**EVOLUTIONARY INVASION OF NEW PISCINE VIRUS THE OLD EXISTING DISEASES AND CONTROL MEASURES: IN AQUACULTURE AND PISCICULURE.**

**D.R. Saxena1, A. D. Saxena2, N.J. Tupkar3, G. S. Tiwary4, and R. A. Lonkar5.**

**HOD KNM1, LAD2, Research student3, ICAD4, Research student4,5**

**Abstract:**

The present paper highlights the causative agents and the preventive treatment measures already in application for infectious bacterial ,fungal ,protozoan ; parasitic ;non Infectious ; miscellaneous and viral lymphocytis diseases respectively generally confronted worldwide and also prevalent in India by scientists ,aquaculturists , fish farmers, fish processing industries involved in trade and commerce locally and internationally , etc. The currently emerging virus diseases has invaded food fish and ornamental fish (modified transgenics and unmodified) in inland cultivation and capture marine ,brackish and fresh water fishery respectively and is of prior concerns for food security, conservation of economically significant invertebrate – vertebrate diversity for future, earning foreign exchange, socioeconomic condition of the pisciculturist in relation to this fastest growing fishery sector, loss of fish biodiversity, collapse of ecosystem food chain – webs that safeguard transfer of matter-energy and “Energy budget of the universe, natural resource sustenance by meticulous use, etc. Survival of future human generations rely on saving and preserving all plant and all animal useful as food; pharmaceuticals ; industries; for biomonitoring ‐ remediation of pollution; bio esthetic value., etc. Commercially unimportant biodiversity have their cryptic dynamic roles in regulating, maintenance, survival and interactions between ecosystems that need to be researched ( D. R. Saxena , 2008-2023).

Globally and in Asia mostly the health of food fish is threatened by 125 different piscine viruses and more are emerging on daily basis ( AGDAFF – NACA , 2007 , Ghosh D, 2005,Haenen et.al., 2006 ). Only few newly emerging viral pathogens infecting food fish has caused minimal loss to Indian fishery in south India during certain short periods ( AGDAFF ‐ NACA , 2007, Holmyard N, 2017 , Ignatius B, 2016). Moreover scanty and stray information of isolation of ornamental fish viral pathogens are available ( Holmyard N, 2017 and Ignatius B, 2016 ), such as Cyprinid herpes virus ‐ 2 ( CyHV – 2 ), Koi ranavirus ( KIRV) afflicting extreme mortality in ornamental Koi Cyprinus carpio , Carp edema , Cyprinus carpio virus ( CEV), Megalocytovirus and gold fish hematopoietic necrosis herpes virus leading to extreme mortality in ornamental Koi Cyprinus carpio ( Ghosh D, 2005 ) but not in common carp food fish ( Haenene et.al., 2006 and Rathore et.al., 2012), also Viral Nervous Necrosis Virus a + ssRNA, Nodaviridae in the food fish Lates calcifer ( Azad l.S, 2005, Glazebrook et.al., 1990 and Parameswaran et.al., 2008 ), Betanodavirus in sea bass( Haenen et.al., 2004 , Munday et.al., 1992 and Kiatpathomchai et.al., 2008 ) and Tilapia Lake viral disease TiLv an orthomyxo like virus of Oreochromis niloticus and other Orechromis sp. ( Holmyard N, 2017 and Surachetpong et.al., 2017). Tha author of this paper suggests that all above stated problems can be solved using “’Green Technology “ in our day to day life without compromising for other issues ( D. R. Saxena , personal observation 2008-2023). .

**Key Words:** Food fish, conservation, diseases, treatment, new viruses, green technology.

The Indian government has revamped the Central Plan Scheme under the “ Blue Revolution ( DAHF, 2017) (a) to elevate fish production from 107. 65 to 150.0 lakh tonnes respectively by 2020 (b) export earnings and (c) double the income of fish farmers etc.,( Algarswami, K 1995, Bonami et. al., 1995). A proposal named National Fisferies Action Plan ( 2020) that aims to raise by 8 % fish production every year in the following 5 years duration is already operative under the control of National Fisheries Development Board in association with the State governments and ICAR for the specific components ( Arthur and Subasinge, 2007). According to the department of Animal Husbandry Dairying and Fisheries, India’s contribution is 6.3% of the world fish production and 1.1 % GDP share and 5.15% share of agricultural GDP. Globally and in Asia associated with food fishes 125 different viruses are on virology record and currently more are being added daily. There are many previous fish diseases on record and many modern emerging diseases are global and prevalent in India that are declining the fish production. More viral diseases are evolving due to animal, humans and import items from elsewhere carried to a specific area or country. Tourists migrating and returning from any part of the world are potential “Human vectors” their contaminated articles, clothes and excreta washings reach the sewage systems eventually spreading the new various types in marine and aquatic ecosystem earlier not reported ( D. R. Saxena personal observations, 2008-2023 ) So, prevention is better than cure but is not possible. Disease diagnosis, prevention and control measures help to contain these problems.

