Biology of Major freshwater cultivable Carps.

Catla:- Rapid growing indigenous carp in India. Body deep stout broad snout, Conspicuous head, large upturned mouth back greeyish colour, silvery on sides. It grows over 1.5 mts length. The fish attains sexual maturity in the 2nd year and are ready to breed.

Rohu: Rohu is considered the tasty among the Indian carps, distinguished by its small or pointed head almost terminal mouth with fringened cover lip. Body elongated with moderately convex abdomen. Back brownish grey. Dull reddish scales on the sides and pink reddish fins. Sexual maturity attains towards the end of 2nd year. Rohu grows 91 cm in length.

Mrigal:- Mrigal is next importance to catla and Rohu for culture. Linear body, Small head with blunt snout. Body silvery dark grey along back fins orange tinged with black. Length over 66 cm. Mrigal grows slower than Catla and Rohu.

Nursery Pond: It is used to rear hatchlings into fry for a period of one month till they attains the size of 2 - 2.5 cm. It is a small pond The size should be 4 x 1.25 x 0.5. The depth of the water column should be 1 - 1.5 m.

Rearing pond: It is used to rear fry into fingerlings for a period of 2 months untill the

Culture of Carps
(Indian Major carps).

Indian major carps are called as fin fishes. The rearing of major carps is called fin fish culture. They are indigenous fishes native to India. The Indian major carps include 3 species namely

1. Catla – *Catla catla* (Surface feeder)
2. Rohu – *Labeo rohita* (Column feeder)
3. Mrigal – *Cirrhinus mrigala* (Bottom feeder).

Catla is a surface feeder, feeding on Zooplankton
Rohu is a column feeder feeding on filamentous algae.
Mrigal is a bottom feeder feeding on detrities

The Indian major carps are cultured by monoculture or polyculture or integrated fish culture.

The maximum growth rate per year is Catla – 2kg, Rohu – 1kg Mrigal – 0.8 Kg. The culture of Indian major carps involves the following steps:

1. Seed collection
2. Culture practices
3. Feeding
4. Pond fertilization
5. Weed control
6. Predator control
7. Disease control
8. Harvesting
9. Marketing
10. Preservation.

1. Seed collection

Hatchlings, fry and fingerlings are fish seeds. Fish seeds are collected from natural habitat or bundhs or by hypophysation. The seeds are transported in tins or polythene bags to nursery ponds.

2. Culture practices

Various culture practices are employed for culturing Indian major carps which include Pond culture, reservoir culture, riverine culture, Monoculture, Polyculture, Sewage fed fish culture, Integrated fish culture, Pokkali culture and Pen culture. The stocking density of catla, Rohu and Mrigal is 3:6:1. In polyculture five species combination and six species combination are also followed.

3. Feeding.

The Indian major carps must be fed by artificial feed. The artificial feed should contain the following ingredients

Bran - 40 kg, Groundnut oil cake 40 kg, Soya bean meal 15 kg Fish meal 4.7 kg Mineral mixture 0.3 kg. The fish are fed two or three times in a day. The feed are kept in trays in shallow waters.

4. Pond fertilization

The fertilizers may be organic or inorganic. The organic fertilizer includes cow dung, pig dung, poultry manure, green manure, compost etc. The inorganic fertilizers include urea, ammonium phosphate and superphosphate. Fertilizers are applied 15 days after liming fry attain the size of 4–10 cm. The size of the rearing pond should be 25×12×1 m. The depth of the water column should be 1·5 – 2 m.

Stocking ponds: Here the fingerlings are reared upto the marketable size till they attain the size of about 1 kg. It is also called as production pond, which is a perennial pond. The village ponds irrigation ponds and temple ponds can be used as culture pond it can be of any size. The culture pond should have well drainage system. The inlets and outlets of the culture ponds should have screen gates to prevent the entry of predators optimal temperature for carp culture is 20 – 25°c. The optimal oxygen content is 5 mg/l.

Culture of *Macrobrachium rosenbergii*

The rearing of freshwater prawn is called freshwater prawn culture. It is a shellfish culture. *Macrobrachium rosenbergii* is the most common freshwater prawn. It is the giant river prawn.

The culture of freshwater prawn involves the following steps. 1. Seed collection 2. culture practices 3 Feeding 4. Fertilization 5. Production 6. Harvesting 7. Marketing.

1. Seed collection

The larvae postlarvae and the juveniles are the seed prawns. The seed prawns are obtained by two methods.

1. collection from wild 2. collection from the brood females.

1. Collection of seeds from the wild.

The prawn seeds can be collected from the estuaries and brackishwater with the help of fine meshed cloth bag with 2m long and 1m dm.

2. Collection of seeds from Brood females:

The brood females carrying eggs are collected from the estuaries and brackish water. A prawn may have 10,000 to 30000 eggs. The eggs hatchout in 4 to 5 days. The ~~po~~ larvae are fed with the nauplii of Artemia fish eggs. The 10 days old larvae swim upside down. After 25 - 28 days of hatching, the larvae swim normally and they are called post larvae. The post larvae are transferred to another concrete tank called holding tank. The holding tank is filled with freshwater. They are fed with nauplii

They are reared in the holding tank for one month. Afterwards they are transported to production ponds in tins or polythene bags.

2: culture Practices.

Freshwater prawns are cultured by following methods 1. Pond culture 2. Polyculture 3. Intensive culture 4. Batch culture 5. Continuous culture 6 Sewage fed prawn culture 7. Integrated prawn culture 8. Pokkali culture.

3. Feeding.

Freshwater prawn is an omnivore. It feeds on living organisms, Vegetable matters, dead organic matter, debris etc., Artificial feed is given in the form of trash fish, molluscs tapioca pig dung broken rice, fruits animal farm wastes, prawn wastes etc. The artificial feed is given once in 3 days at the rate of 5–10% of body weight

4. Fertilization

The stocking pond is fertilized by organic manure and inorganic fertilizers

Cow dung : 200kg/ha
Superphosphate : 25kg/ha.

5. Production

<u>M. rosenbergii</u> grows to a maximum length of 32 cm and weight of 200g.

6. Harvesting

Harvesting is done by pulling a seine net. Care should be taken to ~~avoid~~ be sure that the seine net reaches the bottom of the pond, because large may avoid net by burrowing into the circular breeding depressions they build.

7. Marketing

Freshwater prawn can be harvested when there is high demand They can be sold alive. They can be processed and stored.

Questions

1. Name the Indian major carps.
2. Integrated farming. define
3. Composite fish culture
4. Monoculture
5. Nursery pond.
6. Describe the culture pond
7. Explain the biology of Catla
8. Explain the culture of Indian major carps.
9. Explain the culture of M. rosenbergii.
10. Explain the types of pond.

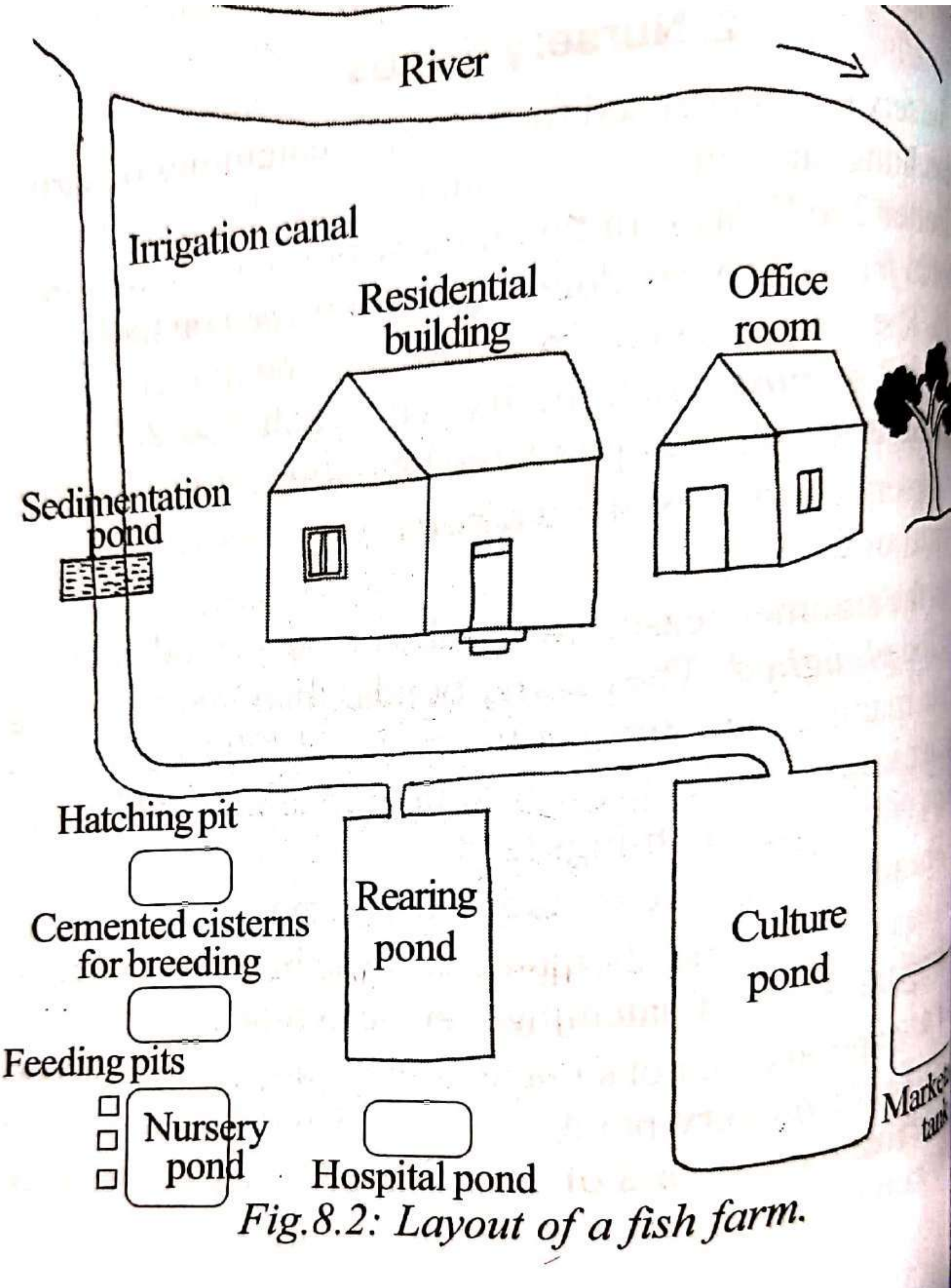


Fig.8.2: Layout of a fish farm.

