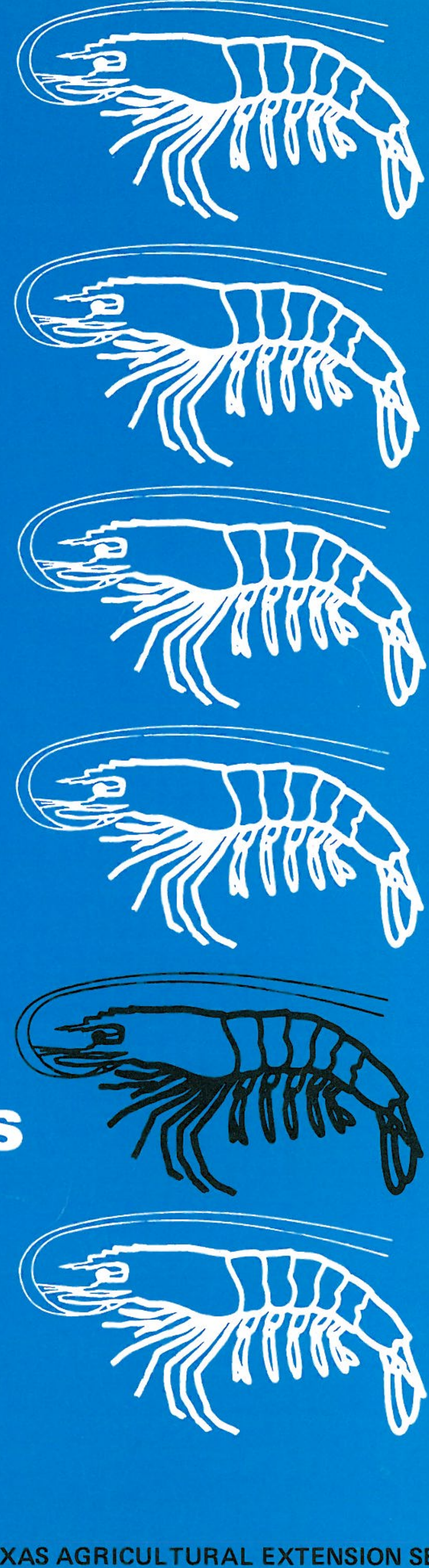

Handbook of Shrimp Diseases

S. K. Johnson

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Handbook of Shrimp Diseases

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This handbook is designed as an information source and field guide for shrimp culturists, commercial fishermen, and others interested in parasites or abnormal conditions of shrimp. In addition to detailed descriptions and illustrations of the common parasites and commensals of commercial penaeid shrimp, the publication includes information on the life cycles and general biological characteristics of these disease producing organisms which spend part or all of their life cycles with shrimp. Several conditions of unknown cause are also described.

Disease is an important factor in reducing shrimp numbers in natural populations. Natural mortality or death from old age is the potential fate of all shrimp, but the toll taken by predation (man being one of the major predators), starvation, infestation, infection, and adverse environmental conditions is highly significant. Therefore, conditions described in the following pages exert a considerable influence on shrimp numbers in natural stocks.

With the development of shrimp culture, disease problems can be expected in the list of obstacles to successful production. Because high density, confined rearing is unnatural and produces stress, some shrimp-associated organisms will become prominent and will require special measures to offset their detrimental effects. Recent advances in knowledge regarding diseases of cultured shrimp have added several new organisms to the list of potential troublemakers.

Disease may be caused by living or non-living agents, as well as by physical or chemical factors. Non-living causes include lack of oxygen, poisons, low temperatures, salinity extremes, etc. This guide concentrates on the living agents and on visual presentation of the structure and effects of such agents.

DEFINITIONS

Bacteria - one-celled organisms that can be seen only with a microscope. Compared to protozoans they are of less complex organization and normally less than 1/5000 inch in size.

Chitinoverous - deriving nutrition from chitin, the support substance of the exoskeleton.

Commensal - a plant or animal that lives in association with a host organism but is not injurious to it.

Ectocommensal - a commensal that lives on the surface of the host's body.

Fungus - in shrimp, a microscopic plant that reproduces by spores and develops interconnecting tubular structures.

Genus - (plural-genera) a classification of plants or animals with common, distinguishing characteristics. A genus may include one or several species. A species name consists of the genus name plus a second word called the specific epithet (for example, *Penaeus aztecus,* the scientific name for the brown shrimp, and *Penaeus setiferus* for the white shrimp; both belong to the genus *Penaeus.*)

Gregarine - name for a group of parasitic protozoans that live in insects, crustaceans, earthworms, and several other types of invertebrate animals.

Hemocoel - the enclosed space around organs of a shrimp which contains the animal's blood.

Host - one that has a parasite or commensal living on or in it.

Invertebrate - animal without a backbone.

Microbe - a very minute living organism, especially bacteria, viruses, and fungi.

Microscopic - small enough to be invisible or obscure except when observed through a microscope.

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Dear Colleague:

Enclosed are printed results of some of our recent work. Perhaps, you will find the information beneficial to your efforts.

Respectfully yours,

S. K. Johnson
Fish Disease Specialist

SKJ:th
Enclosure

Molt - for shrimp, shedding of the exoskeleton. Molting occurs at intervals during a shrimp's life and allows for expansion in size.

Parasite - a plant or animal that lives in or on a host to the detriment of the host.

Protozoan - a microscopic, usually one-celled animal that belongs to the lowest division of the animal kingdom. Normally, they are many times larger than bacteria.

Rickettsia - microorganisms generally intermediate in size between the bacteria and the viruses.

sp. and spp. - singular and plural abbreviations for species, respectively. The singular abbreviation is often used when identity of the genus of the organism is known but the exact species is not known.

Spore - a small cell that can develop into a new individual.

Virus - ultramicroscopic infective agent that is capable of multiplying in connection with living cells. Normally, viruses are many times smaller than bacteria.

SHRIMP SPECIES NAMES

The following species are those discussed in the text of this handbook.

- Brown shrimp - *Penaeus aztecus.*
- Pink shrimp - *Penaeus duorarum.*
- White shrimp - *Penaeus setiferus.*

Shrimp Anatomy

A shrimp is covered with a protective exoskeleton and has jointed appendages. Most organs are located in the head end (cephalothorax) with muscles concentrated in the tail end (abdomen). The following parts are apparent upon outside examination (Fig. 1):

1. Cephalothorax
2. Abdomen
3. Antennules
4. Antenna
5. Antennal Scale
6. Rostrum (horn)
7. Eye
8. Mouthparts (several appendages for holding and tearing food)
9. Carapace (covering of cephalothorax)
10. Walking Legs (pereiopods)
11. Abdominal Segment
12. Swimmerets (pleopods)
13. 6th Abdominal Segment
14. Telson
15. Uropod
16. Gills (under carapace)

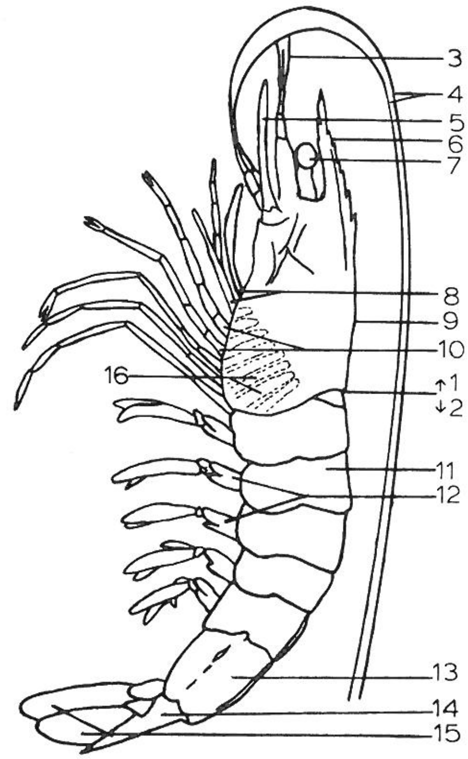

Fig. 1. External anatomy of shrimp. Numbers conform to list at left.

Inside structures include (Fig. 2):

1. Esophagus
2. Stomach
3. Hemocoel
4. Digestive Gland (hepatopancreas)
5. Heart
6. Intestine
7. Abdominal Muscles

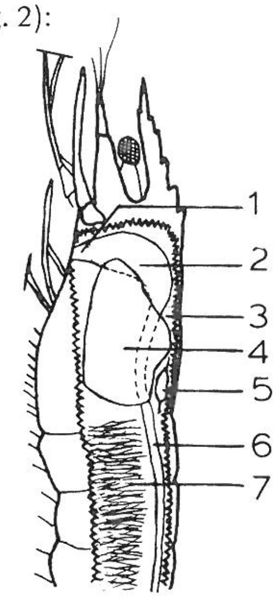

Fig. 2. Internal anatomy of shrimp. Numbers conform to list above. Jagged line represents cut-away of exoskeleton that exposes internal anatomy.

