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DISEASES OF MILKFISH

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Although the history of *Chanos chanos* (Forsskal) culture has been quite long, reports of major epizootics have been few. Trained manpower and disease diagnostic services in most milkfish growing areas have not been readily available. Hence, earlier reports of etiologic agents of these epizootics were limited mostly to direct microscopic examination of specimens. Significant disease cases reported were attributed to bacterial, mycotic, parasitic, and toxic causes. Bacterial infections, primarily due to *Vibrio* sp., have been frequently associated with mortality. To a lesser extent, fungal infections have also been reported. Intoxication of stock in freshwater systems by *Microcystis* toxins has caused massive fish kills in Laguna de Bay, Philippines. In most instances, affected fish were predisposed by environmental stress incurred in handling, storage, and transport. The fry and fingerling stages seemed severely affected compared with the older stages. Control of these infections must include assessment of fish husbandry practices first, before the use of chemotherapeutic agents like antibiotics is considered. Moreover, research thrusts should be geared toward the improvement of vaccination methods as well as defining the disease mechanisms of major milkfish pathogens and stress agents.

INTRODUCTION

The culture of milkfish, *Chanos chanos* (Forsskal), is now a major commercial concern in the Philippines, Taiwan, and Indonesia. As such there is growing interest in maladies that could reduce survival. Cases of epizootics occur among milkfish, but in most instances they remain undocumented due to lack of trained manpower and of available diagnostic services. In the Philippines, a few of these outbreaks attributed to parasites were summarized by Velasquez (1975, 1979). Subsequent reports included other pathogenic organisms (Delmendo 1978, Mercene 1978). Major diseases causing significant mortality among milkfish and other fish in the Philippines were described in a recent report (Lio-Po et al 1982). The present paper is an updated record of cases of milkfish diseases so far reported in the Philippines as well as in other countries. It categorizes milkfish diseases into bacterial, fungal, and miscellaneous etiologies.

BACTERIAL INFECTIONS

A number of significant mortalities among milkfish have been attributed to pathogenic bacteria. The earliest report indicating bacteria as a potential cause of milkfish mortality was that of Ronquillo, Villamater, and Angeles in 1957, which noted reduced mortality of fry and fingerlings with the addition of an antibacterial agent, Terramycin, and Vigofac in the milkfish diet for 2-3 weeks.

In the Philippines, fingerlings stocked in concrete tanks and maintained in crowded conditions in brackishwater ponds manifested signs of eroded fins and discolored patches on the skin. Long, slender bacterial rods were seen on smears made from the kidney, the liver, and external lesions. Associated infestations with *Trichodina* and *Scyphidia* were observed (IFP 1973). Experimental tests showed that the bacterial pathogen was part of the natural flora of either the fish or the rearing water and attacked fish predisposed to handling stress (Table 1).

In another case, mass mortality affecting more than 10 000 milkfish fingerlings occurred a week after stocking in fishpens; the cause was reportedly of bacterial etiology (Duncan 1974). Secondary bacterial infection was also diagnosed among dead milkfish with bruised bodies and injured snouts and eyes resulting from seining injuries and crowding (IFP 1975b).

In Taiwan, the bacterium *Vibrio anguillarum* was identified as causing "red spot disease," which resulted in significant milkfish mortality (Huang 1977). The red spots were hemorrhagic lesions on the body surface of affected fish. Experiments revealed the virulence of the bacteria at increasing concentrations as well as at a lower temperature of 15°C (Song et al 1980). Vaccination experiments using the HIVAX V. *anguillarum* bacterin manufactured by Tavolek, Inc. (Redmond, Washington, USA) indicated that in 30 days milkfish of 1-1.5 g developed some degree of immunity (Song et al 1980). Further experiments, however, showed that the mortality difference between immunized and control fish after challenge was not statistically significant (Lin et al 1982).