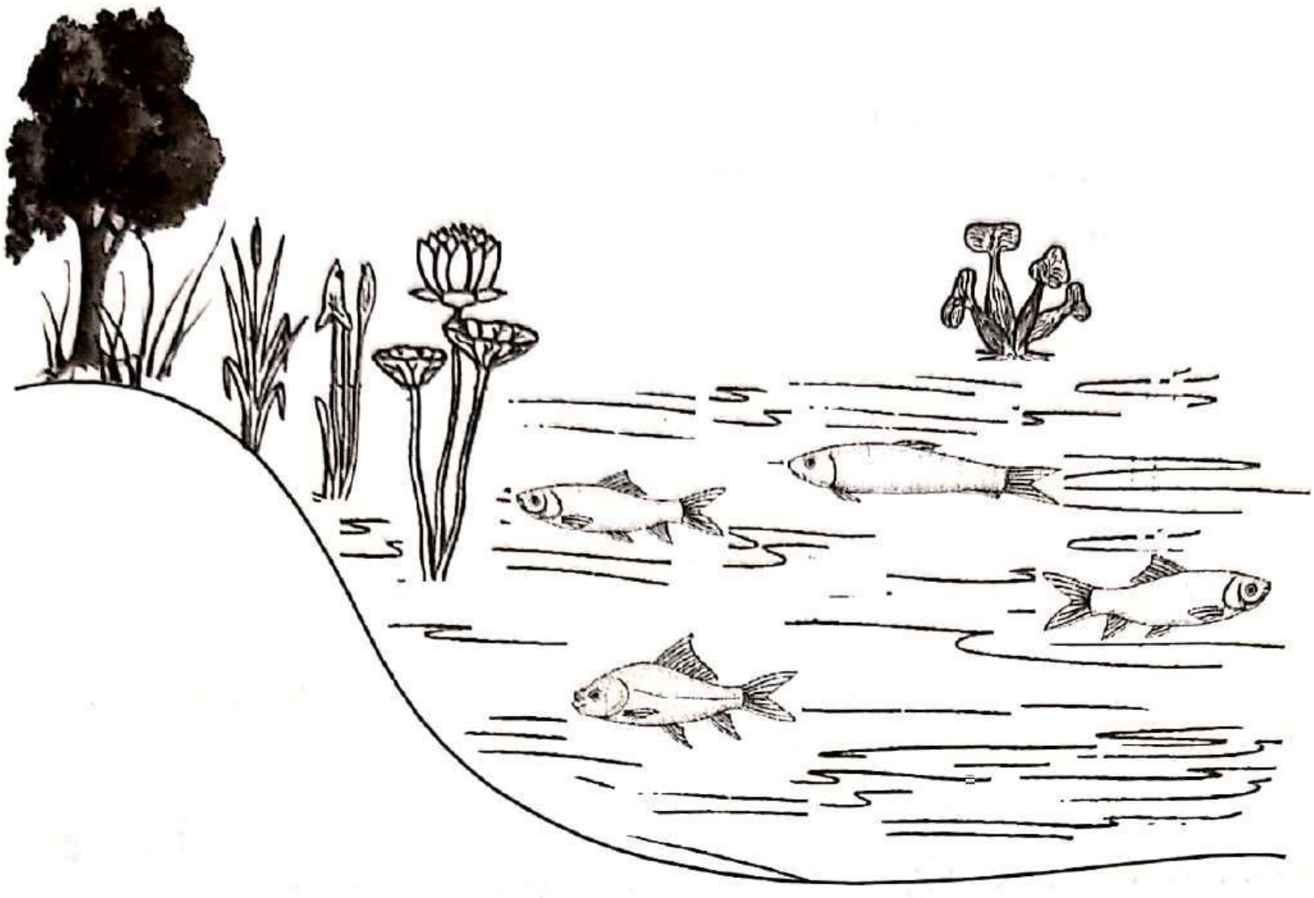


Fig.8.3: A culture pond.

Monoculture Polyculture

bags to nursery ponds.

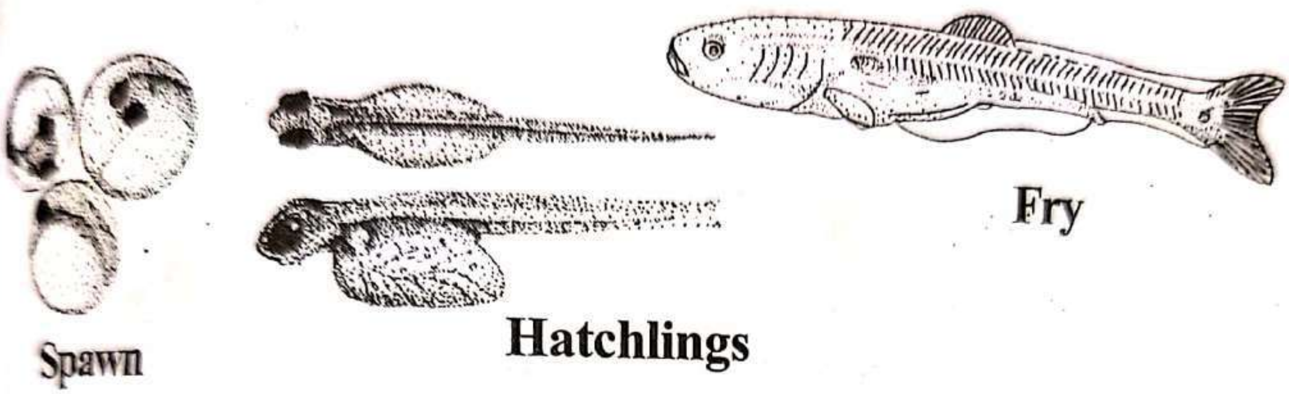


Fig.14.1: Fish seeds.

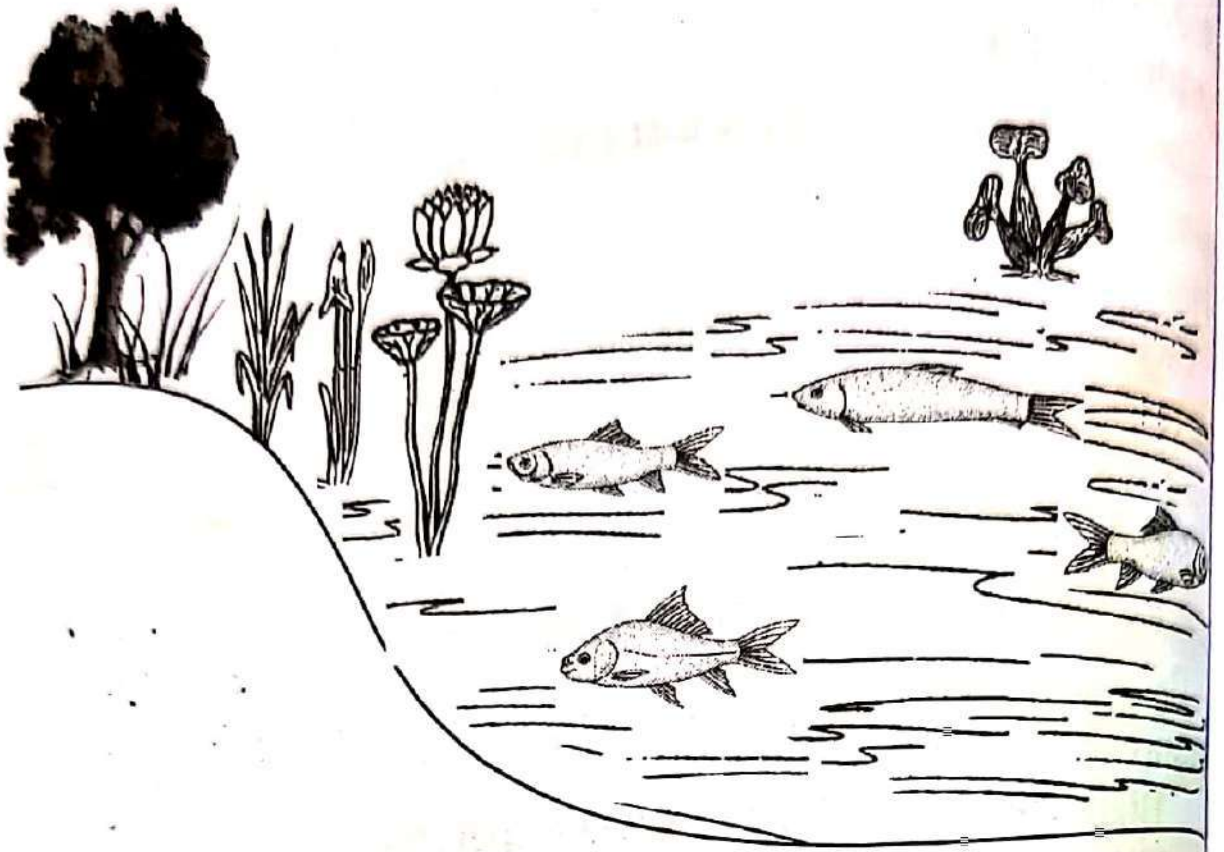


Fig.14.2: Pond culture.

