Order Isopoda. Pages 310, 325–331, 353, 359–360, 375, 377, 379, 383–385, 396, 402, 404–408 In: G. L. Hoffman (Ed.) Parasites of North American freshwater fishes.

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The Crustacea comprise three parasitic groups: the Branchiura (fish lice), parasitic copepods (Entomostraca), and parasitic isopods. Males of the parasitic Entomostraca disappear after copulation in the preadult stages, so identification is usually of females only; both sexes of the Branchiura are parasitic, however.

Certain parasitic copepod species of the genera *Argulus*, *Lernaea*, and *Ergasilus* are serious pests in fish culture, sometimes in nature, and have become increasingly important in recent years. Control of dangerous crustaceans has been difficult, but eradication with the growth regulator Dimilin has been successful experimentally (G. L. Hoffman and Moore, 1981). Interestingly, parasitic copepods are not found in acidic seepage waters (Bere, 1935), and *Ergasilus sieboldi* is highly sensitive to hydrogen sulfide (Gnadeberg, 1949).

Specimens are usually preserved in 70% alcohol, or sometimes in 10% formalin. Smaller specimens may be mounted in balsam but may require dissection for appendage morphology. Dissection is best accomplished in glycerin, polyvinyl lactophenol, or Berlese fluid.

— *Ref.* Fernando and Hanek (1973): methods; Fratello and Sabatini (1972): karyology of *Lernaea cyprinacea*; Fryer (1982): British freshwater parasitic crustacea, including methods; Goldstein (1982): parasitic crustacea of aquarium fishes; G. L. Hoffman (1977a): *Achtheres*, *Ergasilus*, and *Salmincola* leaflet; Humes and Gooding (1964): methods, including lactic acid to soften exoskeleton; S. K. Johnson (1969): sodium hypochlorite to digest soft parts; Kabata (1981): problems and perspectives; Kabata (1988): key to Canadian species; Pennak (1963): methods for identifying cyclopoid copepods; Yamaguti (1963c): worldwide synopsis.

Group Entomostraca

All small freshwater crustaceans.

Subclass Branchiura

One genus is represented here, so only the generic description is given.

sis Tidd and Bangham, 1945). Arthur et al. (1976): *Coregonus clupeaformis*, Aishinik Lake, Canada; Kabata (1988): key, Canadian records, including *Coregonus artedi, C. clupeaformis, C. hoyi, Esox lucius, Prosopium cylindraceum, P. williamsoni*; C. B. Wilson (1908): AK.

- *S. extumescens* (Gadd, 1901) (Syn. *Lernaeopoda extumescens* Gadd, 1901; *L. inermis* Wilson, 1911; *S. inermis* (Wilson, 1911) Wilson, 1915; *S. omuli* Messjatzeff, 1926): *Coregonus pidschian*, AK, Europe; Margolis and Arthur (1979): European records, including *Coregonus artedi, C. clupeaformis, C. hoyi, C. kiyi, C. reighardi*; C. B. Wilson (1920b): *Coregnus nelsonii*, AK.
- *S. falculata*: syn. of *S. californiensis*.
- *S. gibber*: syn. of *S. carpionis*.
- *S. inermis* (C. B. Wilson, 1911b): *Coregonus harengus*, Canada; Bangham (1955): *C. artedi*, Lake Huron; Markevich (1957): syn. of *S. extumescens*; Pritchard (1931): *Coregonus hoyi, C. kiyi, C. reighardi*; Swanson and Pratt (1977): probably *S. inermis* on *C. artedi*, Lake Superior; Tidd (1931): Lake Erie; B. Warren (1952): *Coregonus artedi*, MN; C. B. Wilson (1911b); C. B. Wilson (1915): redescription; C. B. Wilson (1920): *Coregonus nelsonii*, AK; R. R. Wright (1882): Lake Ontario.
- *S. lotae* (Olsson, 1869): first North American record, Lake Superior, WI (Lasee et al., 1988).
- *S. oquassa*: syn. of *S. edwardsi*.
- *S. salmoneus* (Linnaeus, 1758) (Syn., see Kabata, 1969). Author: found on gills and in gill chamber of freshwater *Salmo salar*, North America and Europe; Kabata (1988), Margolis and Arthur (1979): Canadian records.
- *S. salvelini*: syn. of *S. carpionis*.
- *S. siscowet* (S. I. Smith, 1874): *Salvelinus namaycush, Salvelinus* spp., Canada; Chinniah and Threlfall (1978): *S. namaycush*, Lab., Dechtiar (1972b), MacLulich (1943b): same, Ont.; C. B. Wilson (1915, 1920b): *Salvelinus alpinus, S. malma, S. namaycush*, redescription, N.W.T., Greenland.
- *S. thymalli* (Kessler, 1868) (Syn. *Lernaeopoda clavigera* Olsson, 1872; *S. baicalensis* Messjatsev, 1926: *Lernaeopoda t.* Kessler, 1868). Kabata (1988), Margolis and Arthur (1979): Canadian records, including *Coregonus clupeaformis, Prosopium cylindraceum, P. williamsoni, Thymallus arcticus*, B.C., Lab., N.W.T., Y.T. Author: also found in Europe.
- *S. tiddi* C. E. Price and Hames, 1968: gills, *Oncorhynchus mykiss*, WI.
- *S. wisconsinensis*: syn. of *S. extensus*.
- *Salmincola* sp. Bangham (1951): *Oncorhynchus clarki, Salvelinus namaycush*, WY; Bangham (1955): *Prosopium cylindraceum*, Lake Huron; Bangham and Adams (1954): Cottus asper, *Gasterosteus aculeatus, Oncorhynchus nerka, Prosopium williamsoni, S. namaycush*, B.C.; Cope (1958): *O. clarki*, WY; Hanek and Molnár (1974): *Salvelinus fontinalis*, Que.; Heckmann and Ching (1987): *O. clarki*, Yellowstone Lake; Newell and Canaris (1969): *P. williamsoni*, MT; Neiland (1962): *Oncorhynchus clarki*, OR; Rucker (1957): necessity of discarding heavily infected broodstock; Wales (pers. comm., State Fisheries, 1964): brown trout uninfected, but imported brown trout became infected, CA.