The "skin" or hypodermis of a shrimp lies just beneath the exoskeleton. It is functional in secreting the new exoskeleton that develops to replace the old at shedding.

Microbes

BACTERIA

Bacterial infections of shrimp have been observed for many years. Scientists have noticed bacterial infection in the blood or body fluids as an event that usually follows weakening by some other condition.

Bacterial infections of this type have also been demonstrated as the sole cause of diseases affecting shrimp which are otherwise normal. As research on disease agents of shrimp advances, bacteria of groups such as *Vibrio* spp. and *Pseudomonas* spp. will probably be shown to be the types that normally infect shrimp body fluids. Shrimp infected with bacteria show discoloration of the body tissues in some instances, but not in others. The clotting function of the blood, critical in wound repair, is slowed or lost during some infections. Occasionally parts of the body are lost. (Fig. 3C).*

If infected by chitinoverous bacteria, the exoskeleton will demonstrate erosive areas that are blackened (Figs. 4C, 5 and 6). These bacteria typically attack edges or tips of exoskeleton parts, but if breaks occur in the exoskeleton the bacteria are quick to enter and cause damage.

* The letter "C" denotes a color plate which may be found on pages 10 and 11.

Filamentous bacteria are commonly found attached to the exoskeleton, particularly fringe areas beset with setae (Fig. 7). When infestation is heavy, bacteria of this type have been seen attached to the gill filaments in large numbers.

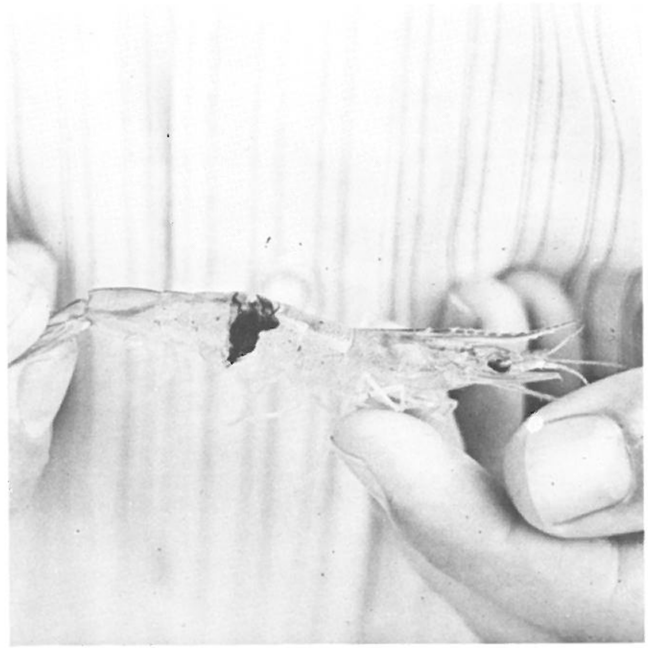

Fig. 6. An advanced lesion.

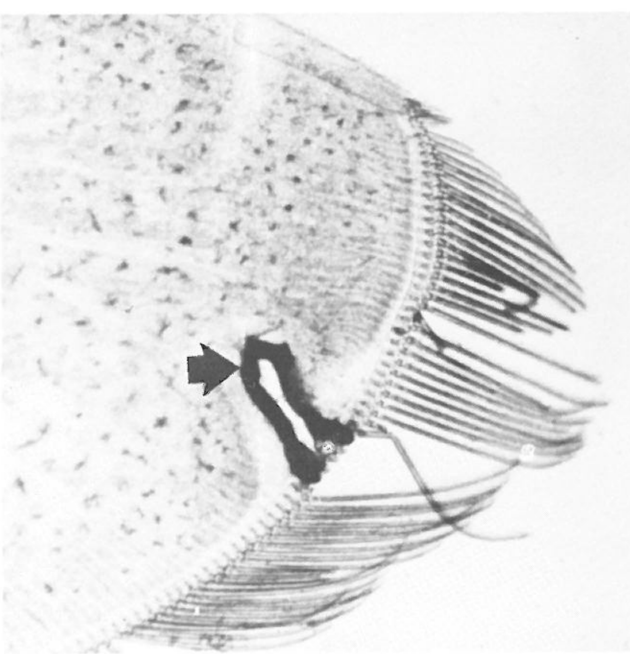

Fig. 5. Microscopic view of a lesion on a uropod (tail part).

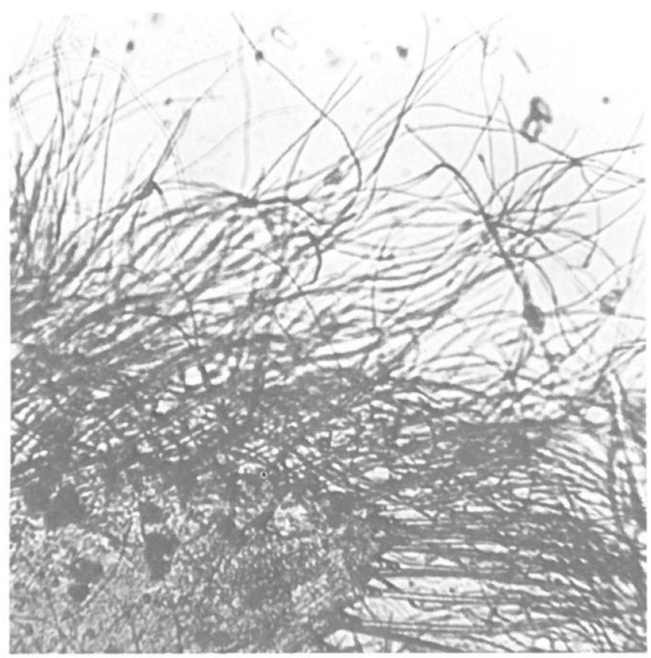

Fig. 7. Microscopic view of filamentous bacteria on a shrimp's pleopod.

FUNGI

The knowledge of fungus infection of shrimp is limited, and only recently have fungi been incriminated as shrimp pathogens. It is expected that fungi will be shown an important parasite of shrimp, as fungus species are known to be the cause of devastating mortalities in crawfish and crabs. Large-scale mortality of postlarval shrimp has been attributed to a species of the fungal genus *Lagenidium* and a fungus similar to *Dermocystidium (=Labrynthomyxa).* A species of *Fusarium* has been noted to infect brown shrimp in a laboratory environment. Examples of fungal infections are shown in Figures 8 - 10.

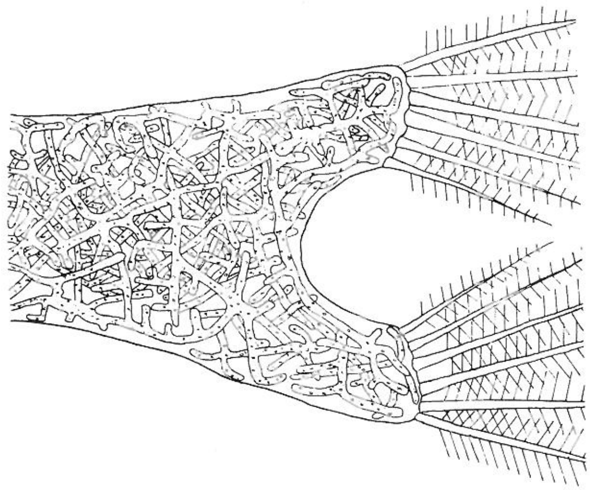

Fig. 10. The tail-end of a larval shrimp as it would appear with heavy fungus infection. Shrimp are able to withstand a high degree of infection before dying.

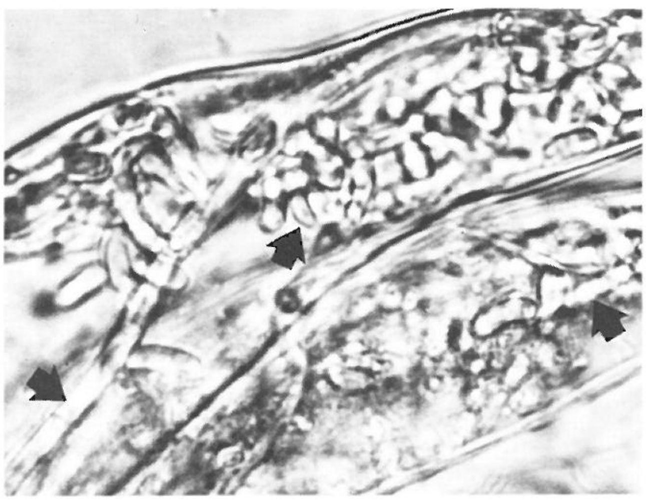

Fig. 8. Microscopic view of fungus in a gill filament.