**Types of fish diseases:**

**Bacterial Diseases**: Various symptoms are manifested on skin, scales, fins, eyes, margin of jaws, etc., such as colour changes, protruberancs, lesions, sloughing, etc., on external surface of cultured wild fishes, in farms and also in ornamental fishes. Internal infections afflict the various organ systems and impair their health status ( D. R. Saxena 2008 ‐ 2023). Noga (1995) reported in fish streaks or spots of red colour and swelling of eyes and abdomen.

**Red Pest:**

It is characterized as bloody streaks on tail or fins in addition to the body that ulcerate at an advanced stage and cause rotting and loss of fins or tails .

Treatment: As infection is internal the external treatments are useless. Hence, cessation of optimum feeding is suspended, frequent cleaning of tank with chemicals antibiotics is done; prepare and add in the tanks or farms trypaflavine (acriflavine) or monacrin (monoaminoacridine) 0.2 to 0.3 % solution at 1ml per liter that impart colour to water that vanishes later. It is cleverness to stop such treatment if desired results are not visible. In 25 gms flake food mix 250 mg of suitable antibiotics like tetracycline or chloromycetin, so that it is sufficient to feed the already starved15 fishes that consume it rapidly for curing the ailment.

**Mouth Fungus:**

It’s a misnomer term as it resembles white fungus that appear as grey whitish linings proliferating and transforming into groups of filaments near the mouth – lip areas. The etiological agent is Chondrococcus columnaris its toxin decline food intake in the distressed fish, weakness, lethargy and death results ; if left untreated cause tremendous losses to capture fisheries regionally and globally ( D. R. Saxena, 2008-2023 personal observations).

Treatment: First dose of 10000 units penicillin followed after 2 days at 10 to 20 mg per litter of chloromycetin eliminated the mouth fungus totally.

Treat fish 3 times at intervals of days to prevent death. Mercurochrome or providone is a strong chemical compound effective at dilute doses and used only if phenoxyethol treatment fails. To prevent infection of freshly laid eggs about 3 to 5 mg per liter of methylene blue solution is recommended to be used by fish farmers.

**Ichtyosporidium:**

This fungus is found at sites like kidney, liver and other viscera imparting hollowness to the belly. Extrinsic cysts that become sores, loss of equilibrium and sluggish movement’s are symptoms observable in sick fishes.

**Treatment:**

If early diagnosis is not done then 1% phenoxyethol or chloromycetin added to food of fish is treatment of choice. But such treatment may kill fishes and make it unfit for consumption.

**Parasitic Diseases:**

Argulosis or Fish lice. It is a crustacean mite 0.25 inch in diameter and 5mm long infecting skin and scales of fish causing irritation and itching due to its activities. Fishes rub their bodies against objects. Red inflamed areas and clamped fins lead to hyperactive response in the fish.

**Treatment:**

Parasitic lice can be removed manually with a forcep in case of larger fishes. In smaller fishes treatment involves 10 to 30 minutes bathin 10 mg per litre potassium permanganate solution. Disinfection with 2 mg per litre of the above solution stains the walls of the tank.

**Anchor worm Lernaea:**

Whitish green thread on fish skin is Lernaea a crustacean buried deep in the muscles that causes inflammation and irritation at the site where it is attached. Youngs need several months to become infective adults that die after laying eggs.

**Treatment:** Same as described for Argulosis.

**Ergasilus:**

It is smaller in size visible whitish green filament like hanging from fish gills may choke and damage it. Fish scrapes its body due to uneasiness.

**Treatment:**

10 mg per litre potassium permanganate solution bath for 10 to 30 minutes eradicate the parasites.

**Flukes:**

The fish rapidly moves and scrapes the body to get relief from inflammation and irritation produced by flukes that are flat worms 1 mm in length. The body skin produce profuse mucus, gills and fins degenerate. Gill flukes kill fish by impairing branchial respiration. Severely worm infected fish symptoms are hollow belly, malnourished, weak, drooping fins, and subnormal accelerated respiratory rate, etc.

