Crustacean parasites and their management in brackishwater finfish culture

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Introduction

There are three main groups of parasitic crustaceans affecting commercially important aquaculture species, most of which are external parasites: the Branchiura, Copepoda and Isopoda. Members of the Branchiura and Isopoda are relatively large and both sexes are parasitic, while copepods, the most common crustacean parasites, are generally small to microscopic with both free living and parasitic stages in their life cycle. Male parasitic copepods die after copulation in the pre-adult stages, so those that are seen attached to fish are generally mature females with distinctive paired egg sacs at the posterior end. The crustacean parasites dealt here are primarily those that are likely to cause problems when commonly cultured fish species are grown in inland low saline or freshwater, though such studies are scarce in India. Under culture conditions, modified specificity is also exhibited by many crustacean parasites in that they will invade 'unnatural' hosts that are not normally present in their natural habitats.

Parasitic crustaceans are numerous and have worldwide distribution in fresh, brackish and salt waters (Figure 1). Usually they cause only minor harm to their hosts when present in small numbers. However, in case of heavy infections severe damage to skin, muscles, and gill tissue accompanied with secondary infections can occur. Parasitic crustaceans a great diversity of forms with marked structural modifications to suit their parasitic mode of life. These range from the typical features of normal copepods such as unfused abdominal segments and nearly full complements of appendages, to genera such as *Lernaea* ('anchor worm') in which the body segments are fused together and many of the appendages are missing or modified at least in parasitic stages. Generally, sensory organs and the reproductive systems are well developed. Sexes are usually separate with clear sexual dimorphism with predominant dwarfism among males. In branchiura the body is dorso-ventrally flattened with two pairs of antennae and pre-oral proboscis. The second maxillae are modified to form prehensile suckers (eg. Argulus).

Parasites

The common crustacean parasite species encountered in brackish water or low saline systems are given in Table 1.

Life cycle and transmission

Parasitic copepods have a complex life cycle with different larval stages; between each of which is a moult. Eggs hatch to release free-swimming nauplius larvae. After a succession of naupliar stages they moult to form copepodid stages. In primitive groups of parasitic copepods such as ergasilids, the copepodids are free swimming. Copulation occurs during the free-swimming stages, after which the male die. The female is left to seek, attach and mature on a marine or freshwater fish host with the help of the prominent claw like second antennae. In more evolved copepods such as the caligids some or all of the copepodid stages may be parasitic including adult males. Caligid copepods generally have direct life cycle, consisting of a free-living planktonic nauplius stage, free swimming infective copepodid stages, attached chalimus, pre-adults and adult stages. In case of *Lernaea* sp. the eggs released by the female hatch in 1-3 days with subsequent nauplii larvae. The nauplius metamorphoses into first or second copepodid stage in 4-16

Figure 1. Important crustacean parasites in brackishwater fish: *Lernanthropus* sp. and *Caligus* sp.

Table 1. Common crustacean parasitic infection in brackish water finfish in coastal and estuarine zones.

Subclass / family	Genus	Characteristics
Branchiura		
Argulidae	*Argulus* sp.	Body broad and flat covered anteriorly with dorsal shield with a pair of compound eyes, hooks and barbs, which it uses to attach to the fins, gills and skin of its host, second maxillae usually form prehensile suckers.
Copepoda		
Caligidae	*Caligus* sp. *Lepeophtheirus* sp. *Anuretes* sp.	Transparent, cephalothorax covered dorsally by a sub circular shield, with a pair of suckers on the frontal edge of the body and four pair of legs, vestigial abdomen in some species, found in large numbers on gills and body surface with different stages of life cycle in the same host.
Ergasilidae	*Ergasilus* sp.	Cephalothorax constituting half or more of body length, the second antennae are modified for clinging to the host, moderate to large numbers on gills with rigorous feeding action and movements.
Lernanthropidae	*Lernanthropus* sp.	Few in number but large in size, feed on gill tissues and blood, seriously damage the tissues.
Lernaeidae	*Lernaea* sp.	Body unsegmented, with its anterior part deeply embedded in host tissue with the help of a hold fast organ, infect nostril, skin, fin, gills, buccal cavity.
Isopoda		
Cymothoidae	*Cymothoa* sp.	Entire dorsal surface of body divided into many narrow segments, eyes are sessile, parasite immovably attached to surface, buccal or branchial cavity of fish.

days. No further development occurs unless it attaches to a host. Larvae pass through five successive copepodid stages before attachment. Copulation occurs during the fourth copepodid stage and the male dies similar to the *Ergasilus* sp. Although *Argulus* sp. cannot survive without a host for long period, they may swim freely looking for new host. Unlike other crustaceans, there is no sexual dimorphism; eggs are not carried by the females in egg sacs, but the parasite leaves its host to deposit its eggs on submerged objects. Larvae do not hatch as nauplii but as copepodid stage with thoracic appendages to follow a series of subsequent larval stages by progressive development of the dorsal shield and abdomen, the maxillary suckers and reproductive organs. Thus, transmission of parasites within the system is by physical contact with infected animals or by the free living infective stages after reproduction. Many species simply glide from one fish to other. Many parasites are transferred to culture system by way of water, live feed, wild fish, contaminated farm implements etc. Hence control methods may vary greatly depending upon the farm conditions, the type of parasites and its life cycle stages.