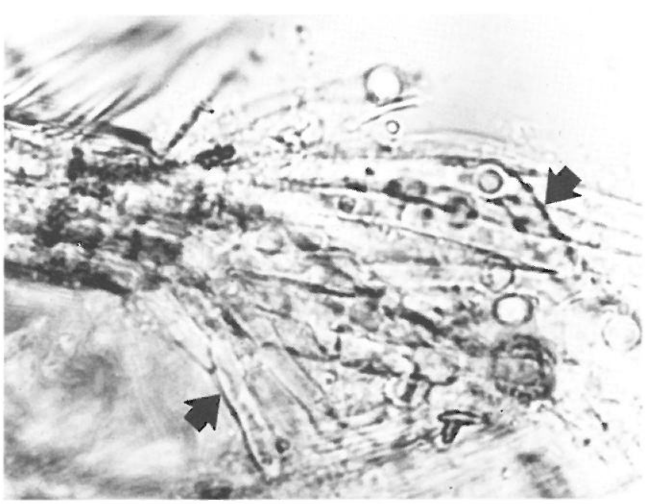

Fig. 9. Microscopic view of fungus at the tip of an antenna.

VIRAL AND RICKETTSIAL INFECTIONS

Although viruses and rickettsia are well known in other related groups such as insects, crustaceans have not been shown as frequent hosts. A polyhedral virus has been recently noted in the hepatopancreas of pink shrimp and the effects of this virus remain to be explored. No rickettsial infections have been identified in crustaceans.

Protozoa

Protozoan parasites and commensals of shrimp may be grouped into those known as gregarines, microsporidians, and ectocommensals. The gregarines and the microsporidians occur internally and have been considered parasitic. The ectocommensals occur on and about the external surface and are considered harmless unless they are present in massive or burdensome numbers.

MICROSPORIDIANS

Microsporidians parasitize most major animal groups, notably insects, fish, and crustaceans. In shrimp, microsporidian infections cause a condition known as "milk" or "cotton" shrimp (Figs. 11, 12C - 14C). Microsporidians become remarkably abundant in the infected shrimp and cause the white appearance of affected tissues. Depending on the type of microsporidian, the site of infection will be throughout the musculature of the shrimp or in particular organs and tissues. A few individuals in a typical catch of wild shrimp will demonstrate the condition. These shrimp are usually discarded before processing.

Microsporidians are present in the affected shrimp in the form of spores. An individual spore is very minute and examination with a microscope is required for detection. An enclosing envelope will surround the spores in some types while not in others. The type without an enclosing envelope is included in the genus *Nosema* (Fig. 15). Those with enclosing envelopes are assigned to the genera, *Pleistophora* and *Thelohania*. *Thelohania* differ from *Pleistophora* in that members of the genus *Thelohania* retain a constant spore number of eight per envelope (Fig. 16). *Pleistophora* spp. have more than eight spores per envelope.

Infected shrimp are noted to be agile and apparently feed as normal shrimp. However, no eggs have been found in "milk" shrimp and it is suspected that all types of microsporidian infections can render shrimp incapable of reproduction.

The life cycles of shrimp microsporidians have not been satisfactorily worked out. However, by examining the cycles of related species and miscellaneous facts from the literature, the cycle presented in Figure 18 may be considered a good representation of a microsporidian life cycle.

GREGARINES

Gregarines are protozoans that occur within the disgestive tract and tissues of various invertebrate animals. They occur in the digestive tract of shrimp

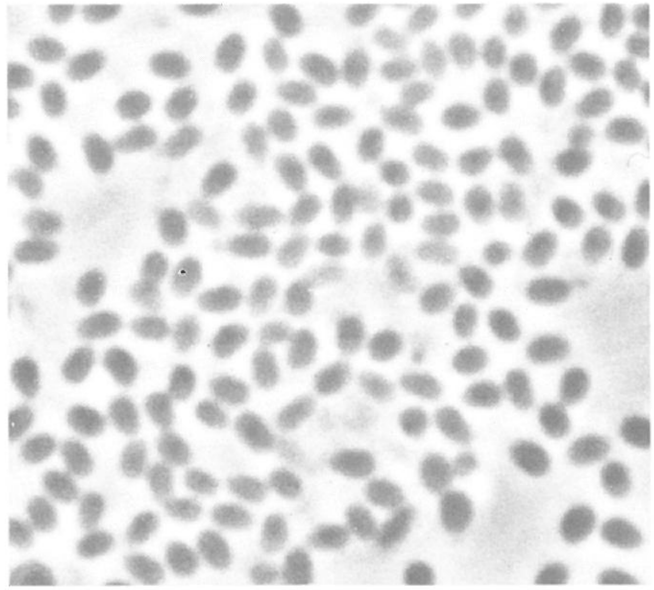

Fig. 15. Microscopic view of many spores of *Nosema nelsoni.*

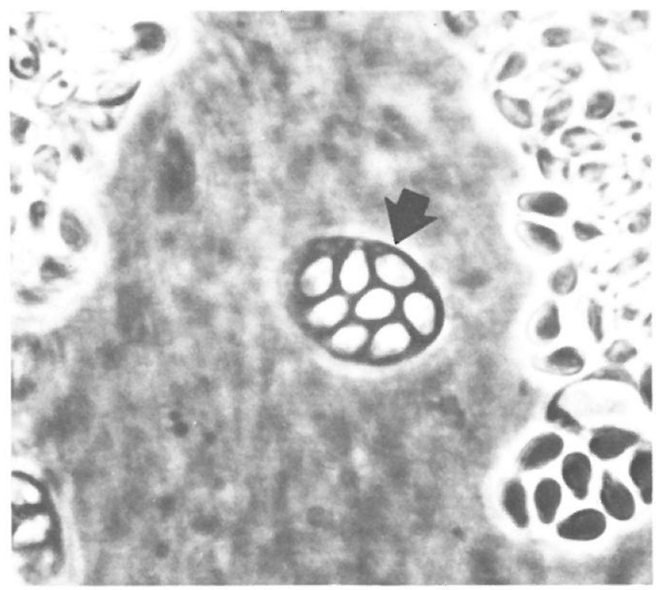

Fig. 16. Microscopic view of many spores of *Thelohania* sp. Note envelope (arrow).

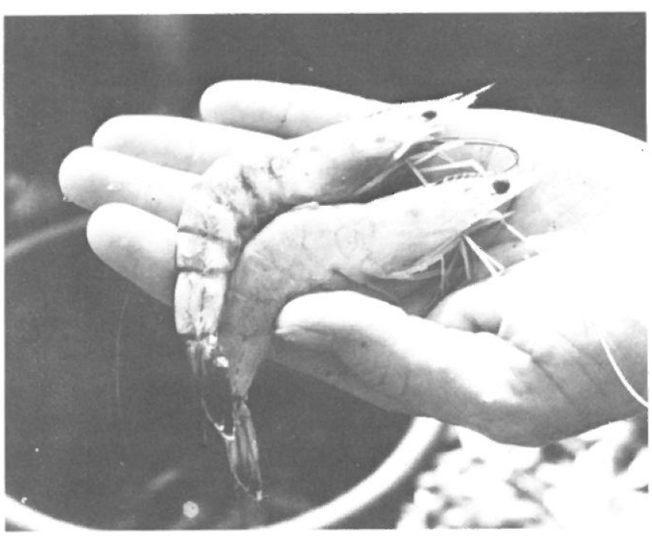

Fig. 11. Infected or "milk" shrimp (upper) in comparison to normal shrimp (lower).
(Photo courtesy of Dr. R. Nickelson, Texas A&M University.)

and are observed most often in the form of a trophozoite (Figs. 19-21), or a gametocyst (Fig. 22). The life cycle involves marine snails or clams and is diagrammed in Figure 23.

Minor damage to the host shrimp results from attachment of the trophozoites to the lining of the intestine. Absorption of food by the protozoans is perhaps detrimental. It is the consensus of most parasitologists that these effects are relatively unimportant and consequently they consider gregarines of little pathological importance.