**Treatment:**

Potassium permanganate solution 10 mg per liter for 10 to 30 minutes is helminthicidal.

**Aquarium diseases:**

Sterilized and disinfected to eliminate larval stages and adult worms.

**Nematode Disease:**

Threadworms may attach to all body parts but endoparasitic species protrude through the anus. Symptoms like hollow belly condition, emaciated, jerky movement, body imbalance, anemia, etc. has been reported by parasitologist, pisciculturists , etc.

**Treatment.**

Mix parachlorometaxylol with food or bathe fish in 10ml added solution of this compound to aquarium water. This is done for many days. Thiabendazole added ingestion of food by fish is beneficial and provide freedom from these nematodes.

**Leech Infestation:**

These sanguivore annelid parasites of various attach to fish integument and underlying flesh to suck blood and move deeper in the body. The fish become weak, anemic, sluggish, etc. before dying.

**Treatment.**

Trichlorof on at 0.25 mg per liter removes the leeches, removal using forceps cause extensive tissue injuries so, 2.5 % salt solution bath for 15 minutes kill the leeches.

**Miscellaneous Diseases:**

Head and lateral line or the hole in the head disease. Dorsal to eye in the head region of fish very small pits that enlarge progressively to reach the lateral line system can be diagnosed . Deficiency of minerals (calcium, phosphorus) and vitamins C and D, non availability of variety of food, and substandard or unfiltered water are responsible for this disease.

**Treatment**:

Regular addition of fresh water and draining the used water. Fortify frozen and processed foods with vitamins and minerals. Flake foods containing desired nutrition , fresh or frozen greens, and natural unprocessed growth promoting food in fish diet may overcome the sickness.

**Eye Diseases:**

Blindness is caused by intense light, poor eyesight, opaque lens, cloudy cornea, swellings, etc. Opaqueness is due to malnutrition. So change the food type. Metacercaria larva in the eye cause poor vision or blindness. Exophthalmic eyes result because of vitamin A deficiency, gas embolism, bacterial infections, abnormal handling of fish, tumors, etc. Amoxicillin and penicillin is used for treatment of bacterial infections.

**Swim Bladder Disease:**

If swimming behavior is abnormal, loss of equilibrium persists, etc., then one can suspect swim bladder disease, diagnostic radiography ( X ‐ rays ) method is proposed to detect swim bladder disorders or diseases ( D.R. Saxena, 2008- 2023 ). Several diseases may accompany the swim bladder performance/ function. Treatment of following maladies like tuberculosis, parasitic and bacterial infections, constipation , poor nutrition, cancer and malformed bladder from the time of birth (congenital defect ), etc., is to be attended first. Later swim bladder problem can be overcome.

**Non Infectious Diseases:**

**Tumors.**

Many causes can be enlisted under genetic and nongenetic categories. Viruses, excessive hybridization, pollution, etc., produced tumors.