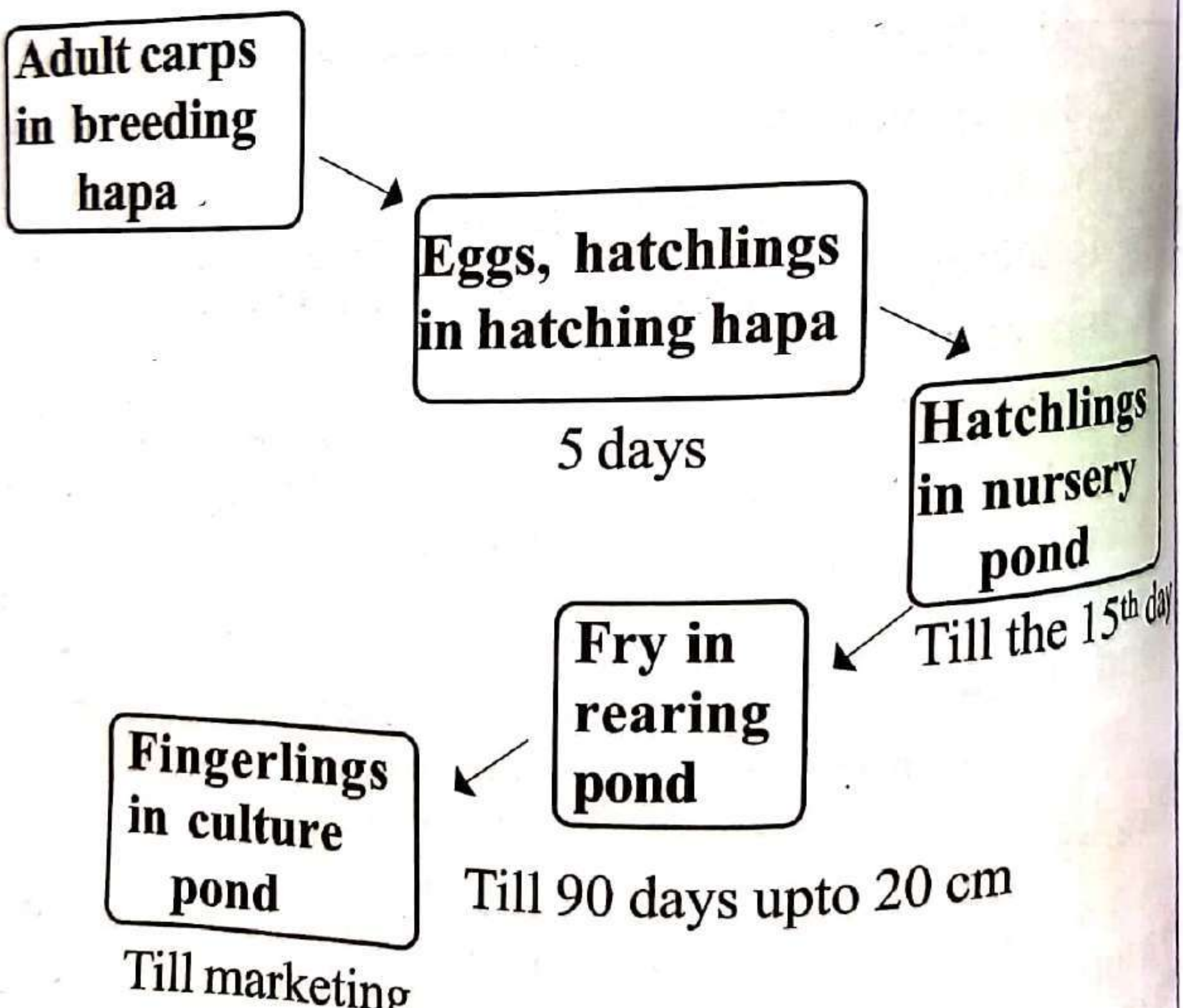


Fig.14.3: St... ...arps.

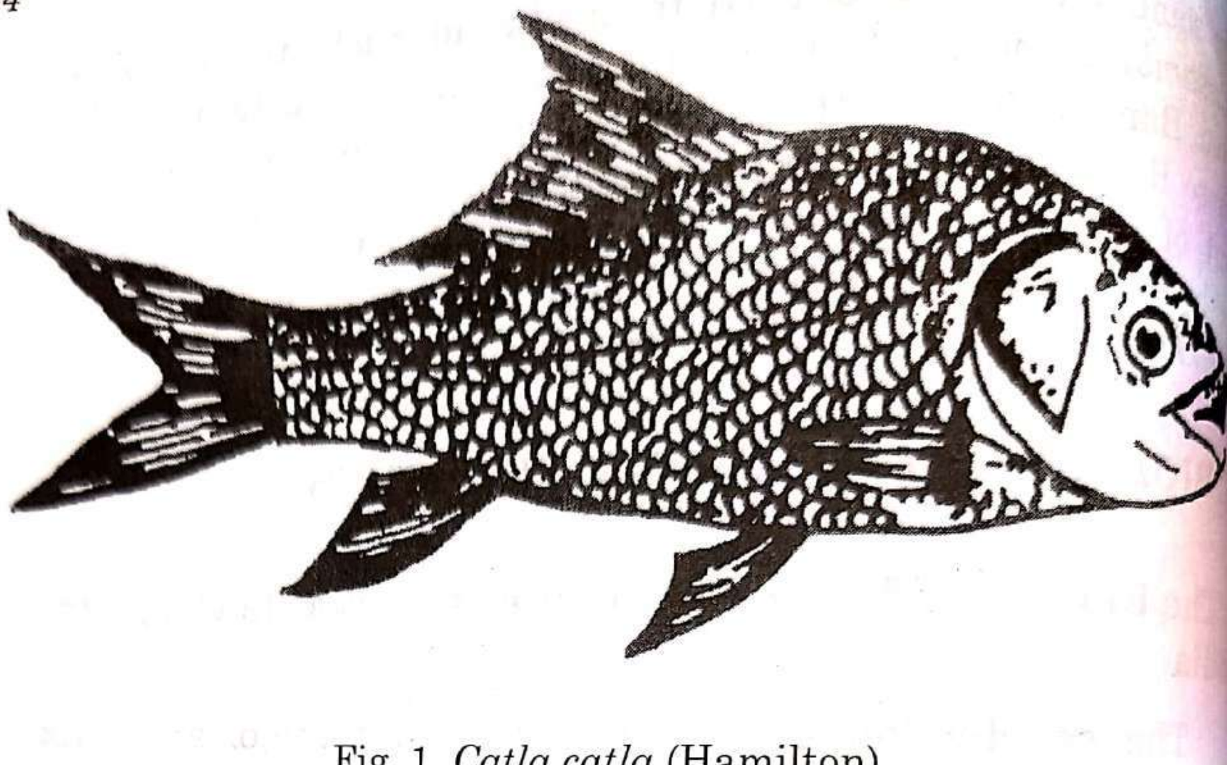


Fig. 1. *Catla catla* (Hamilton)

second year. Rohu gr

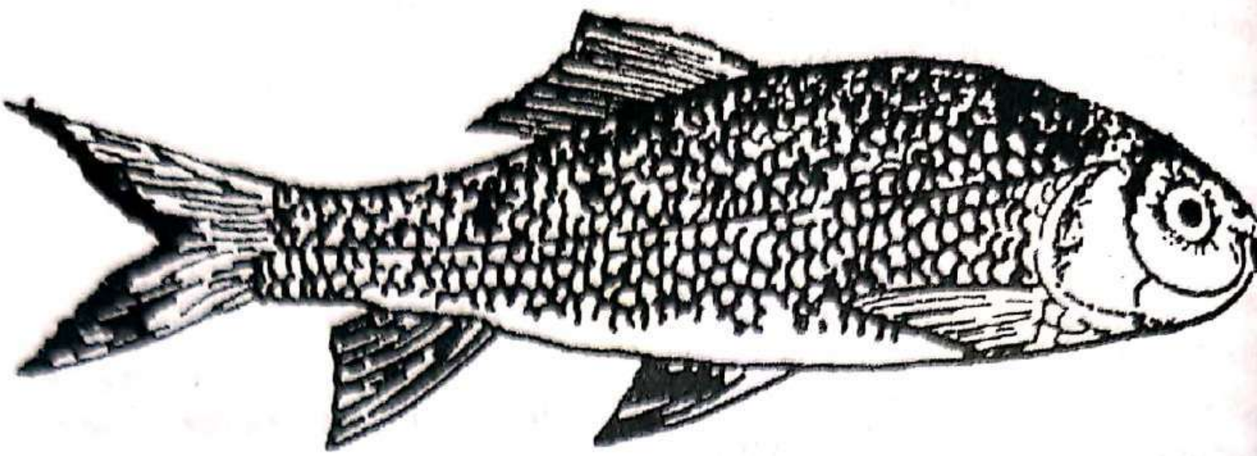


Fig. 2. *Labeo rohita* (Hamilton)

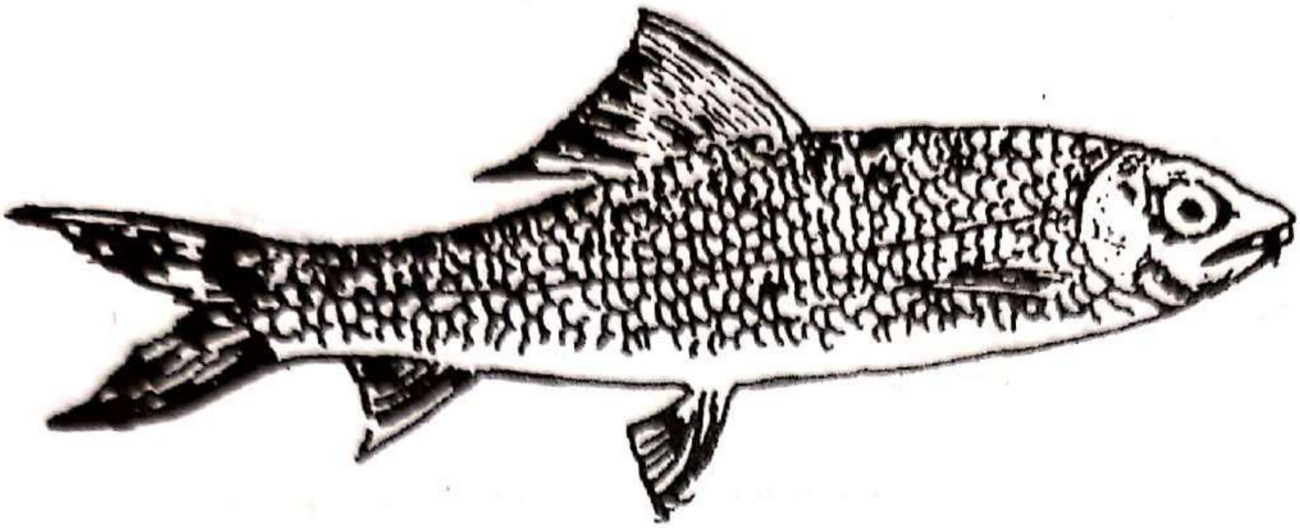


Fig. 3. *Cirrhina mrigala* (Hamilton)

(Fig. 4). Silver carp belongs to Osteichthyes.