Order Isopoda

(Compiled by Ernest H. Williams Jr., Department of Marine Sciences, and Lucy Bunkley-Williams, Department of Biology, University of Puerto Rico, Mayagüez)

Isopods are flattened crustaceans with a body divided into three parts: head (cephalon), trunk (pereon), and tail (pleon [terminal segment = pleotelson]). The head has two pairs of antennae and a pair of compound eyes; the trunk seven pairs of legs; and the tail has six pairs of paddle gills (pleopods) ventrally and a pair of balancing fins (uropods) dorsally. Isopods of fishes typically associate with marine or brackish water fishes, but some do occur on aquarium and freshwater fishes. All occur on fish host on the outer body or fins, in the mouth, gill chambers, or nostrils, or occasionally in self-made pockets in the flesh of their hosts. Isopods are most diverse in the tropics but probably most numerous in temperate areas. Most parasitic species associate with shallow-water fishes, although some occur exclusively on deep-water or pelagic fishes. Parasitic isopods are classified into five families: the Cymothoidae are exclusively parasitic on fishes; the Gnathiidae are parasitic as juveniles on fishes; some Aegidae seem to be semiparasitic on fishes; and the remaining Aegidae and some Corallanidae are more casual parasites or minipredators. Some members of the Cirolanidae may be only temporary or accidental associates. All of these families are represented in North American marine waters, but only the cymothoidae have been known to infest freshwater fishes of North America.

Native isopods included in this book are found on coastal freshwater fishes or on brackish water fishes in freshwater, although these isopod species are primarily associated with marine, brackish water, or euryhaline fishes. S. K. Johnson (1978) noted isopods on freshwater fishes from Texas of coastal areas. Three freshwater fish isopods have been imported to North America on aquarium fishes; one of these isopods may have become established in freshwater in North America (authors). Cymothoids parasitize freshwater fishes in the rivers and lakes of South America (Taberner, 1981), Africa (Paperna, 1980), and Asia (Bruce, 1990). Many of these cymothoids are exclusively freshwater parasites. Some species burrow into the flesh of their hosts, forming a pouch in the muscle with a small opening to the exterior; other speices occur in the gill chambers of their host. One aegid occurs on freshwater fishes in Southeast Asia; corallanids infest freshwater fishes in the Indo-Pacific

Artificial Key to the Females of North American Isopods Reported from Freshwater Fishes

