habitats except river mouths. Turbid to clear water (Orsi 1978).

Salinity: Euryhaline, and tolerates a wide range of salinities, but becomes stressed with sudden changes to fresh water (Heuback 1969). Although most members of the Mysidacea are marine, *N. mercedis* has adapted to an estuarine environment, and sometimes occurs in freshwater (e.g. San Joaquin Estuary, Moldin 2007). Especially common in shallow bays with salinities of 10 and less (Banner 1948b). Ranges farther upstream into fresh water than any other *Neomysis* from salinity of 30 (potentially as high as 32.3, Orsi 1978) to entirely fresh water. This species is a model estuarine species for toxicity testing and has been reared at salinities as low as 2 at 17°C on a diet of *Artemia salina* (see Brandt et al. 1993).

Temperature: Eurythermic and tolerates temperature ranges from 7–27 °C in summer, but winter temperature range is unknown (Holmquist 1973). Upper lethal temperature is 25.5 degrees. Population densities are low when temperatures are over 22 degrees, especially when combined with low dissolved oxygen (Heuback 1969).

Tidal Level: Subtidal, but closer to the surface at flood than at ebb tide (Heuback 1969). Depth distribution is highly variable (e.g. eight to more than 30 meter depths in Lake Washington, Chigbu et al. 1998) but individuals tended to be more abundant at shallower stations, with some diel vertical migration observed (deep water during the day, surface water at night, Cooper et al. 1992; Haskell and Stanford 2006). Juveniles do not always exhibit the diel pattern of adults and may be present in surface waters during the day than mature individuals (Siegfried et al. 1979, but see Heuback 1969).

Associates: Sometimes co-occurs with *Archaeomysis grebnitzkii*, but more rarely with *Exacanthomysis davisii*, *Alienacanthomysis macropsis* and other mysids (Holmquist 1982). In the Columbia River Estuary, *A. macropsis* and *N. mercedis* females host generally inconspicuous ectoparasitic copepods (*Hansenulus trebax*) within their marsupium (see Fig. 2, Daly and Damkaer 1986). Thirty-six percent of brooding females were infected with these copepods, which feed on developing embryos within the marsupium (Columbia River Estuary, Oregon, Daly and Damkaer 1986).

Abundance: Second most common mysid of the northeastern Pacific after *A. grebnitzkii* (Holmquist 1982). In Coos Bay, Oregon, densities varied from zero to 29 individuals per cubic meter (summer, Ziegler 1983). Abundance peaks were observed on May 26, July 3 (highest) and July 24 and correlated with high temperatures, chlorophyll counts, and possibly reproductive swarming. In the California Delta, densities drop off when temperatures are over 18°C, light intensity is high, salinities less than 10 and when little flow reversal occurs at flood tide. Low population densities were observed in Lake Washington and ranged from 0.1–0.17 mysids per cubic meter in 1991 and 1992 (Chigbu 2004).

Life-History Information

Reproduction: All mysid development takes place within the female marsupium, is lecithotrophic and proceeds through three distinct stages: 1) the embryonic stage; 2) the first nauplioid stage (eyeless larva); and 3) the post-nauplioid (eyed larva) stage to a juvenile (see Figs. 38.1–38.2, Vicente et al. 2014). *Neomysis mercedis* individuals are reproductive during most of year, but few gravid females are observed in December and January (Heuback 1969) and peak reproductive time is in summer months. Brood size depends on female body size, egg size, and season (in high and temperate latitudes) (Johnston and Northcote 1989). Estuarine *N. mercedis* females 7–17 mm long had 5–57 eggs per brood (Heuback 1969; Cooper et al. 1992). The percentage of small gravid females (7–10 mm) was greatest late summer and fall with most mortality occurring

thereafter; remaining females lacked marsupium in winter. Females 11–12 mm long were gravid most of year, and produced the most eggs in early summer months. Large females (over 13 mm), were gravid in late winter and spring (California Delta, Heuback 1969). Females may produce 1–5 broods per year (Daly and Damkaer 1986; Johnston and Northcote 1989). Coos Bay brood time is probably 5 weeks (Ziegler 1983).