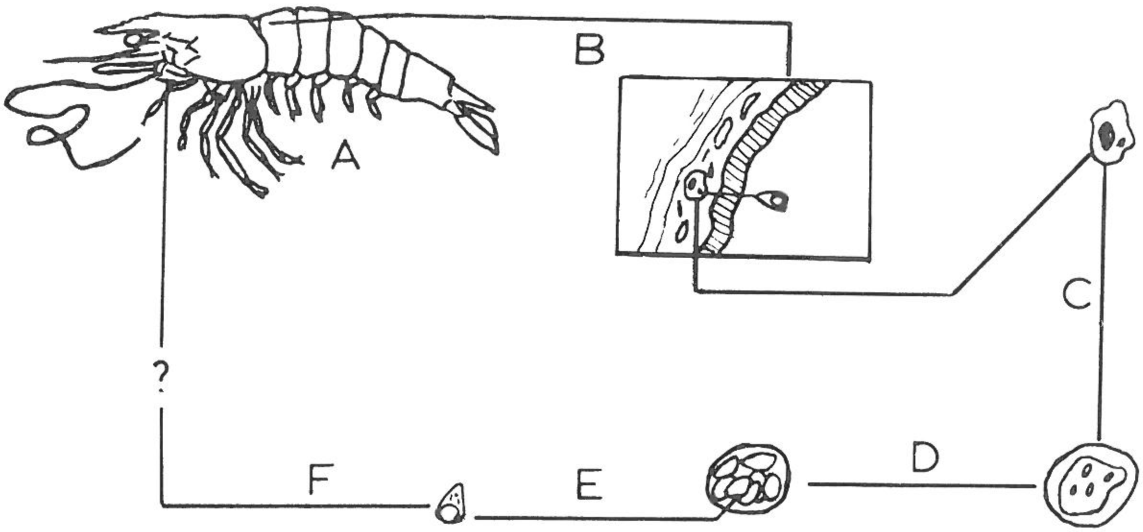

Fig. 18. Life cycle of a microsporidian of shrimp. *A* -- Ingestion of spores by shrimp. *B* -- In gut of shrimp the spore extrudes a filament which penetrates gut wall and deposits an infective unit. A cell engulfs this unit. *C* -- Infective unit enters the nucleus of the cell, undergoes development and then divides to form what are known as schizonts. *D* -- Schizonts then divide and develop into spores. *E* -- By the time spores are formed they are located in a specific tissue (muscle, tissues around intestine, etc.). The spores are either discharged from the shrimp while living or after death, but the method of release and the pathway taken is not known. *F* -- Experiments designed to transmit infection by feeding infected shrimp to uninfected have been unsuccessful. It is assumed particular events such as involvement of another host may be required to complete the passage from one shrimp to the next.

Fig. 19. Microscopic view of trophozoite of *Nematopsis* sp.

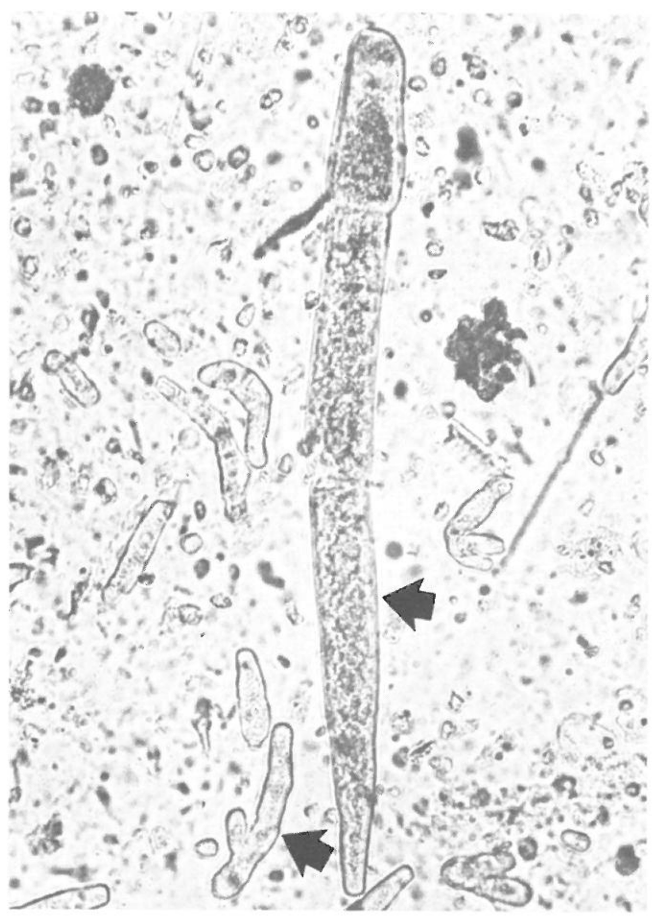

Fig. 20. Microscopic view of trophozoites of *Nematopsis* sp.

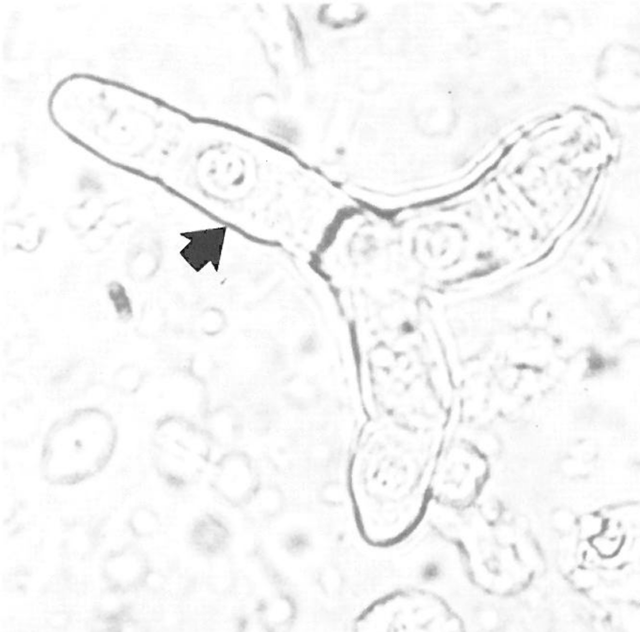

Fig. 21. Microscopic view of trophozoite of *Nematopsis* sp.

Fig. 22. Microscopic view of gametocyst of *Nematopsis* sp.

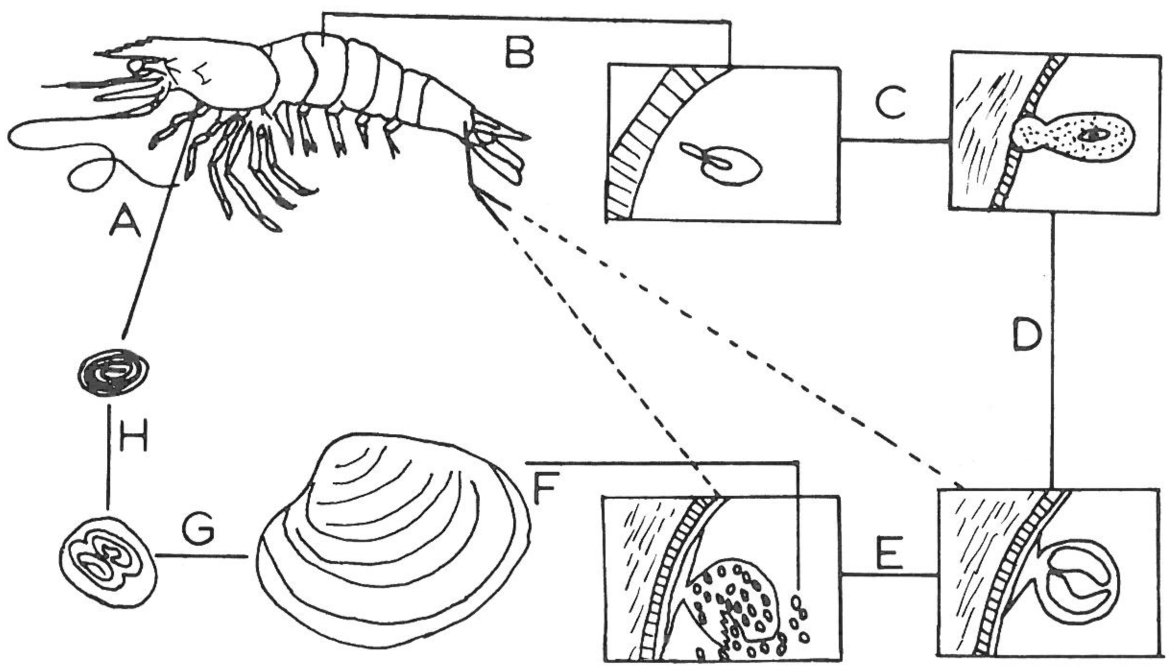

Fig. 23. Life cycle of a gregarine of shrimp. *A* -- Shrimp ingests spores with bottom debris. *B* – Sporozoite emerges in the gut of the shrimp. *C* -- Sporozoite attaches to the intestinal wall and grows into a delicate trophozoite, other trophozoites do not attach to the wall but onto others and form unusual shapes (See Figs. 20 & 21). *D* – The unusual forms develop and attach to the end of the intestine (rectum) to form gametocysts. *E* – The gametocyst undergoes multiple divisions to produce "gymnospores" which are set free with rupture of the gametocyst. *F* -- Gymnospores are engulfed by cells at the surface of the flesh of clams. *G* -- They develop to form spores in the clam. *H* -- Then spores (with sporozoite inside) are liberated from the clam in mucous strings (slime).