3)

5. Weed control.

The weeds can be controlled by the following methods (1) Manual removal 2) Netting 3) Application of herbicides

6. Predator control

The fish eaters of ponds are the predators. The predators are controlled by netting and spraying of Vegetable oil. More than 50% of insect present in the pond are removed by chemical or biological method.

7. Disease control

Fish may be given a salt bath in 100 l of water having 1.5 kg of salt for 1 to 2 hours before stocking. When there is disease outbreak the fish are treated with potassium permanganate solution. Bacterial diseases are treated with chloram phenicol. Fungal diseases are treated with bath treatment in common salt, Potassium permanganate, copper sulphate.

8. Harvesting

Before harvesting, the pond is alloted to drain. Harvesting is done in the morning or evening. The harvesting is done by cast nets, gill nets etc.,

9. Marketing

Before Marketing, the fish are kept in the marketable pond. Marketing is done in alive condition or preserved condition.

10. Preservation

The Indian major carps are preserved in ice or Salt drying.

Crustacean (Argulosis) and Bacterial (Dropsy) Diseases of Fishes

Argulosis

Argulus or **Fish** Lice is a common copepode parasite in **fishes**. It is a large ectoparasite and can move over the body surface of the **fish**. ... The feeding site becomes a wound and haemorrhagic, providing ready access to secondary **infection** of other parasites, bacteria, virus and fungi.

A typical fish louse of the genus *Argulus* is very flat with an oval or rounded carapace, two compound eyes, sucking mouthparts with a piercing stylet, and two suction cups it uses to attach to its host.[4] These "suctorial organs" are the first of its two pairs of maxillae, modified in shape.[5] Its paired appendages have hooks and spines,[4] and are used for swimming.[5] *A. foliaceus* in particular is up to 7 millimeters long by 5 millimeters wide.[5] The female is larger than the male and has a visible pair of spermathecae on its posterior end, in which the male deposits sperm.[4]

The common fish louse lives in marine, brackish, and freshwater environments.[5] All life stages of both sexes are parasitic.[4] It attaches to its host, usually a fish, via its suction cups, pierces the skin with its sharp stylet, and feeds on blood.[5] It may live in the gills.[6] A heavy infestation causes inflammation of the skin, open hemorrhaging wounds, increased production of mucus, loss of scales, and corrosion of the fins. The wounds are often infected with bacteria and fungi, which further degrade the skin layers.[5] The fish can become anemic. During feeding, the louse also injects digestive enzymes into the flesh. Infested fish may exhibit loss of appetite and slowed growth, and behavioral signs such as erratic swimming and rubbing up against aquarium walls.[6] The damage and infection cause stress and mortality.[7]

The common fish louse is also a vector for pathogens, introducing organisms such as bacteria, flagellates, and the virus that causes spring viraemia of carp. It is an intermediate host to nematodes of the family Skrjabillanidae.[8]

To locate its host, the fish louse uses vision, olfaction, and mechanical sensation. During light hours it searches visually for a host, usually remaining still in ambush. When it is dark the louse is more active, swimming about to encounter a host. It senses the smell of the fish and the movement of the water around it. It also becomes more active in searching when it has not fed in over 24 hours.[9]

During the reproductive cycle, the male and female fish louse copulate upon the body of the host, and the female detaches every few days to swim to the substrate and lay eggs. It favors hard strata, and its eggs can be collected by providing it with a wooden board to lay them on. It lays more clutches during daylight hours than at night.[7]

The larva of the fish louse has two main stages. In its newly hatched stage it has been termed a "metanauplius", like the nauplius of many other crustaceans, but with a swimming apparatus that is more developed. It may even be too well developed for the larva to be called a nauplius at all.[10] The newly hatched larva can parasitize a host, attaching to it with its hooked antennae because it lacks suction cups. A second function of its hook-lined antennae is an apparent grooming behavior, in which it drags the antennae across the setae of its swimming legs to dislodge debris. In the second main stage, after its first molt, it is simply called a "juvenile", because it is very similar to the adult, only smaller. It can swim just as efficiently as the adult.[10] The larva molts eleven times before reaching adulthood.[4]

This parasite "has been recorded from practically every freshwater fish species within its natural range".[11] Food and sport fish and other commercially important species parasitized include carp and minnows such as goldfish and koi, members of the sunfish family, and salmonids such as salmon and trout.[4] Hosts include blue bream (*Ballerus ballerus*), silver bream (*Blicca bjoerkna*), European eel (*Anguilla anguilla*), northern pike (*Esox lucius*), three-spined stickleback (*Gasterosteus aculeatus*), pumpkinseed (*Lepomis gibbosus*), ide (*Leuciscus idus*), abu mullet (*Liza abu*), European perch (*Perca fluviatilis*), common roach (*Rutilus rutilus*), common rudd (*Scardinius erythropthalmus*), wels catfish (*Silurus glanis*), zander (*Sander lucioperca*), tench (*Tinca tinca*), and Atlantic horse mackerel (*Trachurus trachurus*).[12]

While it is a generalist parasite not specific to a host taxon, it does display preferences, apparently preferring larger and heavier fish over smaller,[13] and certain species over others when given a choice.[14]

It has also been observed on frogs and toads.[4]

Heavy infestations in fish stocks can lead to large-scale losses. Major outbreaks in rainbow trout fisheries in the United Kingdom have resulted in total losses.[7] Carp aquaculture in Russia has experienced infestations in which fish were coated in "several hundred" parasites before dying.[14] Parasites infested 100% of the fish in a sample at a stricken carp farm in Turkey, with up to 1000 fish lice per individual.[15]

The fish louse will readily lay its eggs on hard objects such as wooden boards, and these can be removed from the water to reduce the egg load in the fishery.[7] A short bath in a sodium chloride solution can reduce the parasite load on a fish, but this treatment must be done carefully, because too short a duration or too dilute a solution is ineffective, while too long or too concentrated a bath can harm the fish

Diagnosis and Management

Because of their size, older stages of *Argulus* can be diagnosed with the naked eye. The parasites are visible moving on the host or swimming in the water. The parasite can also be identified on a wet mount of the affected tissue. Captured fish should be examined quickly because *Argulus* may rapidly leave the fish once it is disturbed or removed from the water. Filtering water from the system through a fine mesh net may also help capture free-swimming *Argulus* adults or juveniles for identification. Adults and juvenile stages (which are similar to adults but lack suckers) are relatively easy to identify, but their identification should be verified by a fish health professional.

Drug choice and length of treatment for *Argulus* infections should take into consideration the life cycle of the parasite, which varies from 30 to 60 days depending on temperature and species. Treatment should target all life stages, including eggs, juveniles, and adults, both on the fish and in the environment. Adult parasites can be manually removed from the affected fish, but this is impractical in many situations and is an incomplete solution because eggs, unattached juveniles, and adults will still be present in the environment. Fish can be moved to a clean tank and treated with the appropriate drugs, while eggs in the original system are eliminated either by cleaning and disinfecting the tank or allowing it to dry completely. However, drying may be difficult in humid areas, and at cooler temperatures eggs can survive much longer time periods. Optimal water quality should be maintained for the duration of any treatments.

Prevention

Because of potential challenges with controlling this parasite, especially in food and pond fish, biosecurity measures should be instituted and followed to minimize introduction or transmission to other ponds, systems, or facilities (see UF/IFAS EDIS Circular 120).

Incoming fish, particularly wild-caught or pond-raised stock, should be quarantined, observed, and sampled in order to minimize the risk of introduction. *Argulus* outbreaks, once recognized, should be managed quickly. Source water should be evaluated to ensure that is not a pathway for introduction of argulid eggs. Ideally, water should be filtered or obtained from a fish-free and *Argulus*-free source.

Dropsy

Dropsy is a **disease in fish** caused by the buildup of fluid inside the body cavity or tissues. As a symptom rather than a **disease**, it can indicate a number of underlying **diseases**, including bacterial infections, parasitic infections, or liver dysfunction.

Symptoms

The characteristically swollen belly of the Dropsy fish disease is the last thing you want to notice in your fish. It means the internal organs are injured and the belly of the fish started to fill itself with water and other fluids, leading to the fishes ultimate demise. In this stage, even with a fast medical response, it is more likely the fish will die. Some fish do not show any other symptoms at all, but there are a couple of symptoms that are visible to the human eye and if noticed on time, you can prevent the spreading of the Dropsy fish disease and even save the ones who are actually infected.