1. Body heavily pigmented, brown to black in color, color often more intense on upper side; external parasite, attaching to body or fins of fishes 2
1. Body lightly pigmented, white to yellow in color, uniform on entire body; found in gill chamber, mouth, or flesh of fishes 4
2. (1) Body brown, usually darker on upper side; lateral projections lacking from first two segments of tail; head pointed anteriorly, not trilobed posteriorly . . . . . (Fig. 465) *Anilocra acuta*
2. (1) Body black or striped black and white; lateral projections present on first two segments; head rounded anteriorly, trilobed posteriorly 3
3. (2) Found on Pacific Coast . . (Fig. 472) *Nerocila californica*
3. (2) Found on Atlantic and Gulf Coasts . . . . . *Nerocila lanceolata*
4. (1) Body elongated, skinny and deep; occurring in mouth of menhaden . . . . (Fig. 473) *Olencira praegustator*
4. (1) Body oval, broad, and flat; occuring in gills; not found in mouth of menhaden 5
5. (4) Third trunk segment wider than fifth, body surrounding first three to four tail segments; found in pouches in muscle of fishes 6
5. (4) Fifth trunk segment wider than third; trunk surrounding first two or fewer tail segments of tail; found in gills or mouths of fishes 7
6. (5) Terminal segment of seventh leg straight; terminal shield (pleotelson) longer than wide; in fishes from South America . . . . . (Fig. 466) *Artystone trysibia*
6. (5) Terminal segment of seventh leg hooked; terminal shield (pleotelson) wider than long; in fishes from Asia . . . . . (Fig. 469) *Ichthyoxenus* sp.
7. (5) Tail (pleon and pleotelson) wide; head surrounded by "shoulders" of body; found on Pacific Coast 8
7. (5) Tail narrow; head not surrounded by "shoulders" of body; found on Atlantic and Gulf Coasts or on aquarium fishes 9
8. (7) Last segment of tail (pleotelson) as wide as long; front of head projected . . . . . (Fig. 467) *Elthusa californica*
8. (7) Last segment of tail twice as wide as long; front of head rounded . . . . . (Fig. 468) *Elthusa vulgaris*
9. (7) Body oval; balancing fins (uropods) much longer than terminal shield; found on Atlantic and Gulf coasts . . . . . (Fig. 470) *Livoneca ovalis*
9. (7) Body rectangular; balancing fin as long as terminal shield; found on aquarium fishes . . . . . (Fig. 471) *Vananea symmetrica*

region. Gnathiids are marine, but Dogiel et al. (1958) found that they could be carried into freshwater habitats by sturgeons. Bowman (1981) provides a brief summary of isopods that parasitize freshwater fishes and shrimp. He suggests that flabelliteran isopods have only been successful as parasites or in caves in freshwater because they cannot compete with aquatic insects in other freshwater habitats.

Many papers concerning isopods on coastal fishes do not note exact salinities. New reports may more accurately represent isopods of freshwater fishes.

— *Ref.* Isopod reviews include: H. Richardson (1905), Schultz (1969): North America; Brusca (1981): eastern Pacific; Kensley and Schotte (1989): tropical western Atlantic.

Family Cymothoidae Leach, 1818

Terminal segment of first six, usually all seven, pairs of legs (peropods) with large recurved hooks; antennae uniformly tapering, not divided into a thick base and much more narrow terminal section; hairs absent from legs and tail of adults.

Females permanently attach to one fish and produce obvious tissue damage on the host. This is the largest family of isopods associated with fishes, both in number of species and size of isopods. The isopods develop from eggs to prejuveniles in a brood pouch under the body of the female. They then leave the female as free-swimming prejuveniles, molt, become males, and eventually develop into females (protandrous hermaphrodites). Most reside on their hosts in male-female pairs. The development of the male into a female is arrested by the neuroendocrine influence of the associated female. Developing isopods (juveniles through males) may cause physical damage to final hosts. Females were thought to be nonfeeding, but we showed that they alternate reproductive (nonfeeding) with vegetative (feeding and growth) stages (Williams and Bunkley-Williams, 1982, 1986 [unpub.]). Juvenile isopods may kill juvenile fishes (Williams and Bunkley-Williams, 1986 [unpub.]). Adult isopods may stunt the growth of adult fishes and may allow the development of secondary microbial infections.

— *Ref.* Brusca (1981); Menzies et al. (1955): general life cycle.

Genus *"Aegathoa"* Dana, 1852 (No. fig.)

Cymothoidae. This genus was based on juveniles of many cymothoid genera. Most cymothoid juveniles, however, are similar and cannot be accurately placed in genera. This genus is no longer recognized, and these

forms should be referred to as "juvenile cymothoids." Juveniles leaving the brood pouch have only six pairs of legs; the seventh pair develops in a series of molts. Attach on the skin, fins, or in the gill chamber or mouth of a variety of fishes; are also found in plankton. Aquarium fishes fed live plankton from coastal waters often become infested with these juvenile isopods. Some attach in the mouth and are difficult to detect (Williams and Bunkley-Williams, unpub. [1994]).

■ *"Aegathoa loliginea"* Harger, 1878 (Syn. *A. oculata*, according to H. Richardson, 1905). Reported from FL by H. Richardson (1901).