Parasites, clinical signs and effects

Branchiurans

Members of the family Argulidae represented by genus Argulus commonly called as 'fish lice' has a broad, flat oval body with hooks and barbs, which it uses to attach to the fins, gills and skin of its host. They are one of the most widespread and dangerous ectoparasites of freshwater and marine fish. They damage the fish directly by extracting blood and vital tissue fluids from the host with their modified mouthparts. The mode of feeding of Argulus involves secretion and injection of relatively large quantities of digestive fluids, which are toxic to the fish. The sting of one fish lice can kill a small fish. Feeding sites become hemorrhagic and ulcerated and provide access to secondary infections by other pathogens. Mucous is secreted when skin, fin and gills become infected.

Branchiuran parasites on fishes are usually found in the walls of the branchial cavity and not permanently attached to their hosts, but can crawl on their surfaces and can slowly swim leaving one fish to another. Sexual dimorphism is not marked. The only way to prevent *Argulus* infection is to deny parasites access to cultivable fish. Since both adults and larval stages are active swimmers, it is difficult to prevent them from entering the pond. Appropriate filter designs might prove more efficacious to check the degree of infestation.

Copepods

Caligus sp.

Caligus sp. or 'sea lice' are common copepod parasites in the family Caligidae, infesting a wide range of fish species in the coastal and estuarine zones although other lesser known fish species viz., *Lepeophtheirus* sp. and Anuretes sp. are have also been reported to be afflicted in the Indian subcontinent. Three species of *Caligus*, *C. epidemicus*, *C. orientalis* and *C. punctatus* are the potential major pathogens in the development of cage culture. *Caligus orientalis* seriously affects wild populations as well. When they first infect a farmed fish population they cause extensive irritation and nervous activity. Feeding on the fish skin, mucous and blood, these lice can cause small hemorrhages and sore, erode the skin and expose the underlying tissue to secondary infection. Caligid copepods have direct life cycle, consisting of a free-living planktonic nauplius stage, free swimming infective

Table 2 Common treatment against copepods in brackish water finfish.

Drugs / chemicals	Dose	Type of treatment, duration
Formalin	100-200 ppm	Short bath; 30-60 min
H_2O_2	1000 ppm	Short bath; 30-60 min
Dichlorvos	0.75 - 1 ppm	Short bath; 60 min
Caprylic acid	I mM	Short bath; 5-10 min

copepodid stages, attached chalimus, pre-adults and adult stages. In most cases, it is the attached chalimus stages that cause significant pathological lesions leading to mortality when present in large numbers. The pre-adult and adult stages are not very invasive and cause minor tissue damage. In disease situations, death is caused by the development of secondary infections exacerbated by stress, osmoregulatory failure and in the case of the gills, respiratory impairment.

The intensity of copepod infestation generally increases after rainfall and late spring and decline in winter and summer due to the lack of recruitment and parasite death. This is a major problem in cage cultured brackish water fishes but the economic impact of this disease is not known.

Ergasilus sp.

Ergasilid copepods are found on the body surface, gills and branchial and nasal cavities of many fish species including seabass, grouper, mullet, pearl spot, tilapia etc, where it feeds on the blood and epithelium. Heavy infestations can result in mechanical damage, patechial hemorrhage, impaired respiration, epithelial hyperplasia, and anemia with growth retardation. Severe gill damage is caused by the feeding activity of the copepod and this often leads to fish death. Proliferation of this parasite is observed in summer.

Lernanthropus sp.

This species is relatively large, reddish in colour, firmly attached to the gills, inflicts serous damage to the gills by way of erosion, desquamation and necrosis of the secondary lamellae near the site of attachment. The grasping action of the mandibles and the maxillae results in the exposure of blood vessels and hemorrhages. This serious pathogen is frequently encountered in many species of wild fish and cage cultured sea bass.

Lernaea sp.

Better known as the 'anchor worm', this species affects a large number of warm water fishes. Adults are visible to the naked eye. Although *Lernaea* is typically a freshwater copepod, it has been reported from brackishwater fish also. The parasite seems to have an affinity for the heart region of small fish and kills them by piercing the heart or other vital organs. The female lernaeidid copepod has long filamentous body with trailing attached eggs sacs. Morphological modifications include the head, which is a rounded knob inserted into the musculature of its fish host; one or two pairs of anchors to hold it in position. Damage to the fish host includes hemmorhagic and ulcerated lesions with potential for secondary infections, anemia, retarded growth, loss of weight and loss of equilibrium.