External symptoms are easy to detect, if the fish are showing them, like when the scales are standing out like a pinecone, have swollen eyes, pale gills, swollen anus with a bloody coloration, pale feces, a curved spine, clamped fins, lethargic movement (this is when the fish just hover near the top of the tank instead of swimming), losing their appetite and etc.

All of these symptoms progress aggressively, so if you notice even one of the mentioned-above, start reacting accordingly.

Treatment

- Create a separate fish tank without any décor, plants, rocks, sand or objects
- Move all fish with the infection the ‘Hospital aquarium’, while monitoring the healthy fish for further spreading of the infection. Don’t forget to change half of the tanks water in your infected aquarium after you move the infected fish
- Add salt to the ‘Hospital aquarium’, 1 teaspoon for every gallon in the fish tank. Maintain a clean environment for the sick fish, changing the water on a weekly basis
- Give your patients fresh food with the highest quality you can manage to acquire. In most cases, a healthy diet is enough to get them through the rough. If you notice the

fish getting better, maintain the diet for next few weeks until the all of the symptoms are gone

- If the healthy diet is not enough, antibiotics are strongly recommended, like the ‘Maracyn-2’. 10 days should be enough to destroy any signs of the Dropsy fish disease, but advice with a vet for proper dosage of the medicine

How to prevent an outbreak

Like all bacterial infections, the best way to prevent them is a healthy and clean environment. Fish are quite prone to stress, and when they are stressed, their immune system fails. Maintaining a clean aquarium is a priority for all fish keepers, because low quality water is the number 1 stress factor for fish. Change the water regularly, maintain a clean fish tank, clean filter, do not overpopulate the aquarium (get another fish tank or create a larger aquarium) and be mindful of what, when and how much you feed your fish. Keep track of the foods shelf life; if you open a flakes package, use it within a month. Don’t feed them with a single food source, a healthy diet consists of freshness and variety.

Causes of the Disease

The nasty little bugger that causes the Dropsy fish disease is a bacteria called Aeromonas. It is a common bacteria, found in almost every aquarium. It is a “gram-negative bacteria” because it can be identified with a Gram Staining technique.

The Aeromonas can lead to the Dropsy fish disease only if the immune system of the fish in the aquarium is already failing.

Stress-factors

- Low-quality water – can be avoided by regularly changing the water
- Ammonia and Nitrite levels changing – can be avoided by keeping an eye on them, watching them to not rise above the preferred levels
- Drastic change in the water temperature – can be avoided by regularly watching if the heating system in the aquarium works properly
- An unhealthy diet
- Aggressive behavior – if you notice some of the fish being aggressive in the tank, it might be best to transfer them into a separate aquarium.

Basically the Dropsy fish disease thrives in an environment where there is at least 1 stress factor. If your aquarium is stress free, you have nothing to worry about.

Protozoan Diseases of Fishes with an Emphasis on Costiasis, Gyrodactylosis, Piscicolosis

Costiasis

Causative Agent and Disease Ichthyobodiasis is caused by a flagellated protozoan of the genus Ichthyobodo, formally known as Costia. These parasites are very small (5-10 um) with both free swimming and attached stages that can easily be overlooked in an examination. I. necator is an obligate parasite infesting the skin and/or gills of fishes including salmonids. When present on gills, Ichthyobodo seriously reduces the ability of young salmon to adapt to seawater.

Host Species

This organism lacks host specificity and parasitizes a wide variety of warm and cold water fish species and amphibians worldwide. Although primarily in freshwater, there have been reports of marine or euryhaline strains/species. Fingerlings and fry are especially susceptible, although older fish also become parasitized.

Clinical Signs

Fish infested with Ichthyobodo are often anorexic and listless and will typically exhibit flashing behavior. In advanced cases a blue-gray film appears on the surface of fish caused by increased mucus production and general hyperplasia of epidermal epithelium. Gill hyperplasia and lamellar fusion (clubbing) can occur if gills are infested. Secondary bacterial and fungal infections are common.

Transmission

This organism is horizontally transmitted from fish to fish. Subclinically parasitized fish are the reservoirs for the parasite in the environment. Ichthyobodo reproduces by asexual longitudinal fission where one cell produces 2 motile daughter cells, each with 2 flagella, that parasitize the same or different host. Motile forms attach by means of a flat disc with two small microtubules extending into the host cell but retain flagella. Infestation of a host must occur within one hour after division or the parasite dies.

Diagnosis

Definitive diagnosis is made by wet mount preparations of skin and/or gills. The organisms exhibit a characteristic asymmetrical, oval, flat-bodied attached form with a smaller number of freeswimming forms that are more ellipsoidal in outline. Two unequal flagella are occasionally visible arising from the anterior end and lie along a funnelshaped groove on the organism’s ventral side. The parasites can also be observed as attached forms in stained histological sections.

- The Costiasis parasite may be becoming salt resistant and is not killed by drying out equipment. So use a decent disinfectant on nets, hands, etc. to prevent parasite transmission between tanks.
- A minimum of 200X magnification is required to spot Costia. Preferably 400X if infection is low.
    - Due to its inability to live in water above 28°C (82.4°F) , treat as if it was Ich by using a commercial Ich treatment or technique.
    - Other recommended treatments include Malachite Green, Potassium Permanganate, Acriflavine and strong salt baths of 3%.

Gyrodactylosis

Gyrodactylosis is a parasitic diseased caused by species of genus Gyrodoactylus, affecting the most species of freshwater fishes characterized by destruction of the skin or rarely the gills.

Signs of disease

Important: animals with disease may show one or more of the signs below, but disease may still be present in the absence of any signs.

Disease signs at the farm level

- high mortality in Atlantic salmon

Disease signs at the tank and pond level

- scrubbing (rubbing against objects in response to skin irritation) and flashing (darting and twisting of fish and erratic swimming)

Clinical signs of disease in an infected animal

- ulcers on infected fish
- peeling of skin
- fish appear pale
- excess mucus on skin
- frayed fins

Most waters in the region have many types of flukes that are parasitic on fish gills and skin. Any evidence of infestation with these parasites beyond what is visible to the naked eye (as described above) requires confirmation by a trained fish pathologist using microscopy.

Disease agent

Naturally susceptible (other species have been shown to be experimentally susceptible)

Presence in Asia–Pacific

EXOTIC -has not been officially reported in the Asia–Pacific region under the NACA-FAO-OIE quarterly aquatic animal disease reporting program.

Epidemiology

- A few parasites cause no problem to healthy populations, but massive infestations lead to compromised resistance to viruses and bacteria.
- *Gyrodactylus salaris* may be present for years in farmed salmonids, especially rainbow trout, without the fish showing any clinical signs of disease.
- Identification of *G. salaris* is based on morphology and morphometry of hooks and bars in the opisthaptor (an attachment organ), or by DNA analysis.
- The whole surface of a fish, including gills and mouth cavity, must be examined under a dissecting microscope.
- The parasite can survive a few days at a salinity of 20 ppt, but cannot survive in seawater.
- The parasite can survive 5–6 days unattached to a host, but cannot survive drying out.

- Transmission is horizontal, direct from the water column.
- Parasites can breed prolifically.
- The parasite is readily spread through transport of infested fish.

Differential diagnosis

The differential diagnostic table and the list of similar diseases appearing at the bottom of each disease page refer only to the diseases covered by this field guide. Gross signs observed might well be representative of a wider range of diseases not included here. Therefore, these diagnostic aids should not be read as a guide to a definitive diagnosis, but rather as a tool to help identify the listed diseases that most closely account for the gross signs.

Management

Prevention Stock transfers of fish from risk areas to uninfested areas should not take place. Mechanical Restrictions on imports. Chemical Eradication using rotenone has been effective in eliminating its presence in 16 Norwegian waterbodies. Aqueous aluminium may be effective for treating fish for stocking. Detached trematodes are able to infect free-swimming salmon although they have no swimming ability themselves. The use of brackish treatments needs to be reviewed. Populations have declined arising from control measures in Indian waters.

Causative Agent and Disease

Piscicola is a freshwater leech belonging to the phylum Annelida (segmented worms) that can be abundant in some freshwater lakes, ponds and streams. *Piscicola* attaches to the skin of freshwater fish and is nourished by sucking blood and other tissue fluids from the host. Members of the genus *Piscicola* usually remain attached to a fish for several days while feeding and then drop off and sink to the bottom where the food is digested. *Piscicola* has well developed oral and caudal suckers with a sub cylindrical and elongate body. Leeches usually do not cause serious harm to their hosts since most tissue damage is localized at the sites of attachment. However, when present in large numbers parasitic leeches can cause extensive tissue damage to fishes including epidermal erosion and ulceration, hemorrhaging, necrosis and anemia. External epidermal erosions may serve as portals of entry for secondary bacterial or fungal pathogens. II. Host Species The parasite occurs on many species of freshwater fishes in Europe and North America. Salmonids are most commonly parasitized by *P. salmositica* in Alaska. III. Clinical Signs *Piscicola* leeches are visible with the naked eye. Attachment of leeches may occur anywhere on the host body and are often found on or under the opercula, in the mouth, along the jaw and at the bases of fins.

Transmission

The life cycle of leeches is relatively simple, consisting of an egg, a juvenile stage and a mature hermaphroditic adult that produces eggs. After digestion of a blood meal, a leech either attaches to a fish for another feeding cycle or it produces eggs. Eggs are encased in oval “cocoons” that are attached to the substrate at the bottom of the lake or river. Juvenile leeches hatch from the eggs and enter the water column to find a fish host. Parasitic juvenile leeches usually require several blood meals before becoming mature adults. Leeches of this genus have been implicated as possible vectors of the fish virus, IHNV.

Diagnosis

Leeches are obvious by visual examination of the host. Observation of the worm under a dissecting microscope for various morphological characteristics including color and pattern of pigmentation, number and arrangement of eye spots on the oral sucker and other external features help identify the genus *Piscicola*.