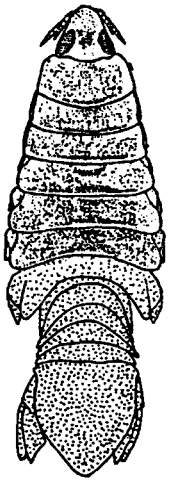
■ *"A. oculata"* (Say, 1818) (Syn. *Cymothoa o.* Say; syn. of *Livoneca ovalis*, as suggested by various authors). Reported from *Archosargus probatocephalus*, *Lepisosteus osseus*, FL, by Pearse (1952) and Say (1818).

Genus *Anilocra*
Leach, 1818
(Fig. 465)

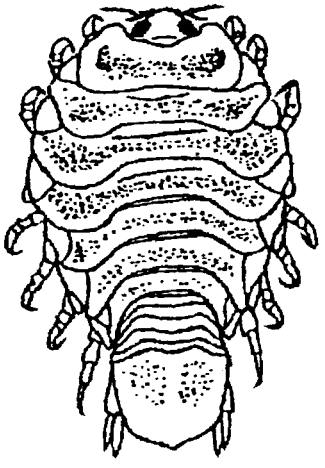
Cymothoidae. Anterior part of head folded down; posterior part not trilobed. Posteriorly pointed projections lacking from tail (pleon) and trunk (pereon) (except for single Caribbean marine species). Paddle gills (pleopods) under tail lacking wrinkles, folds, lobes. Largely tropical coral reef genus, but with some temperate species. Many species highly host specific. Usually occurring on the skin and fins of marine and brackish water fishes. One species has been reported in the gill chamber.

— *Ref.* Bruce (1986): summary and review.

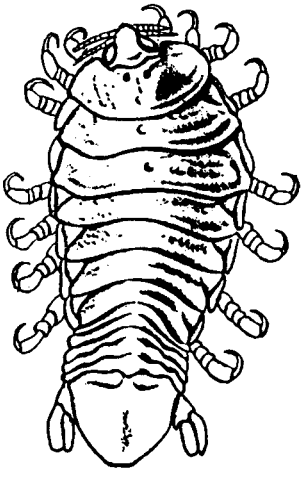
■ *Anilocra acuta* H. Richardson, 1910. Reported from body and fins of *Atractosteus spatula*, *Bairdiella chrysoura*,