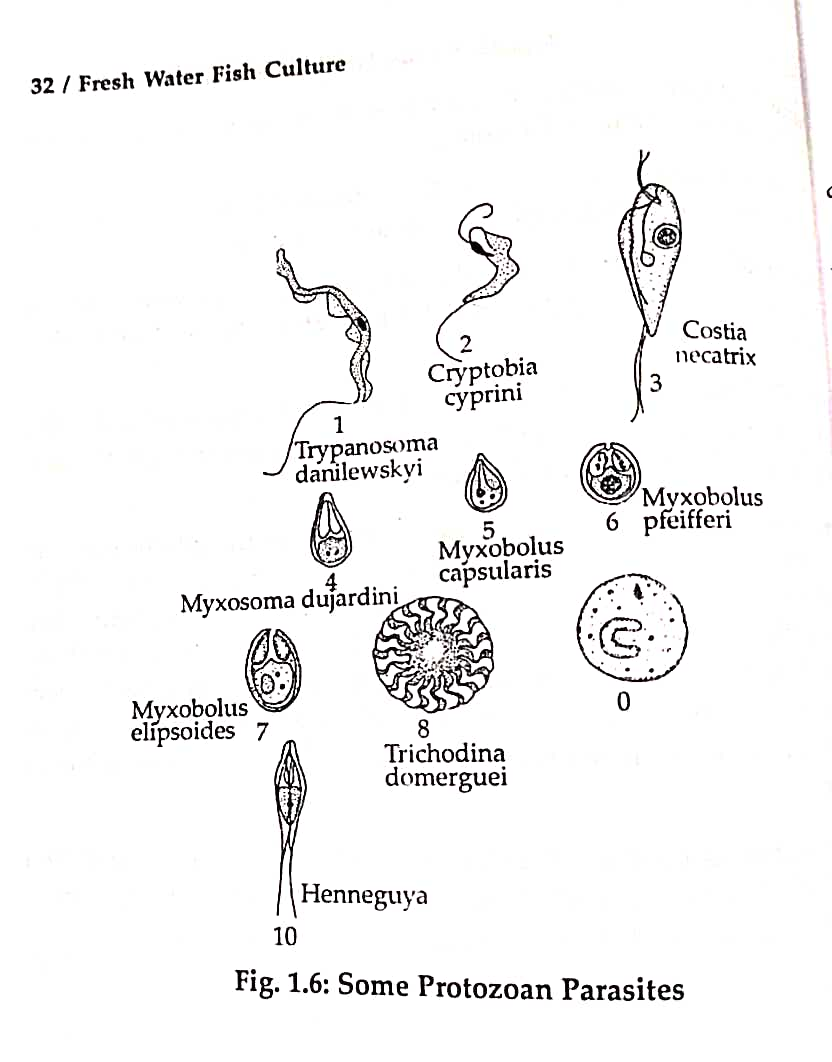
**Physical injuries:**

The injury is treated with 2 % mercurochrome. Keep fish in acid (6.6 pH ) water free from pollutants based on tolerance ability of the fish.