Prognosis for Host

Leeches usually do not cause significant harm to their hosts unless present in large numbers. Prognosis for a host is good when infestations are low to moderate, but host inflammation may occur locally at the site of attachment.

Human Health Signifcance

There are no human health concerns associated with *Piscicola.*

Viral hemorrhagic septicemia

Viral hemorrhagic septicemia (**VHS**) is a deadly infectious fish disease caused by ***Piscine novirhabdovirus*** (originally called ***Viral hemorrhagic septicemia virus***). It afflicts over 50 species of freshwater and marine fish in several parts of the Northern Hemisphere. Different strains of the virus occur in different regions, and affect different species. There are no signs that the disease affects human health. VHS is also known as **Egtved disease**, and the virus as **Egtved virus**.

VHS disease in a gizzard shad

Historically, VHS was associated mostly with freshwater salmonids in western Europe, documented as a pathogenic disease among cultured salmonids since the 1950s.Today it is still a major concern for many fish farms in Europe and is therefore being watched closely by the European Community Reference Laboratory for Fish Diseases. It was first discovered in the US in 1988 among salmon returning from the Pacific in Washington state.[4] This North American genotype was identified as a distinct, more marine-stable strain than the European genotype. VHS has since been found afflicting marine fish in the northeastern Pacific Ocean, the North Sea, and the Baltic Sea. Since 2005, massive die-offs have occurred among a wide variety of freshwater species in the Great Lakes region of North America.

Viral Taxonomy

VHSV is a negative-sense single-stranded RNA virus of the order *Mononegavirales*, family *Rhabdoviridae*, and genus *Novirhabdovirus*. Another related fish rhabdovirus in the genus *Novirhabdovirus* is *Salmonid novirhabdovirus* (formerly *Infectious hematopoietic necrosis virus* (IHNV)), which causes infectious hematopoietic necrosis (IHN) disease in salmonidae.

The viral cause of the disease was discovered in 1963 by M. H. Jenson. The virus is an enveloped, bullet-shaped particle, about 180 nm long by 60 nm in diameter, covered with 5 to 15 nm long palmers.

Molecular Taxonomy

The genome of VHSV is composed of approximately 11-kb of single stranded RNA, which contains six genes that are located along the genome in the 3′-5′ order: 3′-N-P-M-G-NV-L-5′, nucleocapsid protein (N), polymerase-associated phosphoprotein (P), matrix protein (M), surface glycoprotein (G), a unique non-virion protein (NV), and virus polymerase (L).

VHSV enters the host cell through either fusion or endocytosis. It binds to glycoprotein, called fibronectin, in the extracellular matrix. VHSV does its binding through integrin receptors.

Reverse genetics is a powerful tool to study and characterize the previously unknown viral genes. Reverse genetics system is currently available for VHSV. A vaccinia virus free reverse genetic system for Great Lakes VHSV (Genotype IVb) was developed by a research group from the USA.[11] This system allows the investigators to explore the functional properties of individual viral genes of VHSV in detail. This system was immediately utilized to characterize the non-virion (NV) gene of novirhabdoviruses. Even though it has been demonstrated that the NV gene is not necessary for viral replication, it is highly essential for viral pathogenesis. A new role of NV protein has been discovered and demonstrated that it inhibits apoptosis at the early stage of viral infection. This discovery unlocked the mystery of presence of NV proteins in novirhabdoviruses.

Transmission

VHSV can be spread from fish to fish through water transfer, as well as through contaminated eggs, and bait fish from infected waters. The emerald shiner is a particularly popular bait fish in the Great Lakes region, and is among the species afflicted.

Survivors of the disease can become lifelong carriers of the virus, contaminating water with urine, sperm, and ovarian fluids. The virus has been shown to survive two freeze/thaw cycles in a conventional freezer, suggesting both live and frozen bait could be a transmission vector. In Europe, the gray heron has spread the virus, but it does so mechanically; the virus is apparently inactive in the digestive tract of birds.

Symptoms

Fish that become infected experience hemorrhaging of their internal organs, skin, and muscle. Some fish show no external symptoms, but others show signs of infection that include bulging eyes, bloated abdomens, bruised-looking reddish tints to the eyes, skin, gills and fins. Some infected fish have open sores that may look like the lesions from other diseases or from lamprey attacks. There may also be a nervous form of the disease where fish are constantly flashing and showing abnormal behaviour.

Field diagnosis

Living fish afflicted with VHS may appear listless or limp, hang just beneath the surface, or swim very abnormally, such as constant flashing circling due to the tropism of the virus for the brain. External signs may include darker coloration, exophthalmia ("pop eye"), pale or reddotted gills, sunken eyes, and bleeding around orbits (eye sockets) and at base of fins.

VHSV is a hemorrhagic disease, meaning it causes bleeding. Internally, the virus can cause petechial hemorrhaging (tiny spots of blood) in internal muscle tissue, and petechial or severe hemorrhaging in internal organs and other tissues. Internal hemorrhaging can be observed as red spots inside a dead fish, particularly around the kidney, spleen, and intestines, as well as the swim bladder, which would normally have a clear membrane. The liver may be pale, mottled with red hyperemic areas, the kidney may be swollen and unusually red, the spleen may be swollen, and the digestive tract may be empty. External signs are not always present, but if they are, hemorrhaging on the skin's surface can appear as anywhere from tiny red dots (petechiae) to large red patches.

Histopathology

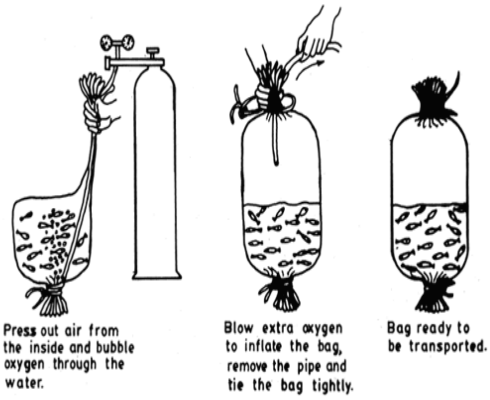
Preliminary diagnosis involves histopathological examination, observing tissues through a microscope. Most tissue changes can be observed as minor to major necrosis (cell death) in the liver, kidneys, spleen, and skeletal muscle. The hematopoietic (blood- forming) areas of the kidney and spleen are the initial area of infection, and should show necrosis. The gill may have thickened lamellae, and the liver may have pyknotic nuclei.

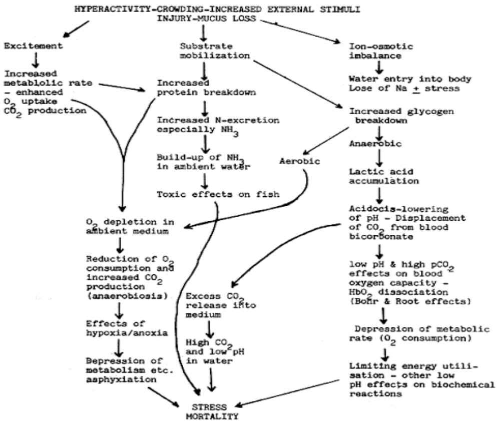
Prevention

Thoroughly cleaning boats, trailers, nets and other equipment when traveling between different lakes and streams also helps. The only EPA-approved disinfectant proven effective against VHS is Virkon AQUATIC). Chlorine bleach kills the VHS virus, but in concentrations that are much too caustic for ordinary use. Disinfecting stations can be found at various inland lake boat launches in the Great Lakes region.

Transport and Marketing in Aquaculture

Transport of hatchlings, fry and fingerlings of culturable species is a common necessity in aquaculture.Transport of fish seed in earthern pots, taken either as head loads or on slings from seed collection centres to spawn markets and to nurseries for stocking is an ancient practice in certain parts of the world.





Transport of hatchlings, fry and fingerlings of culturable species is a common necessity in aquaculture. Often large adult breeders have also to be transported for facilitating seed production. Indeed in certain parts of the world large level of transport of commercial fish in live condition from the areas of capture to the markets is a part of a highly organized industry, but we shall confine here to the transport of brood fish and fish seed, particularly the latter for culture purposes.

Transport of fish seed in earthern pots, taken either as head loads or on slings from seed collection centres to spawn* markets and to nurseries for stocking is an ancient practice in certain parts of the world. These traditional methods often entail heavy mortality during transport. Recently improvements have been made in the techniques of live fish transport with the knowledge of the basic physiological requirements of fishes in different stages of their life history (hatchling, fry, fingerlings, juveniles and adults) and also of the causes of mortality of fishes during transport (e.g. Berka, 1986).

While the empirical knowledge already available may not be ensuring very high survival, it is important that we do not fully discard it for it can still be improved upon and applied especially in rural aquaculture, when high technology is difficult to be applied. Modern developments in transport technology are from two levels; one is from an understanding, as mentioned, of internal physiological mechanisms of the fish and the optimal requirements, ensuring maximum survival of fish under transport and the other is from a study of the environmental parameters of the medium in which fish are transported. It is difficult to separate the two levels, but a synthesis of the two is in the study of the autecology of the fish and application of methods to ensure increased survival, by the control of ambient conditions (eg. ambient oxygen, pH, ammonia) and by ensuring more suitable physiological condition (eg. conditioning fish fry, starvation before transportation) of the fish to be transported.

Fish transport technology has developed from the transport of simple earthern pots, as already referred to, to transport in polythene bags under high pressure of oxygen and use of anaesthetics and chemicals. Under anaesthesia fish can be transported without water even, provided the skin and gills are kept moist under low temperature. The cryopreservation of fish sperm for use at any convenient time can be referred to here, though this would concern seed production more directly than live seed transport.

Several factors, as those given below, may be responsible for mortality of fish in transport:

* used here synonymously with hatchling/young fry.