ECTOCOMMENSAL PROTOZOA

Ectocommensal protozoa are found on surfaces, including gills, of an infested shrimp. Some of the species are definitely associated with shrimp rather than randomly distributed in the environment. Several species prefer particular body parts of a shrimp as sites of attachment. Much is still unknown about the diversity of ectocommensals on shrimp and their association with shrimp. It is certain that new protozoan-shrimp associations will be discovered in the future.

Common on the surfaces of shrimp are species of *Zoothamnium* (Figs. 24 & 25C), *Epistylis* (Fig. 26), *Acineta* (Fig. 27 and *Lagenophrys* (Figs. 28 & 29). Of this group, *Zoothamnium* sp. is a frequent inhabitant of the surface of shrimp gill filaments. When they become abundant on gills of shrimp in ponds with low oxygen content, suffocation can occur. The life of ectocommensals involves continual duplication. The shrimp acquires an increasing burden of these protozoans until shedding of the exoskeleton provides relief.

Fig. 24. Microscopic view of colony of *Zoothamnium* sp. Note myoneme (muscle fiber) at arrow point.

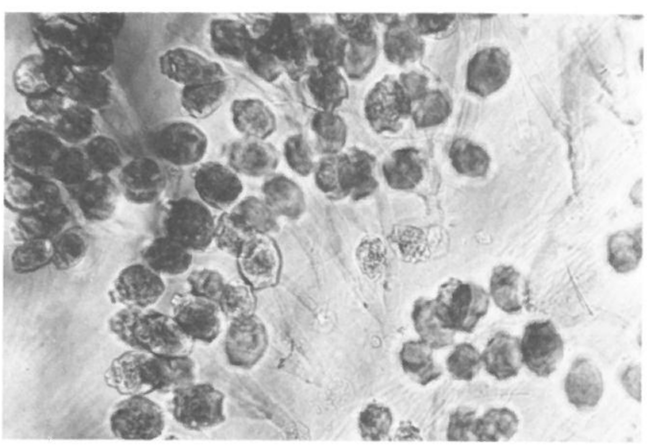

Fig. 26. Microscopic view of colonies of *Epistylis* sp. Note absence of myoneme.

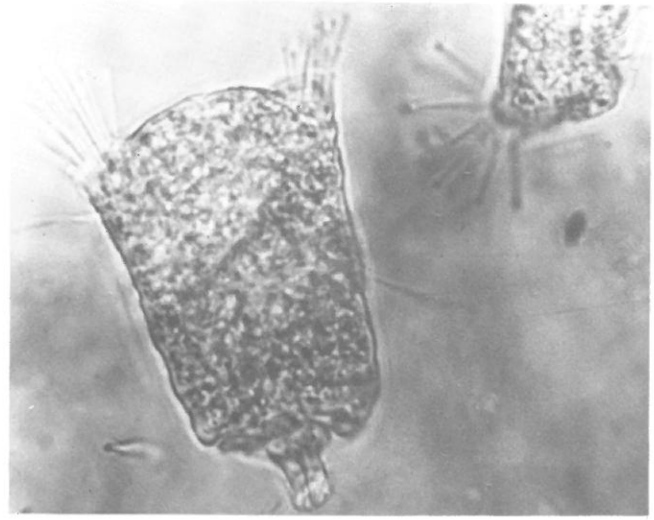

Fig. 27. Microscopic view of *Acineta* sp.

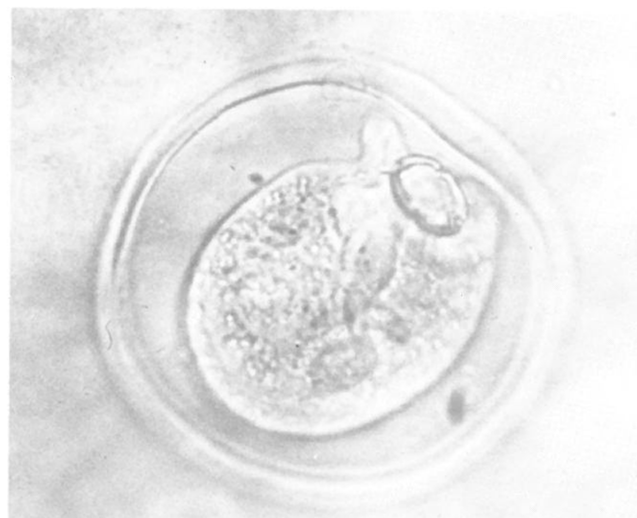

Fig. 28. Microscopic view of *Lagenophrys* sp.

Fig. 29. Microscopic side view of *Lagenophrys* sp.

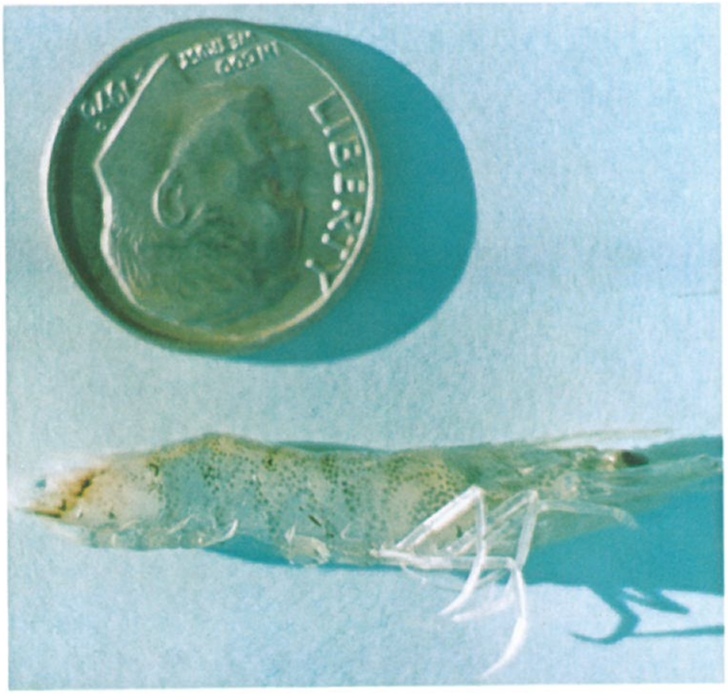

Fig. 3C. Damage to abdomen of a shrimp as a result of *Vibrio* sp. infection.

Fig. 4C. Shrimp with numerous black erosive areas considered a result of action by chitinoverous bacteria.

Fig. 12C. Grass shrimp with "milk" shrimp condition, the normal shrimp in the figure is transparent.

Fig. 13C. White and brown shrimp with "milk" shrimp condition. From top: infected white shrimp, infected brown shrimp, normal brown shrimp.

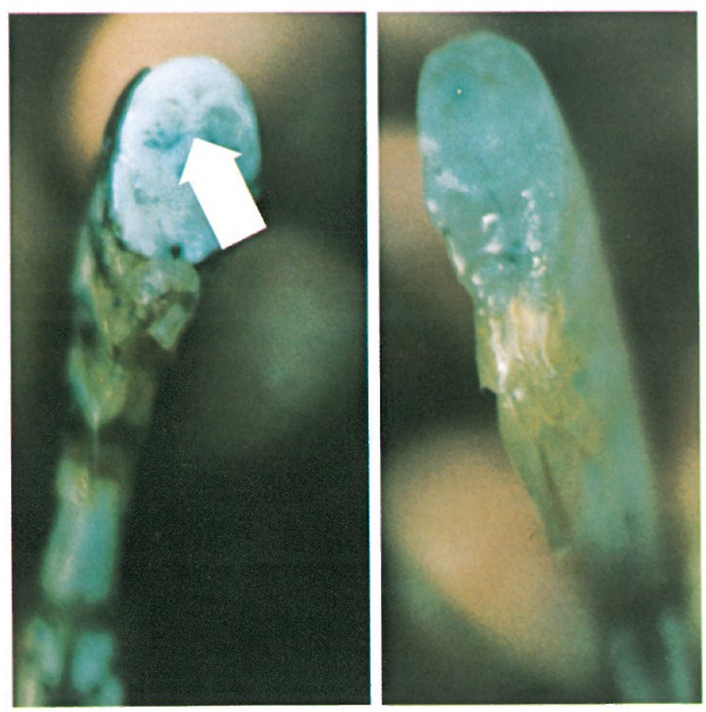

Fig. 14C. Two brown shrimp from previous figure cut across tail. Arrow points to infected shrimp.