In 1980, deaths among hatchery-reared fry at the SEAFDEC Aquaculture Department were associated with the appearance of red spots on rearing tank surfaces which yielded *Vibrio* sp. isolates (Lio-Po et al, unpubl.). The red spots disappeared when fresh water was introduced directly into the tanks (Duray; pers. comm.). Among milkfish juveniles, post-transport deaths have been associated with a preponderance of bacterial elements in the liver and kidney. A daily bath using oxytetracycline for 5

Table 1. Results of a preliminary experiment on bacterial disease development among milkfish fingerlings 24 h after stocking in plastic bags.[a]

Bag no.	No. of fish	%dead	% with frayed fins	% with skin discoloration	Bacteria in kidney smears
1	30	27	80	27	yes
2	20	10	100	10	yes
3	10	0	100	—	yes

[a] Summarized from IFP 1973.

consecutive days arrested the infection (Lio-Po, unpubl.). For fingerlings subjected to transport stress, the use of Furanace at 1 ppm for 5 consecutive days also proved effective (Muroga, unpubl.). This concentration can be tolerated by milkfish fingerlings (Torres 1979). *Vibrio* sp. has also been isolated from pus-forming wounds of the hormone-implanted musculature of milkfish spawners reared in floating cages at Guimaras, Philippines (Lio-Po et al, unpubl.). Affected fish, however, did not exhibit mortality. In India, the bacterium *V. parahemolyticus* (Biotype 2) has been implicated in "scale disease," which causes scale protrusion with pus among cultured milkfish (Mahadevan et al 1978).

Another incidence of fish mortality was associated with gram positive, long, slender bacterial rods in liver and kidney smears (IFP 1973). In addition, the rearing water became yellowish-brown. This occurrence of the yellow water phenomenon had been earlier reported in Taiwan (Chao 1969). Its occurrence was reportedly harmful to milkfish growth, but it did not seem to develop when the blue-green alga *Enteromorpha* bloomed. Gram positive and gram negative rods and cocci were isolated from the yellow waters of milkfish ponds during June-November.

Incidences of fin rot among milkfish have been frequently reported in the Philippines. In one case, the bacterium *Chondrococcus columnaris* was identified as causing erosion of fins among milkfish juveniles in brackishwater ponds. Two percent of stocked fish were affected (IFP 1973-74). Erosion and inflammation of fins were also associated with the presence of a large number of unidentified bacteria and with mortality in freshwater ponds in the Philippines (IFP 1975a). Rabanal et al (1951) likewise mentioned an epidemic of fin rot. A similar condition affecting the caudal fins of milkfish fingerlings was also observed in Hawaii (Timbol 1974). In the Inland Fisheries Project report of 1973-74, two outbreaks of fin abnormality, affecting 30% of juveniles in one case, were reported. In the second case a history of "low silty water" was noted. It is not known whether these last four incidences of fin rot/ inflammation were of bacterial etiology, although earlier reports indicated the association of bacteria with this pathological condition.

In a recent report, bacteria closely related to *V. parahemolyticus* were isolated from the outer corneal layer of opaque-eyed milkfish juveniles. The findings were substantiated by in vivo experiments confirming bacterial pathogenicity by reproducing signs of the eye disease (Muroga et al 1983). The report further revealed the public health implications of the strain isolated.

MYCOTIC INFECTIONS

Very few incidences of fungal infection among milkfish have been reported, and records of identification have not been clearly discussed. Diagnosis has seemed to be based primarily on visual or microscopic examination of affected organs. The earliest report of fungus infection among milkfish fry gave 3% of the sampled fish as being affected (IFP 1973). A similar diagnosis was made on a batch of milkfish juveniles in which 8% of the total stock was killed (IFP 1973-74). The fungal pathogen grew on the eye covering and caused clouding of the area. Upon harvest, 7% of the stock had fungal infections identical to the one reported earlier. In Hawaii, milkfish with missing scales were observed to be susceptible to fungus infection. Treatments with potassium permanganate (1:100 000), pyridyl mercuric acetate (1:500 000), or malachite green (1:100 000) were reportedly effective (Timbol 1974). Delmendo (1978) reported that fungal infections among fry and fingerlings usually occur during the colder months of the year.

The occurrence of "milky eye disease" among milkfish (*sabalo*) affecting one or both eyes was reported in 1976 (IFP). Affected fish manifested a milky white opaqueness in the cornea that partially or completely covered the remainder of the eye. The diagnosis of fungal etiology was based primarily on the resemblance to frayed white cotton fibers at the margin of the opaque area. The disease occurred within 24 h after the fish were handled and released into pens. Recovery without treatment was observed in 3-6 days.