1. Depletion of dissolved oxygen in ambient water due to the respiration of fish and also due to oxidation of any organic matter (BOD load), including excreted waste of the fish, by micro-organisms.
2. Accumulation of free carbon dioxide (CO_2), resulting from respiration, and ammonia (NH_3) as excretory end product.
3. Sudden fluctuations in temperature.
4. Hyperactivity and stress due to handling and 'confined space' - these result in lactate accumulation and affect again lessening of blood oxygen capacity and also 'fatigue collapse'
5. Ion-osmotic imbalance due to stress.
6. Physical injury due to handling before transport and during transport.
7. Diseases.

It will be noted that items, 1 – 3 concern ambient conditions and items 4 – 7 concern the fish *per se* (the internal machinery). We shall now deal with the latter, especially the array of internal changes in fish due to hyperactivity and handling stress.
Live-transport of fish seed and brooders entail handling often involving chasing with or without net, catching and transfer from the nursery/farm ponds to the equilibration (conditioning) system and thence to the transport container. The stress of this pre-transport handling can itself be high, sometimes causing injury and immediate death; the stress of transport itself can be distinguished from the handling stress.

The severity of the transport stress would depend on the duration of transport and the physico-chemical characteristics of the medium/ containers of transport.
The physiological effects of handling including hyperactivity can be mentioned first. Depending on the severity of handling the effects can last over a day even. Hyperactivity or increased physical activity and handling and concomittant excitement cause immediate depletion of the labile energy store in muscle, namely glycogen, mostly through the anaerobic pathway leading to the production of excess lactic acid. The lactic acid causes 'acidocis' and consequent lowering of pH, which results in the liberation of CO_2. The acidic pH and increased pCO_2 in blood would cause reduced loading of oxygen in the blood (Bohr and Root effects), which would seriously impair the energy yielding mechanism of the fish and can cause collapse of the fish. Acidosis of the blood would affect the other bio-chemical reactions as well and can also cause fatigue collapse.

The surviving fish quite often would accumulate an oxygen debt, which under the crowded condition of the transport carrier, coupled with low oxygen conditions can again lead to the collapse and death of the fish. Therefore it is imperative that the fish caught for transport should be given sufficient time in high oxygenated water under optimal conditions for Conditioning of fish before transportation. (see flow chart "Effects of Handling/ Transport on Fish").

1. The amount of water for transport can be calculated by substracting the volume of fish to be transported (with 1 kg litre index) from the total volume of the tank.
2. Data at a temperature value above 15°C refer to fasted fish.
3. Transport guide numbers of fish with 1000 – 1700 g body weight can be increased by 10–15%. Numbers given can be decreased in the following day:
   20–30% if the body weight is about 500–1000 g
   30–50% if the body weight is about 200–500 g
   50–60% if the body weight is about 100–200 g
   60–80% if the body weight is under 100 g.

To make fish available to consumers at the right time and in the right place requires an effective marketing system. Fishermen catch fish by labouring overnight (from common-property water bodies) do not usually sell fish in retail markets

Marketing is the science and art of exploring, creating, and delivering value to satisfy the needs of a target market at a profit. Marketing identifies unfulfilled needs and desires. It defines then measures and quantifies the size of the identified market and the profit potential. It pinpoints which segments the company is capable of serving best and it designs and promotes the appropriate products and services.
Marketing is oft en performed by a department within the organization. This is both good and bad. It's good because it unites a group of trained people who focus on the marketing task. It's bad because marketing activities should not be carried out in a single department but they should be manifest in all the activities of the organization.

The most important concepts of aquaculture marketing are:

1. Segmentation
2. Targeting
3. Positioning
4. Needs & Wants
5. Demand
6. Offerings
7. Brands
8. Value & Satisfaction
9. Exchange
10. Transactions
11. Relationships & Networks
12. Marketing Channels
13. The supply Chain
14. Competition
15. The Marketing Environment
16. Marketing Programs

A good result for an introductory meeting, but you will need something far more concrete to constitute a sale.

Projection

These are essentially a buyer's prediction of the amount of product they could purchase over time. It helps them and you determine whether you can hang in there for the long term as a supplier. A projection is not a sales commitment, but a planning tool from which the two of you can work and negotiate. Be sure to quiz your buyer on how they came up the projection (existing sales history, estimate from some other source) and how solid they feel it is. If you are demoing a new product with them, you may want to develop a stepped projection that is a tiered approach that considers test marketing or the initial in-store introduction of the product, and then longer term stock movement. Any agreement based on projections should include your conditional agreement. For example, a conditional agreement may include a statement that releases you from the commitment if they don't move a given amount of product. These are difficult to get in writing, usually the best you can do is reiterate it to them in an after meeting confirmation memo. HFC (Hold for Confirmation). This can potentially be very problematic if you are new to the game. Any purchase order with “HFC” stamped on it or written into it should immediately be considered a projection and not an order. Buyers will expect you to have product to ship; but the HFC does not necessarily mean that they are ready to receive your product. Your next move is to immediately get back to them and fi nd out what the conditions are of the hold and how to get it lifted, i.e., get a concrete purchase order you can act upon. With a good reputable buyer, the HFC is not necessarily a negative impediment; it can mean that they already have set aside funds within their budget for purchasing your product.

Consignment Sale

Applicable to marketing aquaculture products when sold in community cooperatives, farmer’s markets and similar venues. This is where you, the vendor, retain ownership of the product within the store until it is sold. This may be helpful to you should the store go bankrupt, have limited staff or purchasing power, or similar issues. It may mean that you are responsible for the full service of the product inventory, but may result in better display and product-placement options. Guaranteed Sale, Not necessarily applicable to marketing aquaculture products and more common to other retail arrangements, this is where the buyer holds the right to return all unsold goods and demand partial or full credit on the return. In the most extreme types of contract, the buyer will not pay for any of the product until the entire sales period has passed, returns determined and the difference calculated.

Fish processing & Preservation

The term **fish processing** refers to the processes associated with fish and fish products between the time fish are caught or harvested, and the time the final product is delivered to the customer. Although the term refers specifically to fish, in practice it is extended to cover any aquatic organisms harvested for commercial purposes, whether caught in wild fisheries or harvested from aquaculture or fish farming.

Humans have been processing fish since neolithic times. This 16th-century fish stall shows many traditional fish products.

Fish is one of the protein foods that needs careful handling (Eyo, 2004). This is because fish spoils easily after capture due to the high tropical temperature which accelerates the activities of bacteria, enzymes and chemical oxidation of fat in the fish. Due to poor handling, about 30 – 50% of fish harvested are wasted in Nigeria. These losses could be minimized by the application of proper handling, processing and preservation techniques (Bate and Bendall, 2010). The purpose of processing and preserving fish is to get fish to an ultimate consumer in good, usable condition. The steps necessary to accomplish this begin before the fishing expedition starts, and do not end until the fish in eaten or processed into oil, meal, or a feed (Karube et al., 2001). Fish begins to spoil as soon as it is caught, perhaps even before it is taken out of the water. Therefore, the key to delivering a high quality product is close attention to small details throughout the entire process of preparation, catching, landing, handling, storage, and transport. Fish that becomes spoiled or putrid is obviously unusable (Gopakumar, 2000). Fish that is poorly cared for may not be so obviously bad, but it loses value because of off-flavors, mushy texture, or bad color that discourage (Burt, 2003), a potential purchaser from buying. If customers have bought one bad fish, they probably won't buy another. On the other hand, if you consistently deliver good quality at a fair price, people will become loyal customers

Larger fish processing companies often operate their own fishing fleets or farming operations. The products of the fish industry are usually sold to grocery chains or to intermediaries. Fish are highly perishable. A central concern of fish processing is to prevent fish from deteriorating, and this remains an underlying concern during other processing operations.Fish processing can be subdivided into fish handling, which is the preliminary processing of raw fish, and the manufacture of fish products. Another natural subdivision is into primary processing involved in the filleting and freezing of fresh fish for onward distribution to fresh fish retail and catering outlets, and the secondary processing that produces chilled, frozen and canned products for the retail and catering trades.There is evidence humans have been processing fish since the early Holocene. These days, fish processing is undertaken by artisan fishermen, on board fishing or fish processing vessels, and at fish processing plants.

Preservation

Preservation techniques are needed to prevent fish spoilage and lengthen shelf life. They are designed to inhibit the activity of spoilage bacteria and the metabolic changes that result in the loss of fish quality. Spoilage bacteria are the specific bacteria that produce the unpleasant odours and flavours associated with spoiled fish. Fish normally host many bacteria that are not spoilage bacteria, and most of the bacteria present on spoiled fish played no role in the spoilage. To flourish, bacteria need the right temperature, sufficient water and oxygen, and surroundings that are not too acidic. Preservation techniques work by interrupting one or more of these needs.

Ice preserves fish and extends shelf life by lowering the temperature

If the temperature is decreased, the metabolic activity in the fish from microbial or autolytic processes can be reduced or stopped. This is achieved by refrigeration where the temperature is dropped to about 0°C, or freezing where the temperature is dropped below -18 °C. On fishing vessels, the fish are refrigerated mechanically by circulating cold air or by packing the fish in boxes with ice. Forage fish, which are often caught in large numbers, are usually chilled with refrigerated or chilled seawater. Once chilled or frozen, the fish need further cooling to maintain the low temperature. There are key issues with fish cold store design and management, such as how large and energy efficient they are, and the way they are insulated and palletized.

An effective method of preserving the freshness of fish is to chill with ice by distributing ice uniformly around the fish. It is a safe cooling method that keeps the fish moist and in an easily stored form suitable for transport. It has become widely used since the development of mechanical refrigeration, which makes ice easy and cheap to produce. Ice is produced in various shapes; crushed ice and Flake Ice, plates, tubes and blocks are commonly used to cool fish. Particularly effective is slurry ice, made from micro crystals of ice formed and suspended within a solution of water and a freezing point depressant, such as common salt. A more recent development is pumpable ice technology. Pumpable ice flows like water, and because it is homogeneous, it cools fish faster than fresh water solid ice methods and eliminates freeze burns. It complies with HACCP and ISO food safety and public health standards, and uses less energy than conventional fresh water solid ice technologies.