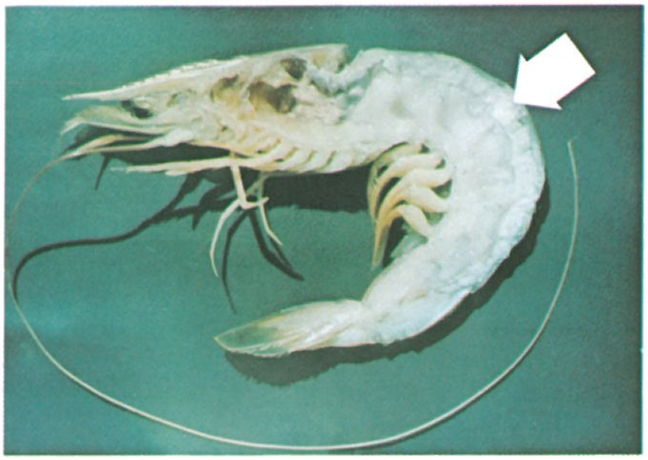

Fig. 17C. *Thelohania penaei* in white shrimp. This parasite is always located along the dorsal midline (arrow). Advanced infections can be seen through the exoskeleton with the unaided eye.

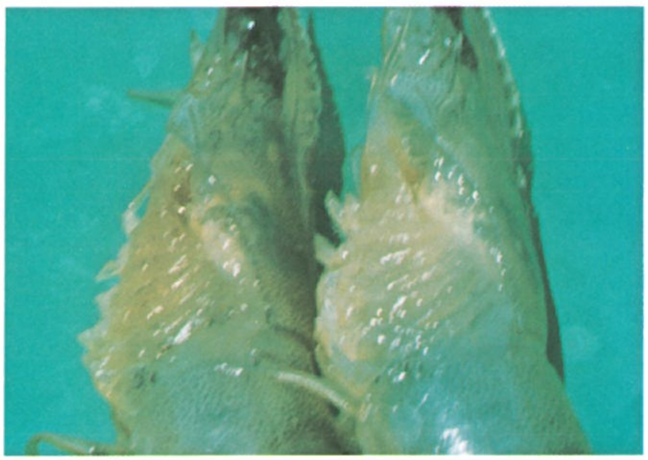

Fig. 25C. Brownish discoloration of gills of a shrimp. A massive infestation of *Zoothamnium* sp. Normal shrimp has lighter gills.

Fig. 38C. "Golden" shrimp condition. The color is distributed throughout the tissues and not just in the exoskeleton or underlying tissue.

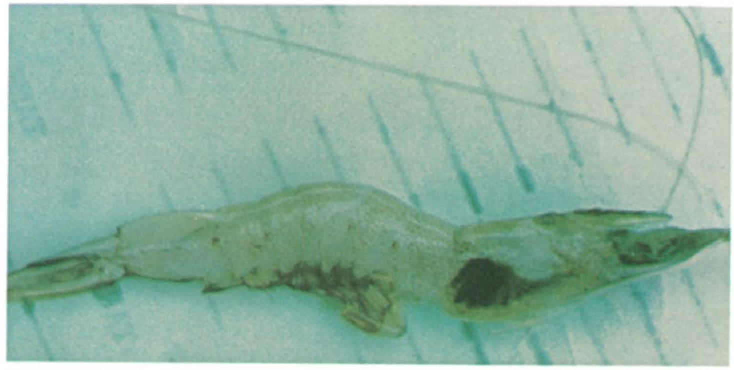

Fig. 40C. Shrimp with darkened condition (advanced). Note prominent darkening of gills.

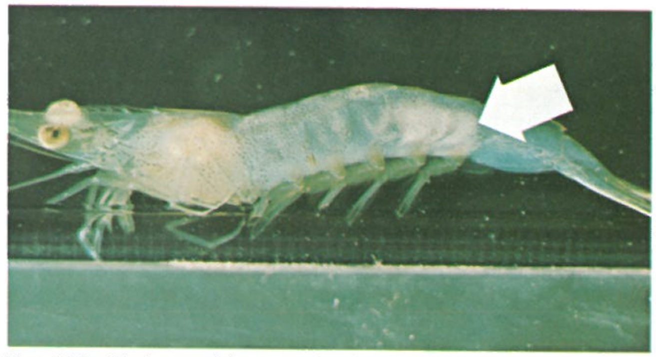

Fig. 42C. Shrimp with necrotic tissue following stress. Affected tissue at arrow.

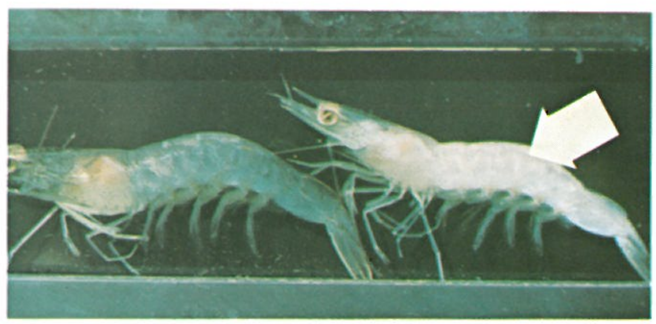

Fig. 43C. Shrimp with advanced necrosis (arrow) shown beside normal shrimp.

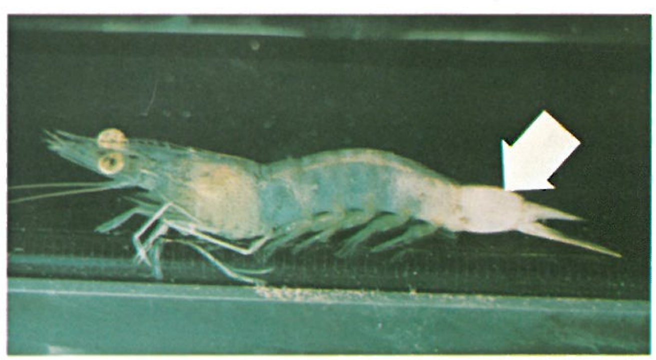

Fig. 44C. Shrimp with tissue (arrow, note pinkness) that was unable to revert to the normal state.

Worms of Shrimp

The worms that have been found in shrimp are trematodes (flukes), cestodes (tapeworms), and nematodes (roundworms). Some species are more common than others and as yet none have been known to cause widespread mortality. Worms may be found in various parts of the body (Fig. 30).

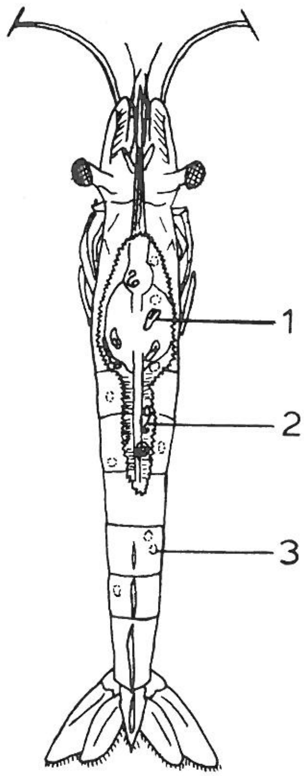

Fig. 30. Common sites of infestation by worms. *1* -- Tapeworms; usually associated with tissues covering digestive gland. *2* -- Roundworms; in and outside of organs in cephalothorax, but also in and along outside of intestine. *3* -- Flukes; commonly encysted in tissues adjacent to organs in cephalothorax but also in abdominal musculature and under exoskeleton.

TREMATODES

Trematodes (flukes) are present in shrimp as immature forms (metacercariae) encysted in various body tissues. Metacercariae of tematodes of the families Opecoelidae, Microphallidae, and Echinostomatidae have been reported from commercial species of penaeid shrimp (Fig. 31). One species *Opecoeloides fimbriatus* has been noted to be more common than others, and the hypothetical life cycle of this species is illustrated in Figure 32.