Larva: The first nauplioid stage has appendages that resemble the typical nauplius larva (e.g. see *Balanus glandula*, this guide), but lacks an eye or swimming setae. The next post-nauplioid stage has all adult appendages, carapace and eyes. Both stages are non-motile and lecithotrophic. Ultimately, the post-nauplioid molts into a free-living juvenile (Vicente et al. 2014). Newly hatched individuals are approximately 1 mm in cephalothorax length (Figs. 1–2, Brandt et al. 1993).

Juvenile: Juvenile *N. mercedis* range in size from 1–3 mm in length (Siegfried et al. 1979; Brandt et al. 1993).

Longevity: *Neomysis integer* lifespan is probably 12 to 18 months, but lives are shorter in dense cultures of diatoms and diatom-free water (see Lucas in Tattersall and Tattersall, 1951) or in the lab (e.g. 150 days, Brandt et al. 1993).

Growth Rate: Growth among mysids occurs in conjunction with molting where the exoskeleton is shed and replaced. Post-molt individuals will have soft shells as the cuticle gradually hardens. During a molt, arthropods have the ability to regenerate limbs that were previously autotomized (Kuris et al. 2007). In Japanese *Neomysis*, the May generation matured in 1 ½ months and the August generation matured the following April (Tattersall and Tattersall 1951). After hatching, individuals are 1 mm (cephalothorax length) and grow to 3.5 mm after 60 days (see Fig. 1, Brandt et al. 1993). Size at sexual maturity ranged from 9–20 mm in two Canadian lakes (Kennedy and Muriel Lakes, respectively, Cooper et al. 1992).

Food: Mysids are generally omnivorous and eat detritus, algae and zooplankton by filtration (Siegfried and Kopache 1980; Moldin 2007). Individuals preferred large diatoms in

the California Delta, but 80% of energy came from rotifers and copepods (Kost and Knight 1975; Siegfried and Kopache 1980).

Neomysis mercedis is not an active predator and captures prey in a self-generated current. Adults feed continuously, especially at night and juveniles eat rotifers when available, but not copepods. Individuals will eat *Artemia salina* nauplii in the lab (Siegfried and Kopache 1980; Brandt et al. 1993). In the Fraser River, British Columbia, *N. mercedis* eats harpacticoid copepods (Johnston and Lasenby 1982) and in Lake Washington, the cladoceran *Daphnia* (Murtaugh 1981a, 1981b; Chigbu and Sibley 1994; Chigbu 2004). In the lab, *N. integer* consumed on average of over 1 million cells, and maximum of 6 million cells, of the diatom, *Nitzschia*, per hour (See Lucas in Tattersall and Tattersall 1951). Although *N. mercedis* is also a food source for juvenile salmonids and other fishes (see **predators** below), this mysid is also a competitor that consumes the same zooplankton prey as several common pelagic fish (e.g. sockeye salmon, Cooper et al. 1992; Hyatt et al. 2005; American shad and chinook salmon, Haskell and Stanford 2006).

Predators: A primary food for fishes of upper bays and the principal food source of young of the year striped bass in the California Delta (Murtagh 1981a). Also eaten by American shad, white sturgeon, white catfish, caridean shrimp and juvenile Chinook salmon (Tiffan et al. 2014) and striped bass (Siegfried and Kopache 1980). Longfin smelt may regulate the abundance of *N. mercedis*, according to a study from Lake Washington from 1988 to 1992 (Chigbu and Sibley 1998; Chigbu et al. 1998). Additional predators include the carnivorous shrimp, *Crangon franciscorum* and *Palaemon macrodactylus* (Sacramento-San Joaquin River Delta, California, Siegfried 1982).

Behavior: In sea water, individuals tend to avoid light when in dense diatom cultures (Tattersall and Tattersall 1951).

Bibliography

1. BANNER, A. H. 1948a. A taxonomic study of the Mysidacea and Euphausiacea (Crustacea) of the northeastern Pacific. Part I. Mysidacea, from family Lophogastridae through tribe Erythropini.