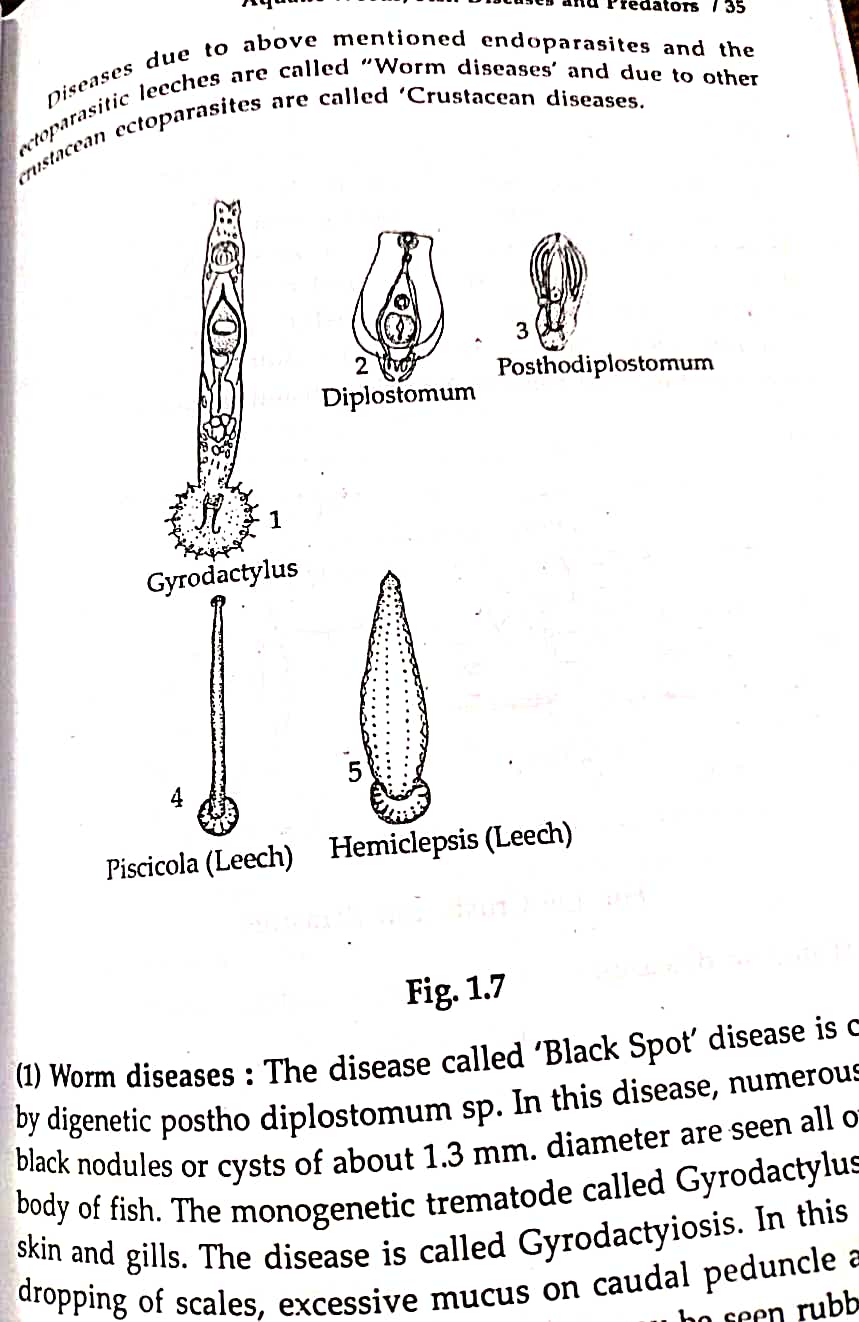
**Constipation:**

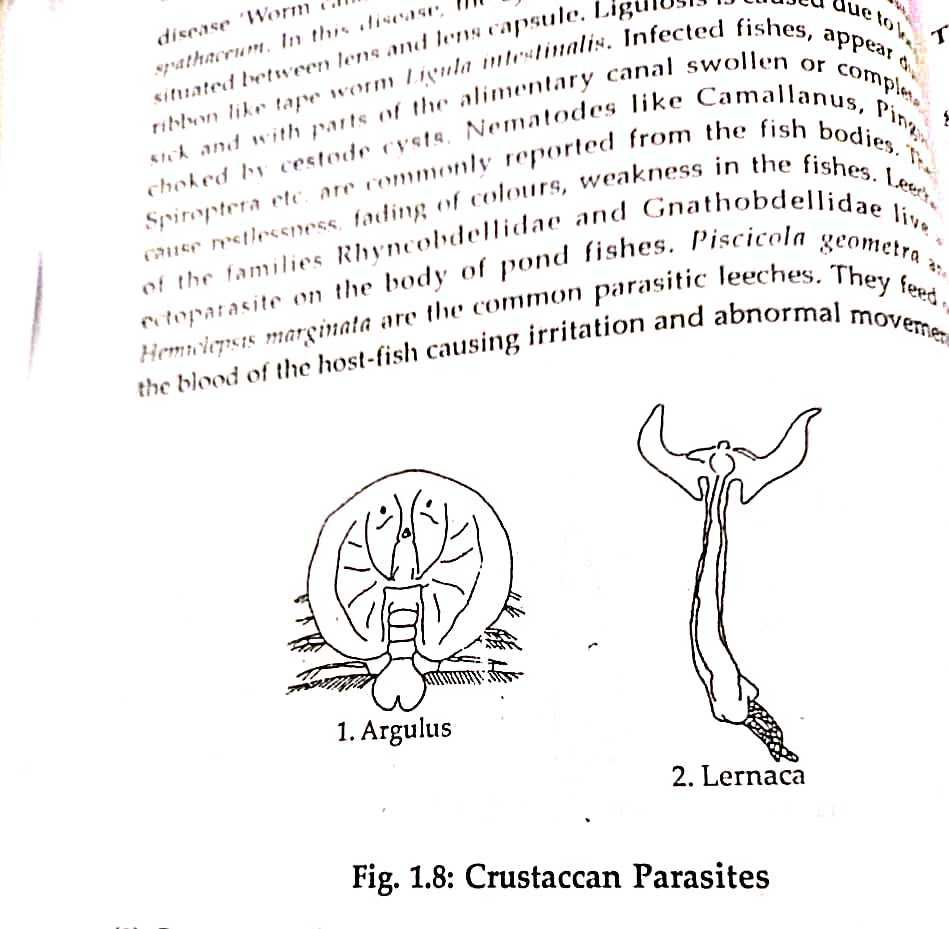
Those fish species possessing laterally compressed bodies suffer more constipation. Other fishes may also suffer from this ailment. Internal architectural defects, defects in neuromuscular control, gut motility, impaired digestive functions, malfunctioning hepatopancreas (liver and pancreas), improper diet, same food type, non fibre diet, etc., all these factors are mentioned as potential “ Causes of Constipation” by D.R. Saxena ( personal observations, 2008- 2023 ).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Table 1- Fish disease and their control** | | | | |
| **Sr. No.** | **Disease** | **Causes** | **Symptoms, Behavioural signs** | **Control measures** |
| 1. | Water-mold disease  (saprolegniasis) | Fungal infection generally due to injuries  (Saprolegnia) | White filaments on the body, head and fin, ulceration, weakness, blindness | Dip treatment in (a) 30% common salt solution for 5-10 min (b) 1:20,000 copper sulphate solution (c) 1:10,000 malchite green for 3 seconds |
| 2. | Gill Rot | Fungal infection  (Branchiomyces san-  guinis) | Weakness, gill fila-  ments become greenish white and finally  drop off. | Thinning the stock, introduction of fresh cool water, avoid artificial food, cleaning of pond, dip treatment as above. |
| 3. | Tail and fin rot | Bacterial (Aeromonasae)  unsatisfactory sanitary condition | White line starting  from the margin of the fin later spreading to-  ward base, finray become brittle and start breaking | Batch treatment inl: 20,000 copper sulphate for 15 min-or for 1 minute in 1:30,000 copper sulphate solution |
| 4. | Ulcer  disease | Bacterial infection  (Hemophilus) | Ulcer in the body which slowly increases in size | Dip treatment in 1:2,000  copper sulphate solution  for one minute for 3 to 4  days. Oral feeding of ox-  ytetracycline and chloram- phenicol. |
| 5. | Abdominal dropsy | Bacterial (Aeromanasae) | Scale potrusion inflation of belly anemia exophalmic condition | Deep treatment in dilute KMnO4 oral chloro mycetin disinfection of pond by KMNO4 |
| 6. | Eye disease | Bacterial (Aeromanasae) | Cornea becomes opaque, eye ball gest putrified | Batt treatment of fish in 8-10 mg/l chloromycetin for 1 hour 2 to 3 hours in the initial stages of disease. |
| 7. | White spot disease (Ichthyophthiriasis) | Protozoan infection (Ichthyophthiriasis) | White spot on the body, fish becomes sluggish and lies at the bottom of pond. | Disinfect the pond with one PPM KMnO4 , bath treatment hourly in 1: 5000 formalin, 7-10 minutes or in 2% salt solution for more than 7 days |
| 8. | Trichodiniasis | Protozoan (Trichodina saprolegnia) | Fish rubs the body on the margins of the pond body gets covered with bluish coating of slime | Dip treatment in 2 to 3% sodium chloride for 5 to 10 minutes or 1:1000 acetic acid or 1:5000 formalin |