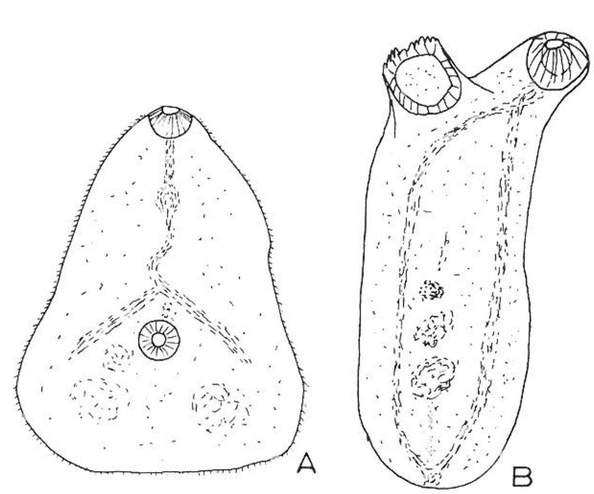

Fig. 31. Drawing of microscopic view of common flukes of shrimps (excysted). *A* -- *Microphallus* sp., *B* -- *Opecoeloides fimbriatus.*

CESTODES

Tapeworms in shrimp are associated typically with the digestive gland. They are usually found imbedded in the gland, or next to it in the covering tissues. In shrimp tapeworms are present as immature forms (Fig. 33) while adult forms are found in rays. Species of the genera *Prochristianella, Parachristianella,* and *Polypocephalus* have been reported from commercial shrimp. Differentiation between the tapeworm groups is made in general body form and tentacular armature. A hypothetical life cycle for *Prochristianella penaei* is presented in Figure 34.

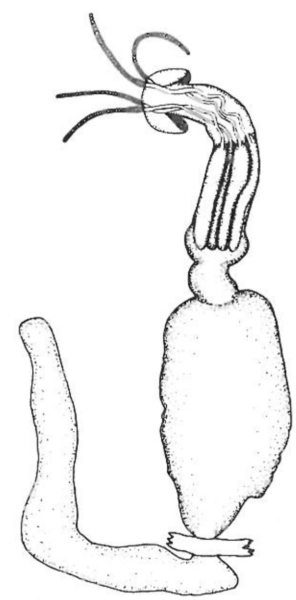

Fig. 33. A drawing of the shrimp tapeworm, *Prochristianella penaei* as it would appear in microscopic view after removal from cysts.

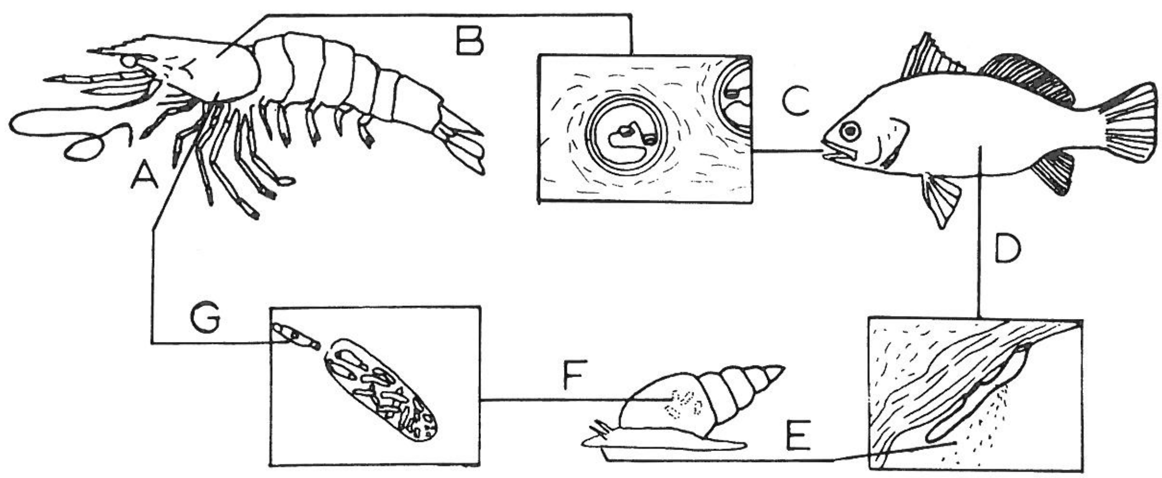

Fig. 32. Hypothetical life cycle of a shrimp fluke, *Opecoeloides fimbriatus*. *A* -- The infective stage or cercaria penetrates shrimp. *B* -- The cercaria migrates to the appropriate tissue and encysts forming a stage called metacercaria. *C* -- Shrimp infected with metacercaria is eaten by a fish (silver perch, redfish, sheephead, or several other types). *D* -- Shrimp is digested which releases metacercaria. A metacercaria stage undergoes development until it forms an adult. *E* -- Eggs laid by adult fluke pass out of fish with wastes. An egg hatches and an infective stage known as a miracidium is released. The miracidium penetrates a snail and multiplies in numbers within cysts called sporocysts. *F* -- Cercariae develop within sporocysts and when fully developed a cercaria leaves the sporocyst and snail and swims in search of a shrimp. If contact is made with a shrimp within a short period the cycle is completed.

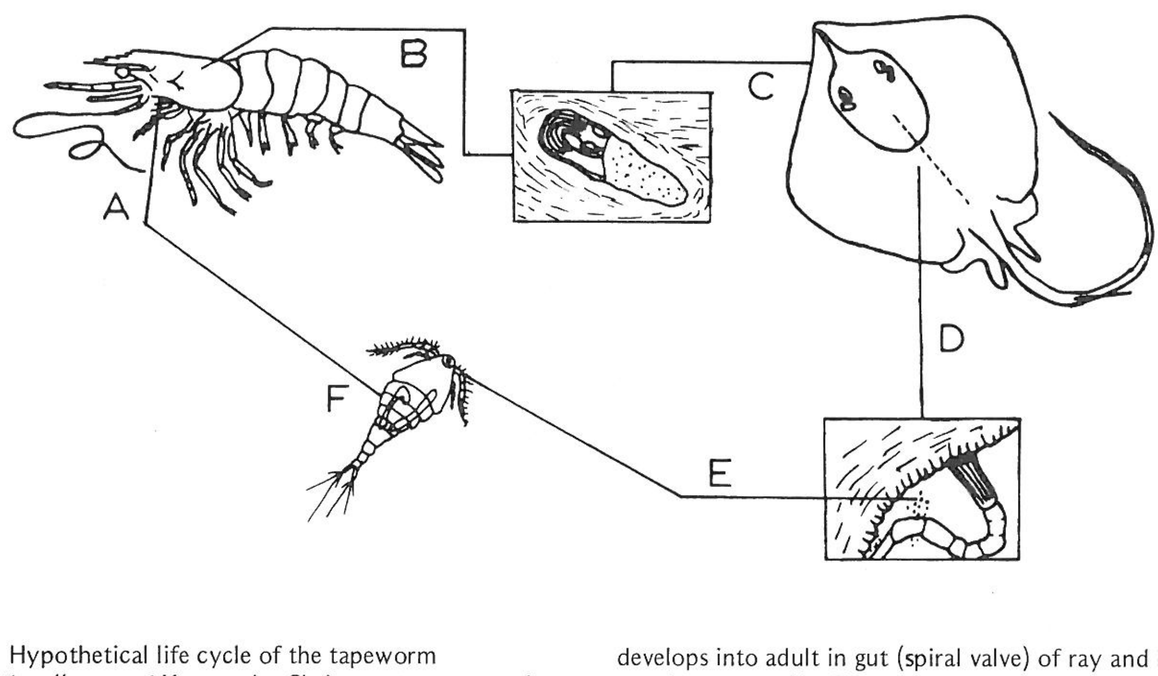

Fig. 34. Hypothetical life cycle of the tapeworm *Prochristianella penaei* Kruse. *A* -- Shrimp eats a copepod or other small crustacean infested with larval tapeworm. *B* -- Tapeworm develops into advanced larval stage in tissues of shrimp. *C* -- Stingray ingests infested shrimp. *D* -- Tapeworm develops into adult in gut (spiral valve) of ray and begins to release eggs. *E* -- Eggs pass out of the fish with feces and are eaten by copepod. *F* -- Eggs hatch and larval worm develops inside copepod.

NEMATODES

Nematodes occur more commonly in wild shrimp than in cultured shrimp. The degree of infection is probably related to the absence of appropriate hosts in culture systems. Nematodes will occur within and around most body organs, as well as the musculature. The most common nematode in shrimp is *Thynnascaris* sp. (Fig. 35B). Other nematodes of shrimp include *Spirocamallanus pereirai* (Fig. 35A) and *Leptolaimus* sp.

It is the juvenile stage of nematodes that infects shrimp with the adult occurring in fishes. An illustrated life cycle for that which is thought to represent *Thynnascaris* sp. is depicted in Figure 36.