DISEASES OF MISCELLANEOUS ETIOLOGY

Other diseases of an organic nature have been reported. A case of stomach lesions defined as "gastritis" affecting 56% of wild milkfish weighing 2-8 kg was first reported in Hawaii (Smith 1978). Superficial erosion and punctuate ulcerations of the mucosa were observed to affect the female of the species predominantly. In 1980, Smith reported the finding of a thrombus occluding the lumen between the bulbus arteriosus and the ventricle of an adult milkfish, maintained in a circulating seawater pond, that unexpectedly began to thrash and died within a few minutes. Only one of the stocked fish was affected.

DISCUSSION

The history of milkfish mortality attributed to microbial disease dates back to early milkfish aquaculture practices. Mortality, though, was considered more as the result of culture practices than of disease as a primary cause. Hence, records of these abnormal phenomena took the form of minor observations in reports on culture techniques (Rabanal 1951).

Eventually, in the early 1970s, the association of mortality or clinical signs with bacterial or fungal infections was considered. Possibly for lack of adequate diagnostic facilities or trained manpower, reports were not very specific. For instance, bacterial or mycological causes were indicated, but specific identification or confirmation of pathogenicity was not established. It was probably only in the latter half of the 1970s that scientific attention was given to diseases of milkfish.

Tables 2, 3, and 4 summarize the records of milkfish diseases attributed to bacteria, fungi, and unknown etiologies so far reported. No virus pathogen has ever been linked to milkfish death, and no attempts to isolate viral organisms have been made because there are no existing facilities. It seems that mass mortality of microbial cause has been quite rare. Foremost in this category are the more than 100 000 dead fingerlings stocked in fish pens (Duncan 1974), red spot disease reported in Taiwan

Table 2. Summary of reports of bacterial diseases among *Chanos chanos* (Forsskal).

Cause	Stage affected	Signs of disease	Remarks	Reference
Bacterial rods	fingerling	eroded fins, skin discoloration	concrete tanks, crowded conditions, brackish water, bacteria in kidney and liver, gills with heavy infestation of *Trichodina* and light infection with *Scyphidia*	IFP 1973
Gram positive rods	juvenile	mild congestion of fins and belly	yellowish-brown pond water, brackish water, preliminary experiment conducted, bacterial isolation unsuccessful	IFP 1973
Chondrococcus columnaris	juvenile	erosion of fins	2% affected, brackish water	IFP 1973-1974
Bacteria	fingerling	fin erosion/ inflammation	freshwater ponds	IFP1975a
Bacteria	fingerling	bruised bodies, injured snouts and eyes, mortality	secondary infection, grown with tilapia	IFP 1975b
Bacteria	fingerling	mortality	more than 100 000 died within a week of stocking in fishpens, handling stress	Duncan 1974
Vibrio anguillarum	fingerling	hemorrhagic spots on body surface (red spot disease)	breaks out in winter, sensitive to chloramphenicol and tetracycline	Huang 1977
V. parahemolyticus		scale protrusion with pus (scale disease)	marine	Mahadevan et al 1978
Vibrio sp.	fry	red spots on tank surface, fry mortality	pathogenicity tests conducted	Lio-Po et al, unpubl.
Vibrio sp.	adult	pus-forming wound at hormone implanted sites	pathogenicity tests conducted	Lio-Po et al, unpubl.
Vibrio sp.	fingerling	heavy mortality, hemorrhagic spots on body surface	brackish water, transport-stressed	Lio-Po et al, unpubl.

Table 3. Summary of reports of fungal diseases among *Chanos chanos* (Forsskal).

Cause	Stage affected	Signs of disease	Remarks	Reference
Fungus	fry	apparent fungus infection	samples from fry dealers, 3% affected	IFP 1973
Fungus	juvenile	eye covering had dense, white, rhizoid growth, clouding the membrane	8% affected, brackish water	IFP 1973-74
Fungus	prefingerling, fingerling, juvenile	none reported	affected fish had missing scales	Timbol 1974
Fungus	spawner	milky, white opaqueness of the cornea (milky white disease)	affected 3 of 4 fish stocked in pens recovery in 3-6 days	IFP 1976
Fungus	fry, fingerling	none reported	occurs usually during the colder months of the year	Delmendo 1978

Table 4. Summary of reports of diseases of unknown etiology among *Chanos chanos* (Forsskal).