| 9. | Knot disease | Protozoan parasite infection (Myxobolus exigus) | Small knots in the skin of common carp | all infected fishes should be destroyed or burn |
| 10. | Pox disease | Sporozoan infection (Myxobolus macrocapsularis) | small milky white spots raised 1 to 2 mm, above the surface of skin | Intraperitoneal injection with one ml of 1% solution of arsenic compound |
| 11. | Boil disease | Protozoan infection (Myxobolus pfeifferi) | Large boils varying from the size of a nut to that of a hens egg on several parts of the body | Bath in 3% common salt solution or 1:2500 formalin solution 10 minutes |
| 12. | Whirling disease | Protozoan infection (Myxosoma cerebralis) | Caudal bend, deformity of the anal region and blackening of tail region | Destroy all infected fishes by applying quicklime at the rate of 2000 kg/hectare |
| 13. | Mexosporidiasis | Mexosporida infection | cysts on the body internal tissues and organs fish becomes week and scales become perforated and fall off. | deep treatment in 10% common salt solution |
| 14. | Costiasis | Protozoan parasite infection (Costia necatrix) | fishes come to surface or accumulate at the inlet, body becomes bluish grey | bath treatment in 1:2500 formalin or 1:5000 glacial acetic acid or 3% common salt solution for 10 minute. |
| 15. | Black spots | Worm infection (Posthdiplostomum) | Small black cyst all over the body | Isolation and deep treatment in 3000 picric acids for an hour |
| 16. | Worm disease | Worm infection (Glyrodactylus) | fading of colour, dropping of scales mucus on Gill and caudal peduncle fish rub the body against substratum | Dip treatment for 5 minutes in 5 to 10% common salt solution in 1:5000 formalin or acetic acid or KMnO4. |
| 17. | Argulosis | Fish louse infection (Argulus) | Transparent round parasite on the parts affected, weakness, fish runs in irregular manner | Dip treatment in 5% KMnO4 solution for 3 to 5 minutes |
| 18. | Anchor worm | Worm infection (Learnaea) | Fish becomes restless and rubs the body against stones resulting in injury | Removal of parasite by hand or forceps. Dip treatment in dilute KMNO4 for solution |
| 19. | Fish Leeches | Parasite sucking blood (Hemiclepsis piscicola) | Presence of parasite on the body | Dip treatment in 2% common salt solution apply mercuro Chrome on the wounds. |
| 20. | Asphyxia | Oxygen depletion | fishes come at surface for air | Provide aeration control algal bloom by application of 2 to 4 PPM of KMnO4 reduce the stock |
| 21. | Gas bubble | Accumulation of gas bubbles under the skin usually in the eye region | blood oozes out through the skin | add fresh water remove macrovegitation and algal blooms |
| 22. | Mal nutrition | lack of protein and vitamins | Retarded growth poor reproduction sluggishness gills becomes pale | Provide balance diet and live food |



