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Argulus, a Branchiuran Parasite of Freshwater Fishes

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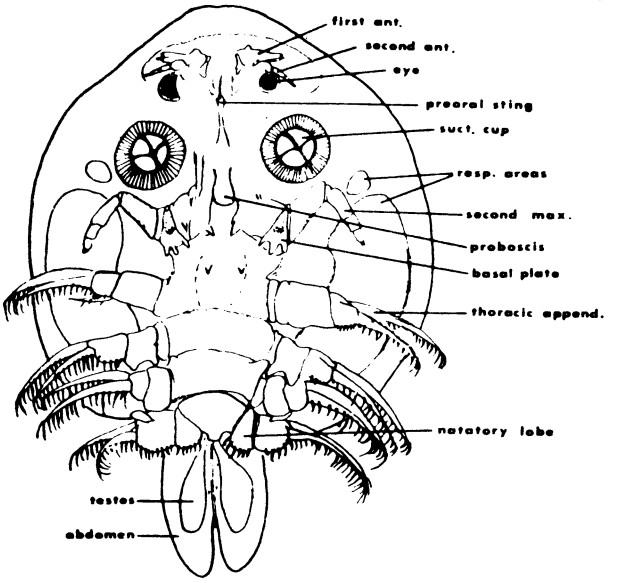
1/ Revision of Fish Disease Leaflet 3 (1966), "Parasites of freshwater fish. IV. Miscellaneous 3. Parasitic copepod *Argulus*," by J. T. Bowen and R. E. Putz.

"Fish lice" of the genus *Argulus* (suborder Branchiura) are common parasites of freshwater fish, and may occur on frogs and salamanders. Argulids often cause severe mortality of fish in farm ponds, and sometimes in natural waters. Because information on life cycles, ecology, and host specificity is incomplete only a generalized account can be given.

MORPHOLOGY AND IDENTIFICATION

The sexually mature adult is composed of head, thorax, and abdomen. The head is covered by a broadly enlarged and flattened horseshoe-shaped carapace. A pair of compound eyes and a median nauplius eye are on the dorsal surface; ventrally a pair of respiratory areas can be seen on the alae or wings of the carapace. The head appendages include two pairs of reduced antennae, a pair of large suction cups, and two hooked second maxillipeds (the first maxillipeds degenerate in early developmental stages). The mouth, with preoral sting and basal glands, lies in the oral groove on the midline.



Drawing of an optically cleared *Argulus*

The thorax has four segments, the first of which is fused to the carapace; each segment has a pair of swimming legs. The abdomen is a single, bilobed segment containing testes or a round seminal receptacle.

Argulus is the only large (6-22 mm long) external fish parasite, except for leeches and a few isopods, that can move freely over the surface of a fish. It can be seen with the unaided eye, but microscopic examination is necessary for the detection of copepodid stages.

Fourteen species of *Argulus* have been described as parasites of North American freshwater fish. Some are questionable and may prove to be synonymous. Keys for species identification were

published by Cressey (1972), Meehean (1940), and Wilson (1902, 1944). Species and host genera are listed below as an aid to identification:

Argulus	
appendiculosus:	*Catostomus, Dorosoma, Ictalurus, Ictiobus, Micropterus, Stizostedion.*
canadensis:	*Acipenser, Coregonus, Esox, Gasterosteus, Perca, Salvelinus, Salmo, Notropis, Stizostedion.*
catostomi:	*Catostomus, Cyprinus, Erimyzon, Hypentelium, Etheostoma, Stizostedion, Semotilus.*
diversus:	*Ictalurus.*
flavescens:	*Amia, Erimyzon, Micropterus, Pylodictis, Micropogon, Mugil, Cyprinus, Lepomis.*
japonicus:	*Carassius.*
lepidostei:	*Lepisosteus.*
maculosus:	*Esox, Amia, Umbra, Erimyzon, Lepomis.*
meehani:	*Lepisosteus.*
mississippiensis:	*Lepisosteus.*
nobilis:	*Lepisosteus.*
pugettensis:	*Salmo.*
stizostethi:	*Coregonus, Gasterosteus, Esox, Salvelinus, Acipenser, Alosa, Notropis.*
versicolor:	*Esox, Perca, Stizostedion, Ambloplites, Percopsis.*

LIFE CYCLE

Upon maturity the adult females leave the host and lay eggs in masses on vegetation, rocks, sticks, or other hard substrates. The nauplius, metanauplius, and in some species the first copepodid stages, develop within the eggs, which hatch as metanauplii or copepodids. Other metamorphic stages of both sexes are the second through seventh copepodids, subadults, and adults.

Argulids are parasitic from the time of hatching but leave the host to molt and reproduce. The adult may be free-living for as long as 15 days. The stage or stages at which copulation occurs is unknown.

Depending on the species and temperature, argulids require 40 to 100 days for completion of the life cycle. They overwinter as adults or copepods. The life-span of the female may be as long as 18 months, but the male usually lives less than a year.

The egg is ovoid, 0.3-0.6 mm long, and covered with a gelatinous capsule that cements the egg firmly to the substrate. From 20 to 300 eggs are laid at a time, and three or more generations can be produced in a year.

The first copepodid resembles a miniature adult, except that the last three thoracic segments bear rudimentary legs and the first antennae are plumose instead of reduced. Sex can already be determined at this stage.

The second copepodid has functional swimming legs on all four thoracic segments. When the larvae are 3 or 4 days old they average 1 mm in length.

The organisms advance from the third through seventh copepodid stages, by gradual metamorphosis, in 14 to 15 days. The length increases to about 2 mm. The first maxillae gradually degenerate except for the basal segments, which enlarge and become modified into the suction cups of the adult.