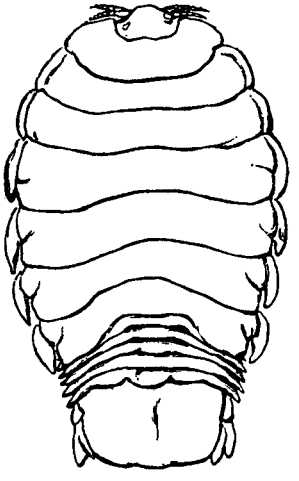
465. *Anilocra*



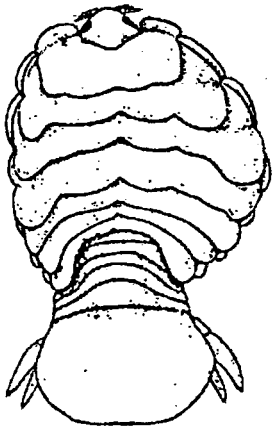
466. *Artystone*



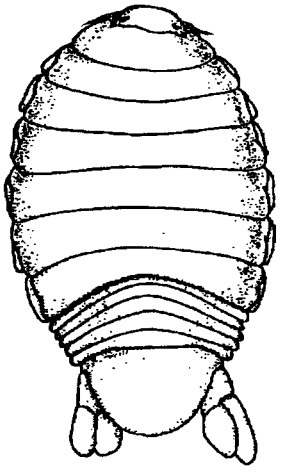
467. *Elthusa*



468. *Elthusa*



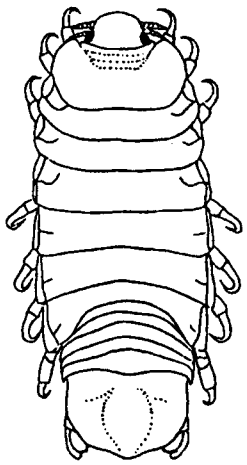
469. *Ichthyoxenus*



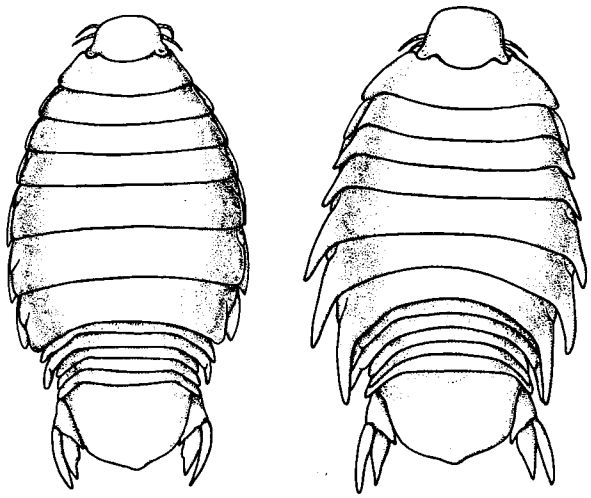
470. *Livoneca*

Parasitic isopods

FIG. 465. *Anilocra acuta* (from H. Richardson, 1910, and Bowman et al., 1977, in part). **FIG. 466.** *Artystone trysibia* (from Van Name, 1936). **FIG. 467.** *Elthusa californica* (from H. Richardson, 1905 by permission of Academic Press). **FIG. 468.** *Elthusa vulgaris* (from H. Richardson, 1905). **FIG. 469.** *Ichthyoxenus japonensis* (from H. Richardson, 1913). **FIG. 470.** *Livoneca ovalis* (from Kensley and Schotte, 1989, by permission of Academic Press).

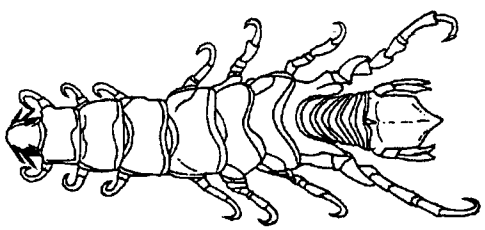


471. *Vanamea*



a b

472. *Nerocila*



473. *Olencira*

Parasitic isopods

FIG. 471. *Vanamea symmetrica* (from Van Name, 1936). **FIG. 472.** *Nerocila lanceolata:* **a**, acuminata form; **b**, aster form (from Kensley and Schotte, 1989). **FIG. 473.** *Olencira praegustator* (from Schultz, 1969).

Esox niger, Leiostomus xanthurus, Lepisosteus oculatus, L. osseus, Lepisosteus sp., and "garpike" from FL, GA, LA, MS, NY, TX by Bowman et al. (1977): reviewed, partially refigured and partially redescribed; Hutton (1964); S. K. Johnson (pers. comm., Texas A&M Univ.); Joy (1976); Overstreet and Howse (1977): debilitation of gars infested with this isopod and *Argulus lepidostei*, hemorrhagic lesions around attachments of isopod; R. P. Phelps (pers. comm., Auburn Univ.); H. Richardson (1910). *A. acuta* is one of the few exclusively temperate species of this genus and possibly the only one to tolerate freshwater. Although it is found in freshwater, it does not penetrate inland to any extent and may be a brackish water species. Williams and Bunkley-Williams (1996) extended the known range for this isopod approximately 350 km to south Texas and suspect that it continues into northern Mexico with *A. spatula*.

Genus *Artystone*
Schioedte, 1866
(Fig. 466)

Cymothoidae. Terminal segment of last pair of legs straight instead of hooked, as in first six pairs; tail segments free, rather than fused into a flat plate. Greatest body width in anterior region; head and tail set into trunk (immersed). Occurring on river fishes throughout South America. Only one species in genus.

— *Ref.* Trilles (1973): review.

■ *Artystone trysibia* Schioedte, 1866. Found in encapsulated pouch in muscle and partially in body cavity of host, with small opening of pouch to the exterior; in river fishes throughout South America (Taberner, 1981; Bowman and Diaz-Ungría, 1957). Found in aquarium fishes imported to North America from South America. Reported from *Corydoras aeneus, Corydoras* sp., *Crenicichla lacustris, Geophagus brasiliensis, Symphysodon discus, Symphysodon* sp. from CA, FL, IL, TX.

References: Bowman in Huizinga (1972), Bowman (pers. comm., 1986), Bowman and Diaz-Ungría, (1957): may penetrate near anus; T. W. Dukes (1975): isopod may cause inflammation in the eye of host, based on Huizinga (1972) finding of severe hemorrhage and destruction of fish eye in experimental infestation; Goldstein (1970): can probably occur in almost any large cichlid from South America, frequently imported with cichlids; Herman (1973); G. L. Hoffman and Schubert (1984); Huizinga (1972, 1975): normal penetration position behind either the pectoral or pelvic fins,

infested fishes grow more slowly than noninfested siblings, are paler in color, have twisted body and unusual swimming behavior; life history, host penetration, development, pathobiology; F. G. Smith (1975): may cause muscle and visceral atrophy, based on Huizinga (1972), who noted muscle penetration by developing isopod, resulting in only slight compression or displacement of internal organs; R. Socoloff (pers. comm., FL); Bunkley-Williams and Williams (1994–1995) note that the juveniles probably can damage any aquarium fish. If the adult is host specific to cichlids, this species could be useful in controlling tilapias, where tilapias have become pests.