The destructive activity of *Lernaea* sp. is due to its relatively large size and its mode of attachment and feeding. As the maximum damage to the fish is caused by the adult parasite which remain attached to the host tissue with an anterior holdfast organ and also by the developmental stages that remain attached to the host, any reliable and effective prophylactic measures should aim at killing the free living stages of the parasites at nauplii and copepodid stages before it gets attached to the fish host. *Lernaea* is extremely difficult to control because only the free-living larvae are susceptible to treatment. The adult female produces three sets of eggs; these eggs produce larvae over a four week period. Since the larvae remain free living for about one week, it is necessary to treat once a week for four weeks to eliminate this parasite.

Isopods

Cymothoa sp.

This cause serious problem in fishes kept in captivity or cages. Isopods are large parasites of wild tropical marine fish and rarely found in other culture of crustacean organisms (*Macrobrachium* sp., *Peneaus monodon*) in coastal freshwater or on brackishwater fishes inhabiting freshwater. They have a short free-living planktonic phase; juveniles and adults are exclusively parasitic living on the skin, buccal cavity and gill chamber of the fish (eg. *Cymothoa*). The damage caused by them resembles that of other copepods but the most serious effect of isopod infection is destruction of host tissue resulting from the pressure of the parasites body. No specific control or therapeutic measures against isopods have been in practice except the manual removal of the parasite and by implementing optimum management practices during culture as infection by the planktonic phase is the common feature.

Diagnosis and management

Diagnosis is usually done by gross and microscopic examination of scrapings from skin, gills, fins etc. from affected fishes and by observing general clinical symptoms. Pre-disposing factors for transmission of crustacean parasites are poor water exchange and thus sufficient water exchange can prevent their proliferation. Modification of husbandry practices can be a very effective method to reduce the magnitude of infection. Application of husbandry practices to control the abundance of parasitic copepods requires a good knowledge of their biology (eg. growth rates, duration of survival of infectious stages off-host etc.) and host range. Routine disease management measures such as reducing stocking density and water quality management are likely to reduce the impact of parasitic copepods. It is well recognized that a few unhealthy / stressed animals are more susceptible to infection and harbour the majority of the parasites. In pond culture, overcrowding and poor water quality has been cited as factors responsible for the development of parasitic copepod diseases. The important management techniques to be followed are, rearing different batches in separate tanks, pond drying, removal of all probable hosts from the

stocking sites prior to stocking so that all infectious stages die due to lack of hosts, quarantine prior to stocking and introduction to the rearing system and frequent cleaning of holding tank/nets. The parasites can be controlled by fresh water bath for 10-15 min or by chemical treatment using 1000 ppm hydrogen peroxide or 100-200 ppm formalin for 30-60 min. Some of the treatments commonly applied in brackishwater fishes are shown in Table 2. Strong aeration must be provided during treatment. Drying of unused tanks also helps to destroy the developing stages. Treated fish should be transferred to clean parasite free facility.

It is well recognized that parasites act as mechanical vectors of the pathogens though they are not an obligatory host. It is likely that any fluid or tissue feeding parasites could potentially act as a vector for bacteria, fungus, virus etc. It has been speculated that parasitic copepods may serve as vectors of viral and bacterial diseases of fish due to their feeding activities on host mucous, tissues and blood.

Parasitic copepods with relatively narrow host ranges such as Ergasilus are easier to control especially, where there are few wild hosts present. Species with broad host ranges and / or abundant wild hosts (eg. *Caligus* sp.) in the vicinity of aquaculture sites are generally difficult to control because of recurrent infestations from carrier hosts. *Lernaea* sp. is very difficult to control due to different stages of life cycle showing different susceptibility to chemicals. Further the concentration of these chemicals required to kill the developmental stages are toxic to fish. Temperature dependant development of larval stages and the lethal effects of even low salinity on larval stages etc. can be utilized for the control of fresh infections in the system. Eradication of copepods using freshwater bath is also suggested.

Conclusions

Crustacean parasites are numerous and have a worldwide distribution in marine and brackishwater aquaculture systems. Copepods comprise the largest group of crustacean parasites on fish causing economical loss. Disease outbreaks and subsequent mortalities are rare under effective broodstock management systems due to effective treatment methods. However, increasing incidence of copepod parasitism is becoming a regular phenomenon in culture conditions. The only sure way to prevent parasitic infection is to deny the parasite access to the protected habitat. Although it is well established that parasitic crustaceans have a major impact on brackish water aquaculture there are relatively few published reports of disease and / or disease treatments and economic losses associated with these infections in India. We need to study the ecology of the parasite, including seasonality, maturation and the population dynamics and transmission mechanisms vis-à-vis physicochemical parameters of the rearing water in order to prevent and control the outbreak of the species in brackish water aquaculture.

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