**Fig. 1- Protozoan Parasites**



 **Fig. 2- Helminthes Parasites**

**Fig. 3- Crustacean Parasites**

**References:**

AGDAFF-NACA (2007) Aquatic animal diseases significant to Asia-Pacific: Identification field guide. Australian Government, Department of Agriculture, Fisheries and Forestry, Canberra, Australia.

Āhameda K, SAARC Agricultural Information Centre (2005) Handbook on Fish and crustacean diseases in the SAARC region. (1stedn), SAARC Agricultural Information Centre, Bangladesh.

Algarswami K (1995) Status report on shrimp disease outbreak in coastal aquaculture farms on the east coast of India during 19941995, for the Technical Committee, Government of India, Ministry of Agriculture, New Delhi, India.

Aqua Aquaria India (2017) Aquaculture Production in India. Aqua Aquaria India, Kerala, India.

Arthur JR, Subasinghe RP (2002) Potential adverse socio-economic and biological impacts of aquatic animal pathogens due to hatchery-based enhancement of inland open water systems, and possibilities for their minimization. In: Arthur JR, Phillips MJ, Subasinghe RP, Reantaso MB, MacRae IH (eds.). Primary Aquatic Animal Health Care in Rural, Small-Scale, Aquaculture Development, FAO Fish Tech. Pg no: 113-126.

Ayyappan S, Biradar RS (2004) Enhancing global competition. The Hindu Survey of Indian Agriculture. Pg no: 97-100.

Azad IS, Shekhar MS, Thirunavukkarasu AR, Poornima M, Kailasam M, et al. (2005) Nodavirus infection causes mortalities in hatchery produced larvae of Lates calcarifer: first report from India. Dis Aquat Organ 63: 113-118.

Bonami JR, Mari J, Poulos BT, Lightner DV (1995) Characterization of hepatopancreatic parvo-like virus, a second unusual parvovirus pathogenic to penaeid shrimps. J Gen Virol 76: 813-817.

Bondad-Reantaso MG, Subasinghe RP, Arthur JR, Ogawa K, Chinabut S, et al. (2005) Disease and health management in Asian aquaculture. Vet Parasitol 132: 249-272.

Brock JA, Gose R, Lightner DV, Hasson K (1995) An overview on Taura syndrome, an important disease of farmed Penaeus vannamei. In: Browdy CL, Hopkins JS (eds.). Swimming through troubled water: Proceedings of the special session on shrimp farming, Aquaculture ’95. World Aquaculture Society, Baton Rouge, LA, USA. Pg no: 84-94.

FAO (2010) The state of world fisheries and aquaculture 2010. Food and Agriculture Organization of the United Nations, Rome, Italy. Pg no: 197. 43. FAO (2014) The state of world fisheries and aquaculture 2014. Food and Agriculture Organization of the United Nations. Rome, Italy. Pg no: 215.

Food and Agriculture Organization of the United Nations (2017) Outbreaks of Tilapia lake virus (TiLV) threaten the livelihoods and food security of millions of people dependent on tilapia farming. In: Global Information and Early Warning System on Food and Agriculture (GIEWS), Special Alert No. 338, Food and Agriculture Organization of the United Nations, Rome, Italy. Pg no: 1-6.