Genus *Braga*

Schioedte and Meinert, 1881
(No fig.)

Cymothoidae. Occurring on South American freshwater fishes, and reported twice, apparently erroneously, from the west coast of the United States. Brusca (1981) suggested that species of this genus do not occur in the eastern Pacific.

— *Ref.* Trilles (1973): review of genus.

■ *Braga occidentalis* Boone, 1918. Boone (1918), Schultz (1969): no host mentioned from CA. Lemos de Castro (1959): specimen actually *B. patagonica* Schiodte and Meinert, 1884, was probably collected from eastern South America and incorrectly reported from North America; Thun and Brusca (1980): confirmation of above (Lemos de Castro, 1959).

■ *Braga* sp. Ho (1975): *Hypsosetta guttulata*, CA, saltwater; Ho in Thun and Brusca (1980): specimen probably *Elthusa* sp.

Genus *Elthusa*

Schioedte and Meinert, 1884
(Figs. 467, 468)

Cymothoidae. Body, weakly vaulted, neither flat, nor highly inflated. Anterior of head not folded under; posterior not trilobed. Head surrounded by shoulders of the body (immersed); tail (pleon) almost as wide as trunk (pereon). First antennae shorter than second. All paddle gills (pleopods) beneath tail (pleon) possessing slight folds or lobes (lamellar). In the gill chambers and sometimes in the mouths of marine and brackish water fishes.

— *Ref.* Bruce (1990): summary and review.

■ *Elthusa californica* (Schioedte and Meinert, 1884). (Syn. *Lironeca c.* Schioedte and Meinert, 1884). Found in gill chambers of mostly temperate marine fishes; found especially in bays and lagoons from shore to 90 m along North American coast from AK to Baja California. Bruce (1990) *Gasterosteus aculaeatus*, *Luciania parva* (introduced), CA, Brusca (1981): could be in genus *Mothocya*, redescription, refiguration as *Lironeca californica*; Carleton in Brusca (1981): *G. aculeatus* adversely affected; Keys (1928): drop in salinity or oxygen levels more detrimental to infested than uninfested *Fundulus parvipinnis*; parasitized fishes smaller.

■ *Elthusa vulgaris* (Stimpson, 1857) (Syn. *Anilocra occidentalis* Richardson, 1899; *Lironeca panamensis* Schioedte and Meinert, 1884; *Lironeca v.* Stimpson, 1857). Known from Coos Bay, OR, to Malpelo Island, Colombia; common south of San Francisco, CA; depths from 1 to 311 m. Brusca (1981): females in gill chamber, sometimes mouth, of various marine fishes; males, if present, in opposite gill chamber from female, redescription and refiguration as *Lironeca vulgaris*, biology; Jennings and Hendrickson (1982): *Oncorhynchus tshawytscha*, CA; Keusink (1979): ecology.

Genus *Ichthyoxenus*

Herklots, 1870
(Fig. 469)

Cymothoidae. Body inflated (vaulted), oval nearly circular in dorsal view. Body axis straight, bilaterally symmetrical. Small "shoulders" of body extending slightly beyond base of head (cephalon not deeply immersed in pereonite no. 1). Side plates (coxae) all short and rounded. Tail (pleon) narrow, approximately half the width of trunk (pereon). Last segment of trunk partially overlaying first tail segment. Antennae no. 1 shorter than no. 2. Bases of antennae separate. Segments nos. 3 to 5 of leg (ischium to carpus) flat, forming widest part of leg. Hooks (dactyls) flat in cross section (not round, as in other genera). At least 11 known species; many poorly defined species in need of revision. Largely restricted to freshwater fishes in Asia; one species reported from Africa; three marine species reported from Japan, Australia, Malaysia, and Hawaii. Occurring from deep sea (182–420 m) to Himalayan Mountain streams. Found in the gills or mouths, or embedded in pockets of muscle of fishes. Shiino (1951) reported *Ichthyoxenus minabensis* from the mouth. Williams and Bunkley-Williams (unpub. [1985]) found it occupies a passage between the gill chamber and the small gill opening in fishes collected in Japan.

— *Ref.* Bruce (1990): summary and partial review; H. Richardson (1913).