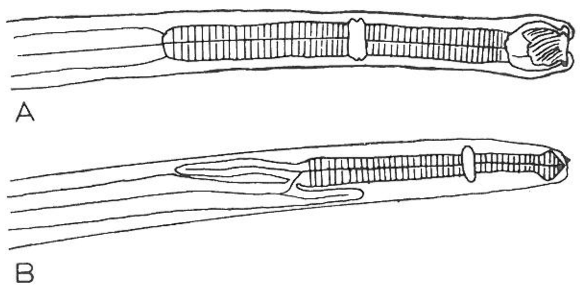

Fig. 35. Microscopic view of *A* -- *Spirocamallanus pereirai* and *B* -- *Thynnascaris* sp. common roundworms found in penaeid shrimp.

Miscellaneous Conditions

BARNACLES

Barnacles (Fig. 37) have been noted on the exoskeleton of shrimp as a rarity. It is thought that the frequent molting of shrimp does not allow enough time for barnacles to become established on the exoskeleton.

Fig. 37. A fresh water shrimp, *Macrobrachium ohione*, caught in Galveston Bay, with barnacles attached to its exoskeleton. The shrimp specimen is large (3.0 inches total length) for the species and over 20 barnacles of the size shown were counted.
(Specimen courtesy of R. D. Reimer.)

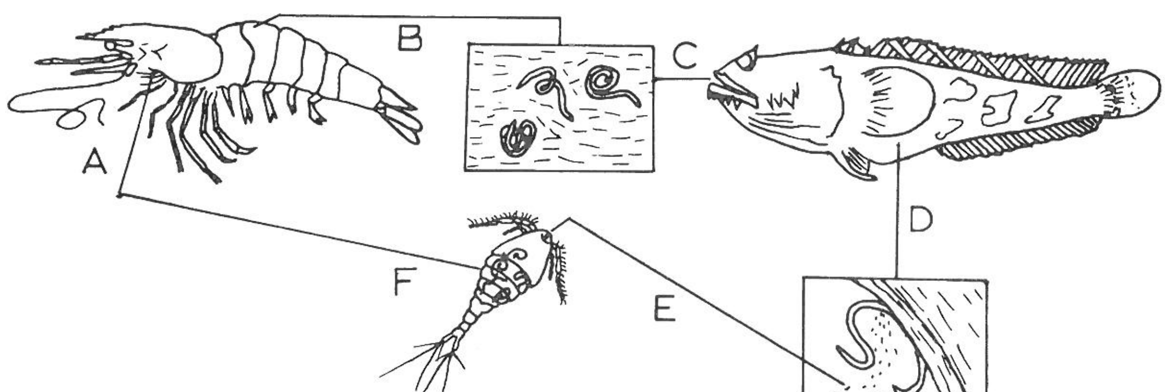

Fig. 36. Hypothetical life cycle of *Thynnascaris* sp., a roundworm of shrimp. *A* -- Shrimp eats a copepod or other small crustacean infested with larval roundworm. *B* -- Roundworm develops into advanced larval stage in tissues of shrimp. *C* -- Toadfish ingests infested shrimp. *D* -- Roundworm develops into adult in gut of fish and begins to release eggs. *E* -- Eggs pass out of the fish with feces and are eaten by copepod.

GOLDEN SHRIMP

Another rare condition with penaeid shrimp is where the tissues of the shrimp take on a golden appearance (Fig. 38C). The cause is unknown but some suspect that it is hereditary. The golden color is throughout and not confined to the exoskeleton or tissues next to it.

DARKENED SHRIMP

This condition is apparently different from the spotty, erosive-type damage attributed to chitinoverous bacteria. Darkening occurs over all the surface of the shrimp and is most intense on the gills. During the initial stages of the condition random gill filaments become darkened (Fig. 39, 40C). Later, all become abnormal. Shrimp with this condition have been observed in rearing ponds in Brazoria County, Texas.

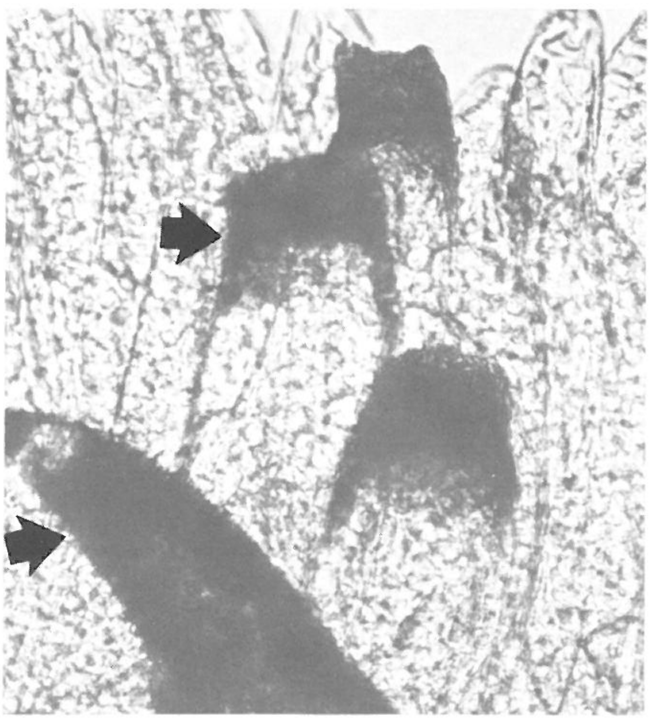

Fig. 39. State of gills of shrimp during initial stages of darkening condition.

CRAMPED SHRIMP

This is a condition described for shrimp held as bait in vats. The tail is drawn under the body and becomes rigid to the point that it cannot be straightened. The cause of the cramping is unknown.

MISCELLANEOUS ORGANISMS USING SHRIMP AS ATTACHMENT SITE

Other organisms found attached to shrimp are the colonial hydroid *Obelia bicuspidata,* the blue-green alga *Schizothrix* calcicola and a leech, *Myzobdella lugubris* Leidy.

These organisms probably attach to shrimp as a convenience when they are present in great numbers in the vicinity of the shrimp. Leeches may be particular, however, as they have been noted as common residents of the exterior of crabs and grass shrimp (Fig. 41).

Fig. 41. Grass shrimp with leech attached. (Photo by Kenneth R. H. Read.)

SPONTANEOUS NECROSIS

Opaque muscles are characteristic of this condition. When shrimp are exposed to stressful conditions, such as low oxygen or crowding, the muscles lose their normal transparency and become blotched with whitish areas throughout (Fig. 42C). This may progress until the entire tail area takes on a whitish appearance (Fig. 43C). If shrimp are withdrawn from the adverse environment before prolonged exposure, they may return to normal. Extremely affected shrimp do not recover and die within a few minutes. In moderately affected shrimp, only parts of the body return to normal; other parts, typically the last segments of the tail, are unable to recover (Fig. 44C). These shrimp die within one or two days. Shrimp muscles with this condition are known to undergo necrosis (death or decay of tissue). The whitish condition can be confused with milk shrimp (microsporidian infection) but examination of the figures should aid in distinguishing the two diseases.

Table 1.
Parasite and commensal relationships of Penaeid shrimp of commercial importance. *

Parasite or Commensal	Shrimp Species								
	Penaeus aztecus	*P. braziliensis*	*P. duorarum*	*P. occidentalis*	*P. setiferus*	*P. stylirostris*	*P. vannamei*		
Microsporidians									
Nosema nelsoni	X		X		X				
Pleistophora sp.	X				X				
Thelohania duorara		X	X						
Thelohania penaei					X				
Gregarines									
Nematopsis duorari			X						
Nematopsis penaeus	X		X		X				
Cephalolobus penaeus	X		X		X				
Other Protozoa									
Zoothamnium sp.	X		X	X	X	X	X		
Lagenophrys sp.					X		X		
Epistylis sp.	X			X	X		X		
Acineta sp.	X				X		X		
Trematodes									
Opecoeloides fimbriatus	X		X		X				
Microphallus spp.			X		X				
Parorchis sp.					X				

*Since several shrimp species are not mentioned, space is provided in the table for additions. Also, the parasite and commensal list is restricted to published accounts and space is provided for future additions.

Table 1. cont.

Parasite or Commensal	*Penaeus aztecus*	*P. braziliensis*	*P. duorarum*	*P. occidentalis*	*P. setiferus*	*P. stylirostris*	*P. vannamei*		
				Shrimp Species					
Cestodes									
Prochristinella penaei	X		X		X				
Parachristinella monomegacantha			X						
Parachristinella dimegacantha	X		X						
Polycephalus sp.	X		X		X				
Nematodes									
Thynnascaris sp.	X		X		X				
Spirocamallanus pereirae					X				
Leptolaimus sp.	X				X				
Barnacles									
Balanus amphitrite nivens					X				
Balanus improvisus					X				
Balanus sp.					X				
Miscellaneous									
Obelia bicuspidata	X								
Schizothrix calcicola	X				X				
Myzobdella lugubris					X				
Golden Shrimp	X				X				

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