Ghosh D (2005) Ecology and Traditional Wetland Practice: Lessons from Wastewater Utilisation in the East Calcutta Wetlands. Worldview, Kolkata. Pages: 120. 52. Glazebrook JS, Heasman MP, de Beer SW (1990) Picorna-like viral particles associated with mass mortalities in larval barramundi, Lates calcarifer Bloch. J Fish Dis 13: 245-249.

Haenen O, Hedrick R (2006) Koi herpesvirus workshop. Bull Eur Ass Fish Pathol 26: 26-37. 54. Haenen OLM, Way K, Bergmann SM, Ariel E (2004) The emergence of koi herpesvirus and its significance to European aquaculture. Bull Eur Ass Fish Pathol 24: 293-307.

Holmyard N (2017) Tilapia virus, spreading rapidly, poses threat to global food security. SeafoodSource, USA.

Ignatius B (2016) Cage Aquaculture. Training Manual on Theeranaipunya - Equipping Fisherwomen Youth for Future. Ch. 31, ICAR-Central Marine Fisheries Research Institute, Kochi, India. Pg no: 175-178.

Jhingram V.G. 2007: Fish and fisheries of India.

Lagler et. al.,. Ichthyology

Lightner DV (1996) A Handbook of Pathology and Diagnostic Procedures for Diseases of Penaeid Shrimps. World Aquaculture Society, Baton Rouge, LA, USA.

Lightner DV, Redman RM, Bell TA (1983) Infectious hypodermal and hematopoietic necrosis, a newly recognized virus disease of penaeid shrimp. J Invertebr Pathol 42: 62-70.

Mark, D.L. (1983), Fish Diseases. T.F.H. Publication Inc. New Jersey.

MPEDA (2016) State-wise aqua culture productivity: Area utilized and production of Tiger Shrimp during 2015-16, The Marine Products Export Development Authority, Ministry of Commerce & Industry, Government of India, Kochi, Kerala.

Munday BL, Langdon JS, Hyatt AD, Humphrey JD (1992) Mass mortality associated with a viral-induced vacuolating encephalopathy and retinopathy of larval and juvenile barramundi, Lates calcarifer Bloch. Aquaculture 103: 197-211.

NACA (Network of Aquaculture Centres in Asia-Pacific) (2017) Tilapia Lake Virus (TiLV) - an Emerging Threat to Farmed Tilapia in the Asia-Pacific Region. Disease Advisory. Asia Regional Aquatic Animal Health Programme, Network of Aquaculture Centres in Asia-Pacific, Bangkok, Thailand.

NFDB (National Fisheries Development Board) (2016) Guidelines for Cage culture in Inland open water Bodies of India, National Fisheries Development Board, Department of Animal Husbandry, Dairying & Fisheries, Ministry of Agriculture and Farmers Welfare, Government of India, New Delhi. Pg no: 14.

NFDB (National Fisheries Development Board) (2017) About Indian Fisheries, National Fisheries Development Board, Department of Animal Husbandry, Dairying & Fisheries, Ministry of Agriculture and Farmers Welfare, Government of India, Downloaded on 17 Oct. 2017 .

Noga J.E. (1995), Diagnosis and Treatment. Blackwell Publishing pages 1-339. Unterasser Dieter (1999), Hand Book of Fish Diseases. La Broke's Cardon Path and pond LLC. 8 Pitt Street Brushton pages 160.

Parameswaran V, Rajesh Kumar S, Ishaq Ahmed VP, Sahul Hameed AS (2008) A fish nodavirus associated with mass mortality in hatchery-reared Asian Sea bass, Lates calcarifer. Aquaculture 275: 366-369.

Rathore G, Kumar G, Swaminathan TR, Swain P (2012) Koi Herpes Virus: A Review and Risk Assessment of Indian Aquaculture. Indian J Virol 23: 124-133.

Shrivastava, C.B. L.- A Textbook of fishery science and Indian fisheries.

Subasinghe RP et., al (2008): The FAO/NACA Asia regional technical guidelines for the responsible movement of live aquatic animals; lesons learned from their development and implementation. Rev Sci Tech 27: 54-63.

Surachetpong W, Janetanakit T, Nonthabenjawan N, Tattiyapong P, Sirikanchana K, et al. (2017) Outbreaks of Tilapia Lake Virus Infection, Thailand, 2015-2016. Emerg Infect Dis 6: 1031-1033. Katiha PK, Jena JK, Pillai NGK, Chakraborty C, Dey MM (2005) Inland Aquaculture in India: Past Trend, Present Status and Future Prospects. Aquaculture Economics & Management 9: 237-264.