■ *Ichthyoxenus* sp. of Bowman (pers. comm.). Reported from the R. L. Herman and Bowman (pers. comm., 1987): gill chamber, *Barbus semifasciolatus*, MD. Causes considerable hyperplasia of the gill and opercular epithelium. Subdermal hemorrhages were confirmed with histological sections. These isopods may be imported on other Asian or African tropical fishes (Bowman, pers. comm., 1987; Herman, pers. comm., 1987).

Genus *Livoneca*
Leach, 1818
(Fig. 470)

Cymothoidae. Body weakly vaulted, neither flat nor highly inflated. Anterior of head folded under, posterior trilobed. Head not surrounded by "shoulders" of body. First antennae shorter than second. Paddle gills (pleopods) beneath tail (pleon) possessing large, bushy projections at bases. Limited to the New World. One species each on U.S. Atlantic and Pacific coasts, and one in the Caribbean. Occurring in the gill chamber of marine and brackish water fishes. The two western North Atlantic species have not been adequately studied.

[Note: There has been a long controversy over the name of this genus. We preferred using *"Lironeca"* because *"Livoneca"* is an obvious printer's error of this genus which was intended by the original author to be an anagram of "Caroline" (as in *Nerocila, Rocinela,* etc.), but by the mindless laws of taxonomy, the misspelling *"Livoneca"* is technically correct.]

— *Ref.* Bruce (1990): summary and review.

■ *Livoneca ovalis* Say, 1818 [Syn. *C. olivacea* DeKay, 1843(?): *Cymothoa ovalis* Say, 1818; *C. triloba* De Kay, 1843]. Found in gill chamber or mouth of a wide variety of marine and brackish water fishes of the Atlantic coast and Gulf of Mexico, from New England to Texas and possibly along the Central American coast (but not occurring in the insular West Indies). Frequently eroding up to one third of the gill filaments of the host (Williams and Bunkley-Williams, unpub. [1986]). Reported from *Bairdiella chrysoura, Caranx hippos, Dorosoma cepedianum, Fundulus heteroclitus, Lagodon rhomboides, Leiostomus xanthurus, Lepomis gibbosus, Morone americana, M. saxatilis, Strongylura marina,* "sunfish" from DE, FL, MD, NJ, NY, PA.

References: Alperin (1966); Beacham and Haley (1976); Briggs (1970); Bruce (1990): synonymizes with *L. redmanii* Leach, 1818; Light (1937); Kaczynski and Cannon (1974): parasitized hosts weighed less than nonparasitized; Lindsay and Moran (1976): infestation of 4.1% of 390 *M. americana* fishes, 6.1% of 196 *B. chrysoura,* 1.5% of 273 *M. saxatilis,* 0.4% of 981 *L. xanthurus*; Paperna and Zwerner (1976); H. Richardson (1901, 1905); Sadzikowski and Wallace (1974): infestation of 1.7% of *M. americana,* Delaware River; Say (1818); Schmidt and Roberts (1977); Trilles (1976): synonymizes with *L. redmanii*; Wass et al. (1972): species may be euryhaline; E. H. Williams and Bunkley-Williams (1978, unpub.): from field observation, believe that *L. ovalis* and *L. redmanii* are distinguished by host specificity and by strict male-female pair formation in *L. redmanii*; both of these characteristics are lacking in *L. ovalis.*

Genus *Nerocila*
Leach, 1818
(Fig. 472a,b)

Cymothoidae. Body two to three times longer than wide, dorsoventrally flattened. Head with wide anterior margin, without rostrum and not folded under; posterior of head trilobed. Trunk (pereon); much broader than tail (pleon); posterior trunk and tail possessing numerous pointed projections (ventrolateral margins produced on pereonite no. 7, usually nos. 5 to 7, and nos. 1 to 2). Paddle gills (pleopods) under tail (pleon) possessing complex folds and lobes (accessory lamellae). Some species showing great variation in body shape (see "aster" and "acuminata" forms, Fig. 472a,b). Parasitizing a variety of marine and brackish water fishes; also found on coastal freshwater or euryhaline fishes. Species often showing little or no host specificity. Occurring on bodies and fins of their hosts; one species occurring in gill chamber.

— *Ref.* Bruce (1987): summary and review.