The subadult molts several times to become an adult in 14 to 16 days. The length averages 6 to 7 mm during this period but may be 10 mm or more in some species.

ECOLOGY

Egg development in *Argulus* stops when water temperature falls to 12 C (54 F), and oviposition ceases below 16 C (61 F). At temperatures below 8 C (47 F), the adults and the larvae hibernate on the body of the host, and metamorphosis is arrested. The periods of egg development (to hatching) for different species and water temperatures are as follows: *Argulus americanus*, 16 days at 22 C (72 F) and 18 days at 18 C (64 F); *A. catostomi*, 35 days at 22 C (72 F); *A. japonicus*, 12 days at 30 C (86 F) and 60 days at 15 C (59 F); and *A. lepidostei*, 10 days at 22 C (72 F).

At 24-28 C (75-82 F), metamorphosis to the subadult requires 15 to 18 days, and maturity is normally reached 30 to 35 days after hatching. Although the optimum temperature of adults is 28 C (82 F), they can withstand 43 C (108 F).

Eggs are usually deposited at a depth less than 1 mm (Bauer 1959; Meehean 1940). Light stimulates hatching, whereas darkness delays it as much as 30 days.

Drying for 24 h kills eggs, larvae, and adults. Salinity of 2% kills the larvae, but the adults can live indefinitely in 3.5%, and can withstand long exposure in 5%.

Crowding of fish, high temperatures, low dissolved oxygen, and standing water or slow current favor *Argulus* in natural waters and in fish-culture facilities.

TRANSMISSION

Introduction of infested fish is the most common method of transmission. Infestations also result from the presence of infested fish or amphibians in the water supply.

PATHOLOGY AND PATHOGENICITY

Argulids puncture the skin, inject a cytolytic toxin through the oral sting, and feed on blood. A single sting of a European species, *Argulus giordanii*, is reported to kill larval eels (P. Ghittino, personal communication), and another, *A. japonicus*, is a serious pathogen. Feeding sites often become ulcerated and hemorrhagic, providing ready access to secondary infections by other parasites, bacteria, fungi, and viruses. It has been shown that *Argulus* transmits spring viremia of carp, a virus disease.

CLINICAL SIGNS

Advanced infestations are characterized by weakness, erratic swimming, considerable "flashing," and lack of growth. Infested goldfish jump. Moribund fish appear exhausted and cannot maintain equilibrium, particularly if the lateral line has been damaged. Usually *Argulus* can be seen with the unaided eye.

GEOGRAPHICAL RANGE

Argulus is cosmopolitan, with no known geographical restrictions. The main areas of inhabitance are the major river systems. Occurrence is sporadic in the western United States.

CONTROL AND TREATMENT

Chemical treatments are time-consuming and expensive, may be toxic to fish, and are of questionable effectiveness. Non-chemical control methods are cheaper and easier to apply and do not affect the fish.

The following control methods are helpful, if applied early enough:

a. Removal of hard substrates, including submerged vegetation, and tarring of concrete structures prevents their use for egg deposition. Wooden lattices are sometimes placed in the pond to serve as artificial substrates, and removed and dried at intervals to kill eggs laid on them.

b. Removal of all dead and moribund fish.

c. Covering pond inlets with 1/8-inch-mesh (3.2 mm) screen prevents adults, but not larvae, from entering the ponds.

d. Increasing the flow of water to lower the temperature, or fertilizing to darken the water, extends the time required for egg development and retards an epizootic.

e. Complete drying of ponds kills eggs, larvae, and adults within 24 h.

The following have been used for chemical treatment (see also Hoffman 1976):

a. The method of choice: Two applications (1 week apart) of Masoten (Dylox) at 0.25 ppm (active ingredient). Masoten has been registered for use on bait minnows and aquarium fishes but not on food fishes.

b. Two applications of Baytex, at 0.13 ppm (formulation), 2 weeks apart at temperatures below 21 C (70 F); or 0.25 to 0.5 ppm, 7 to 10 days apart at temperatures above 21 C. Goldfish, golden shiners, and channel catfish tolerate this treatment but black bass and grass carp do not. Baytex is not registered for use on fish.

c. Malathion at 0.25 ppm. Use with caution; toxic to man and to centrarchids; not registered for use on fish.

d. Methyl parathion at 0.125 ppm (F. Meyer, personal communication). Use with great caution; highly toxic to man, and toxic to centrarchids; not registered for use on fish.

e. Pyrethrum at 30 to 100 ppm of aqueous extract for 10 to 20 min for carp (A.T. Safonov, in Dogiel et al. 1961); not registered for use on fish.

f. Balsam of Peru (Peru oil) at 40 ppm for 3 h for carp in aquariums (Kelly 1962); not registered for use on fish.

g. Ammonium chloride at 500 ppm kills *Argulus* in 24 h (Chen 1933).

h. Lysol at 2000 ppm used as a 5- to 15-s dip for carp (Dogiel et al. 1961); not registered for use on fish.

i. Potassium permanganate at 10 ppm for 30 min for carp (V.K. Kiselev and I.V. Ivleva, in Dogiel et al. 1961); not registered.

j. Benzene hexachloride (BHC), gamma isomer; generic name 1, 2, 3, 4, 5, 6-hexachlorocyclohexane. This chemical should be used with caution, if at all, because it is more toxic to some species (e.g. catfish and centrarchids) than others. Oil formulations are highly toxic to fish, and only the wettable powder formulation should be used. The use of BHC in ponds cannot be recommended because it is not readily biodegradable and has not been registered for use on fish. It must not be used on food fishes.

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