- Transactions of the Royal Canadian Institute. 26.
2. ——. 1948b. A taxonomic study of the Mysidacea and Euphausiacea (Crustacea) of the Northeastern Pacific. Part II: Mysidacea from tribe Mysini through subfamily Mysedellinae. Transactions of the Royal Canadian Institute. 27:65-125.
 3. HAIR, J. R. 1971. Upper lethal temperature and thermal shock tolerances of the opossum shrimp, *Neomysis awatschensis*, from the Sacramento-San Joaquin Estuary, California. California Fish and Game. 57:17-27.
 4. HEUBACH, W. 1969. *Neomysis awatschensis* in the Sacramento-San Joaquin River estuary. Limnology and Oceanography. 14:533-546.
 5. HOLMQUIST, C. 1973. Taxonomy, distribution and ecology of the three species *Neomysis intermedia* (Czerniavsky), *N. awatschensis* (Brandt) and *N. mercedis* Holmes (Crustacea, Mysidacea). Zoologische Jahrbücher. Abteilung für Systematik, Ökologie und Geographie der Tiere. 100:197-222.
 6. ——. 1981. The genus *Acanthomysis* Czerniavsky, 1882 (Crustacea:Mysidacea). Zoologische Jahrbücher. Abteilung für Systematik, Ökologie und Geographie der Tiere. 108:386-415.
 7. ——. 1979. *Mysis costata* Holmes, 1900, and its relations (Crustacea, Mysidacea). Zoologische Jahrbücher. Abteilung für Systematik, Ökologie und Geographie der Tiere. 106:471-499.
 8. ——. 1982. Mysidacea (Crustacea) secured during investigations along the west coast of North America by the National Museums of Canada, 1955-1966, and some inferences drawn from the results. Zoologische Jahrbücher. Abteilung für Systematik, Ökologie und Geographie der Tiere. 109:469-510.
 9. JOHNSTON, N. T., and D. C. LASENBY. 1982. Diet and feeding of *Neomysis mercedis* Holmes (Crustacea, Mysidacea) from the Fraser River Estuary, British Columbia. Canadian Journal of Zoology. 60:813-824.
 10. KOZLOFF, E. N. 1974a. Keys to the marine invertebrates of Puget Sound, the San Juan Archipelago, and adjacent regions. University of Washington Press, Seattle & London.
 11. MAUCLINE, J. 1980. The biology of mysids and euphausiids, p. 681. *In*: Advances in marine biology. Vol. 18. J. H. S. Blaxter, F. S. Russell, and C. M. Yonge (eds.). Academic Press, London; New York.
 12. MURTAUGH, P. A. 1981. Selective Predation by *Neomysis mercedis* in Lake Washington. Limnology and Oceanography. 26:445-453.
 13. ORSI, J. J., and A. C. KNUTSON. 1979. An extension of the known range of *Neomysis mercedis*, the opossum shrimp. California Fish and Game. 65:127-130.
 14. SIEGFRIED, C. A., and M. E. KOPACHE. 1980. Feeding of *Neomysis mercedis* (Holmes). Biological Bulletin. 159:193-205.
 15. TATTERSALL, W. M. 1932. Contributions to a knowledge of the Mysidacea of California. I. On a collection of Mysidae from La Jolla, California. University of California Press, Berkeley, Calif.
 16. ——. 1933. Euphausiacea and Mysidacea from Western Canada. Contributions to Canadian Biology and Fisheries. 8:181-205.
 17. TATTERSALL, W. M., and O. S. TATTERSALL. 1951. The British Mysidacea. Ray Society, London.
 18. TURNER, J. L., and W. HEUBACH. 1966. *Distribution and concentration of Neomysis awatschensis in the Sacramento-San Joaquin Delta*. California Fish and Game. 133:105-112.
 19. ZIEGLER, R. 1983. A study of *Neomysis mercedis* in the Coos River., p. 13. University of Oregon Institute of Marine Biology, Charleston, Oregon.