Stage affected	Signs of disease	Remarks	Reference
Fingerling	fin rot	brackishwater ponds	Rabanal et al 1951
Fingerling	eye abnormalities, constricted pupils	5% affected	IFP 1973
Juvenile	eroded fins	30% affected	IFP 1973-74
Juvenile	eye abnormalities	3% affected	IFP 1973-74
Juvenile	fin inflammation	history of silty water	IFP 1973-74
Juvenile	constricted pupils, no lenses, very small eyeballs without pupils or lenses	3% affected, bilaterally affected fish were slightly smaller than average	IFP 1973-74
Juvenile	whitening of one or both eyes	impaired feeding	Timbol 1974
Prefingerling, fingerling, juvenile	tail rot	seawater aquaria, flow-through system	Timbol 1974
Adult	thickened, hyperemic gastric rugae and focal hemorrhage (gastritis)	occurs predominantly among female adults weighing 2 000 g or more	Smith 1978
Adult	lethal clot formation occluding the lumen between the bulbus arteriosus and the ventricle	seawater pond, sudden death	Smith 1980

(Huang 1977), the *Vibrio* infected fry associated with red spots on the rearing tank surfaces (Lio-Po et al, unpubl.), and the deaths associated with the algal bloom of *Microcystis* (Delmendo 1978). Fungus infections have not figured in major catastrophies in the milkfish industry.

In most of these occurrences, environmental factors have been strong indicators of predisposing conditions. Deaths, whether affecting a few or a large number of milkfish, have almost always been associated with stress due to transport, handling, or crowding (IFP 1973, 1975b; Duncan 1974). In addition to these are toxic levels of un-ionized ammonia (Jumalon 1979, Cruz 1981, Cruz and Enriquez 1982), temperature stress (Tsai et al 1970, Huang 1977, Delmendo 1978, Lin 1982), starvation (Rabanal 1951), and gas supersaturation (Lio-Po et al 1983). In addition, it is not generally known whether the presence of pesticides in the rearing water has some stressful effect on milkfish; studies have established pesticide accumulation in milkfish tissues (Palma-Gil et al, unpubl.). A common observation of stressed milkfish is the development of a dark blue to blackish color on the back of the fish. Smith and Ramos (1976, 1980) recommended methods of detecting stress conditions among milkfish through tests for the presence of occult hemoglobin on the mucus of the skin with chemical analysis of certain skin mucus such as lactic acid, glutamic oxaloacetic transaminase, sodium, calcium, and chloride. Where intensive culture methods are used, the probable outbreak of disease must be considered. Moreover, it is claimed that freshwater milkfish are more sensitive to stress than those under brackishwater conditions (IFP 1975a).

Frequently reported observations of diseased milkfish are eye abnormalities including constricted pupils, absence of lenses, very small eyeballs without pupils or lenses, and whitening of one or both eyes (IFP 1973, 1973-74, 1976; Timbol 1974; Tamse et al 1983; Muroga et al 1983). Fungal, bacterial, and nutritional etiologies have been cited. Richards and Roberts (1978) mentioned the disease vibriosis in other fish species resulting in corneal opacity, which may develop into ulceration and evulsion of the orbital contents. It does seem that stress from physical injury or handling superimposed by bacteria in the water is the most plausible explanation. The most significant implication, though, is the apparent effect on fish weight which, from the aquaculturist's point of view, will affect production.

When posed with the problem of fish kills, the usual question of the appropriate chemotherapeutic agent is asked. Although this is probably the easiest solution, it may not be a panacea. Tolerance levels of the host fish, effectivity of the drug, condition of the fish, economics, and, most important, the eventual development of drug resistant strains must be evaluated in the light of the urgency and seriousness of the disease condition. Tolerance limits of milkfish to potassium permanganate (Cruz et al 1983), furanace (Torres 1979), formalin, and oxytetracyline (Cruz, unpubl.) have so far been worked out. Disease prevention through physical or biological methods should be given priority. In Taiwan, studies on vaccination against vibriosis due to *V. anguillarum* have been initiated (Song et al 1980, Lin et al 1981). Research on further improvement of the methods used as well as the involvement of indigenous *Vibrio* species will be very useful.

Aware of the hazards awaiting cultured milkfish in rearing systems, aquaculturists will be best benefited if outbreaks of disease are immediately made known to fish disease workers in the area. Then accurate diagnosis and scientific documentation can be done and possible recommendations can be made for existing or future stocks. Research on the mechanisms of disease development of major milkfish pathogens, including their physiological and ecological requirements, should likewise be pursued.

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