■ *Nerocila californica* Schioedte and Meinert, 1881. Found along the Pacific coast, from Los Angeles, CA, to Peru, including the Galapagos Islands. Brusca (1978): life cycle and biology; Brusca (1981): synonymized with *N. acuminata,* hosts listed; W. R. Courtenay (pers. comm.), Williams and Bunkley-Williams (unpub. [1987]): *Tilapia mossambica, Tilapia* sp., CA; Williams and Bunkley-Williams (unpub. [1987]) do not synonymize with *N. acuminata* (syn. *N. lanceolata*), which is a temperate parasite in the Atlantic; *N. californica* inhabits warmer waters of the eastern Pacific and parasitizes different families of hosts although most of these host families are available.

■ *N. lanceolata* (Say, 1818) (Syn. *Cymothoa l.* Say; probably *N. munda* Harger, 1878; *N. acuminata* Schioedte and Meinert, 1881). Found on a variety of marine fishes from New England to Panama. No host specificity apparent. Usually on body of host, and causing considerable tissue damage. Reported from *Atractosteus spatula, Lepisoteus osseus, Mugil cephalus, M. curema, Sciaenops ocellata,* FL, GA, LA, TX.

References: Bruce (1987): revision of genus; Caribbean species; Brusca (1981): revision of genus, Heard in Paperna and Overstreet (1981): use name *N. lanceolata* for species in GA; Hutton (1964); Kensley and Schotte (1989); Paperna and Overstreet (1981); H. Richardson (1901); Simmons and Breuer (1962); Williams and Bunkley-Williams (unpub. [1987]): disagree with Bruce (1987), believe that species is not Caribbean but temperate; the only Caribbean records are from the Central American coast and the Gulf Coast of Cuba.

Genus *Olencira*
Leach, 1818
(Fig. 473)

Cymothoidae. Body elongated; tail (pleon) much narrower than trunk. Antennae bases separate. Anterior of head folded under; posterior trilobed. Side plates (coxae) of each trunk segment (pereonite) almost reaching posterior margins of segment. Posterior margin of trunk segment no. 7 produced posteriorly. Legs nos. 4 to 7 possessing flange (carina) on upper leg segment (basis). Single species; parasitizes menhaden of the genus *Brevoortia* in marine to freshwater in the northwest Atlantic Ocean.

■ *Olencira praegustator* (Latrobe, 1802). (Syn. *Oniscus p.* Latrobe, 1802; *Cymothoa p. Latrobe*; *O. lamarkii* Leach, 1818). Description given with type host. Reported from *Brevoortia patronus, B. smithi, B. tyrannus*, and hybrids of these species from FL, MD, NJ, TX, VA.

References: Dahlberg (1969); Goode (1879): original host description vague, but the presence of this isopod allowed it to be recognized; Kroger and Guthrie (1972): 0 TO 64% of menhaden infected at early age; Wass et al. (1972): may be euryhaline.Very host specific, not known from *B. gunteri*, which also occurs in the Gulf of Mexico. Hosts often called "bug-head" or "bug-fish," because of this common parasite.

Genus *Vanamea*
Thatcher, 1994
(Fig. 471)

Cymothoidae: Body elongated, not flat, but not very inflated (weakly vaulted). Posterior margin of head not trilobed. Head not surrounded by shoulders of the body (not immersed). First antennae shorter than second. Side plates (coxae) small, no longer than segment. Paddle gills (pleopods) beneath tail (pleon) with bushy projectiosn at bases (lateral laminar lobes on peduncles). One species limited to South America, from Venezuela to Brazil. Occurs in mouth on top of tongue of freshwater fishes.

■ *Vanamea symmetrica* (Van Name, 1925). Described from river fishes in Guyana, South America and found in aquarium fishes imported to North America and reared in FL. Reported from *Astronotus ocellatus, Cheirodon axelrodi, Danio rerio, Paracheirodon innesi, Poecilia latipinna, P. sphenops, Pterophyllum eimekei, Xiphophorus helleri, X. maculatus* from FL, MD, TX.

References: Bowman (pers. comm.); Herwig (pers. comm., 1976): imported to tropical fish farm in FL, 1975 or 1976, passed to pet shops in TX, juveniles showed no host specificity, species damaged variety of aquarium fishes; smaller fishes can potentially be killed; species reared to females about 2½ cm long in aquaria; Herwig (1976), G. L. Hoffman and Schubert (1984): may be established in wild fishes of southern FL and has serious potential of becoming a pest in other warmwater areas; F. J. Kerr (pers. comm.): commonly imported from Colombia; Reichenbach-Klinke (1954b): imported to Germany on *Carnegiella strigata* from Brazil; Shotts and Gratzek (1984): damaged variety of tropical fishes; Williams and Bunkley-Williams (unpub. [1986]): these fishes were shipped from FL to MD, TX, many other U.S. locations, and Peurto Rico in 1976–1977 and has serious potential of becoming a pest in other warmwater areas.