Control of water activity

The water activity, a_w, in a fish is defined as the ratio of the water vapour pressure in the flesh of the fish to the vapour pressure of pure water at the same temperature and pressure.

It ranges between 0 and 1, and is a parameter that measures how available the water is in the flesh of the fish. Available water is necessary for the microbial and enzymatic reactions involved in spoilage. There are a number of techniques that have been or are used to tie up the available water or remove it by reducing the a_w. Traditionally, techniques such as drying, salting and smoking have been used, and have been used for thousands of years. These techniques can be very simple, for example, by using solar drying. In more recent times, freeze-drying, water binding humectants, and fully automated equipment with temperature and humidity control have been added. Often a combination of these techniques is used.

Physical control of microbial loads

Heat or ionizing irradiation can be used to kill the bacteria that cause decomposition. Heat is applied by cooking, blanching or microwave heating in a manner that pasteurizes or sterilizes fish products. Cooking or pasteurizing does not completely inactivate microorganisms and may need to be followed with refrigeration to preserve fish products and increase their shelf life. Sterilised products are stable at ambient temperatures up to 40 °C, but to ensure they remain sterilized they need packaging in metal cans or retortable pouches before the heat treatment.

Chemical control of microbial loads

Microbial growth and proliferation can be inhibited by a technique called biopreservation. Biopreservation is achieved by adding antimicrobials or by increasing the acidity of the fish muscle. Most bacteria stop multiplying when the pH is less than 4.5. Acidity is increased by fermentation, marination or by directly adding acids (acetic, citric, lactic) to fish products. Lactic acid bacteria produce the antimicrobial nisin which further enhances preservation.

Other preservatives include nitrites, sulphites, sorbates, benzoates and essential oils. Control of the oxygen reduction potentialSpoilage bacteria and lipid oxidation usually need oxygen, so reducing the oxygen around fish can increase shelf life. This is done by controlling or modifying the atmosphere around the fish, or by vacuum packaging. Controlled or modified atmospheres have specific combinations of oxygen, carbon dioxide and nitrogen, and the method is often combined with refrigeration for more effective fish preservation.

Preservation for short duration

Chilling

The first and simplest method to both preserve and process fish is to keep it cool. Cool fish keeps longer than uncooled fish, although both will spoil in a matter of hours . This is obtained by covering the fish with layers of ice. However, ice alone is not effective for long preservation, because melting water brings about a sort of leaching of valuable flesh contents which are responsible for the flavour. But ice is effective for short term preservation such as is needed to transport landed fish to nearby markets or to canning factories, etc. Here autolytic enzymic activities are checked by lowering the temperature (FAO, 2007). Most fish caught are preserved with ice at some stage in their processing. Trained taste panels are usually unable to distinguish well-iced fish kept less than six or seven days from fresh fish, and storage life can be extended somewhat if antibiotics are added to the ice. Ice works in two ways:. It reduces the growth rate of bacteria by reducing the temperature of the fish; and 2. It also washes the bacteria and slime away as it melts. Because of this, it is important to keep melt water drained away from the fish.

Preservation for Long Duration Salting

There are many different kinds of salt, some being better than others for fish curing. However, in islands or in outlying places there is often no choice, and whatever is available in the way of salt has to be used, whether it is bought in a shop, prepared on the spot, or extracted from earth containing salt. A distinction must be made between the two chief techniques of salting: wet salting and dry salting.

Wet Salting

The principle is to keep the fish for a long time in brine. The equipment needed consists of a watertight container, which can be a tin, drum, canoe, barrel, etc. To make the brine, one takes four parts of clean water (sea or fresh water) and one part of salt. If the salt is coarse, it has to be ground or pounded first. It is then dissolved into the water by stirring with a piece of wood. To be good, the brine must float a fish. The next step depends on what kind of fish one wants to salt. It is best first to cut off the head, and gut and clean the fish, though small fish can also be salted whole. Large fish must be cut open, and it is preferable to take out the backbone. Fish with a heavy armour of scales must be scaled. In 12 places where the flesh is thick, slashes must be made so that the salted brine can penetrate the flesh. Very large fish should be cut in thin fillets. After the fish has been prepared according to its size, it must be cleaned and put in the brine (FAO, 2008). A plank or matting is laid over it and weighted with rocks so that the fish is entirely covered with brine. This salted fish can be kept for a long time in a dark or at least a shady place. The remaining brine can be used three times, but water and salt must be added every time until a fish can again float on the liquid. In any case, fresh brine is always best. 3.2.1.2 Dry Salting In this method the fish is salted but the juices, slime and brine are allowed to flow away. Dry salting can be done in an old canoe, or on mats, leaves, boxes, etc. In any case, the brine formed by the fish juices and the salt must be allowed to run away. For two parts of fish, one needs one part of salt. Layers of fish must be separated by layers of salt. It is a valuable method when one has no containers. This method is used to salt down flying fish in open fishing boats while at sea, and the fish in this case are kept whole. Some people like the salty taste of fish prepared in this way, but it is always possible to wash the salt away by soaking it in fresh water before use.

Funding Agencies involved in Aquaculture Development in India

The country is endowed with vast resources in terms of ponds & tanks, rivers & canals, reservoirs, lakes and other water bodies having immense scope for development of fisheries to strengthen the food security, generate employment opportunities and earn foreign exchange with the ultimate objective of improving the socio economic status of fishers and other people engaged in the sector. In this direction, the Government of India formulated and launched the Centrally Sponsored Scheme on "Development of Inland Fisheries and Aquaculture" under macro-management approach in States/UT's during the 10th Plan. The total outlay approved for the entire 10th Plan period is Rs 135.00 crore. The components approved under the scheme are:

- Development of Freshwater Aquaculture.
- Development of Brackishwater Aquaculture.
- Coldwater Fisheries and Aquaculture.
- Development of Waterlogged Areas.
- Productive Utilization of Inland Saline/Alkaline Soils for Aquaculture.
- Integrated Development of Inland Capture Resources (reservoirs/rivers etc.)

The expenditure on developmental activities will be shared on 75:25 basis by the Government of India and the State/UT Governments in respect of all aforesaid components. The two components namely, Development of Freshwater Aquaculture and Brackishwater Aquaculture are to be implemented by a single agency (FFDA). The remaining four components are to be implemented through the Fisheries Department of the respective States/UT's. The States/UT's is required to bear full cost on base as well as incremental staff salary, maintenance of vehicle, office contingencies and acquisition of land wherever necessary, etc. The cost towards purchase of vehicles will, however, continue to be shared on 50:50 basis between the Government of India and the State/UT Governments.

The Government of India's share is in the form of grant-in-aid for all the items given under each component as per the approved norms. Subsidy on these items is given only once to a beneficiary. In addition to individual beneficiary, the financial assistance under the above components of the scheme is also available to Self-Help Groups, Women Groups and Fisheries Co-operative Societies, etc. The State/UT Governments on all these components have to make a matching contribution.

Besides subsidy on the approved items under the scheme, the balance amount for these items may be obtained as loan made available to the beneficiaries through FFDA's/States/UT's Fisheries Department from lead banks/participating banks. Subsidy for all approved items under the scheme can also be given to a beneficiary if the remaining cost of items is contributed by him from his/her own resources and is duly certified by the FFDA's/States/UT's Fisheries Department.

The implementing agencies had to furnish quarterly/annual progress reports indicating physical and financial achievements regularly in the prescribed format already communicated to the State/UT Government. The accounts of the agency shall be subject to audit by Chartered Accountants appointed by the agency and/or by such other officers of Government of India/State/UT Governments as required under the rules and report should be intimated to this Ministry.

The State/UT Governments has to ensure that the proposals for the various components are complete in all aspects accompanied by detailed progress reports of the central share released during the proceeding years and reasons for shortfalls, if any, etc. The availability of budgetary provision in the State Budget should be specifically indicated in the proposal.

Fish Farmers Development Agency (FFDA)

- Expenditure on all items above except purchase of vehicles (item 15) will be shared on 75:25 basis between Government of India and States.
- The above assistance under FFDA programme is available only once to a beneficiary.
- Subsidy for the construction of new ponds and tanks, reclamation/renovation of ponds/tanks and first year inputs to an individual beneficiary up to 5 ha is available with or without institutional finance in the plain areas and 1.0 ha in the hill States/Districts on pro-rata basis.

Indian marine exports accounted for about 3.7% of the Global sea food exports. During the year 2016-17, exports of marine products aggregated to 11,34,948 MT valued at ` 37,870 crore (US$ 5.78 billion). During the last 25 years the marine exports achieved CAGR of 7.8% in volume and 12.4% in value terms. The share of marine exports to the total exports of the country accounted for 1.16% and to that of agricultural exports accounted for around 12%. The Indian fisheries sector is characterised small scale farming and provides full time/ part time employment to over 14.50 million people. India is home to more than 10 percent of the global fish diversity. The fisheries sector has been recognised to contribute elimination of hunger, promote health, and reduce poverty by providing food and nutritional security to the vast majority of the population. Fish contributes substantially to the domestic food and nutritional security of India which has a per capita consumption of about 8-9 kg per annum, though it is a poor 50% of the global rates of 20kg/capita and 12 kg/capita recommended by Indian Council of Medical Research. With freshwater aquaculture being a homestead activity in several parts of the country, besides adding to the nutritional security it also helps in bringing additional income to rural households

National Bank for Agricultural and Rural Development (NABARD)

Major activities and functions undertaken under **NABARD** include:

1. Providing financing and refinancing support for the improvement of rural infrastructure
2. Credit plan preparation in the district level and administration of Rural Banks and cooperative banks.

3. Provides funds for developing food parks and food processing units for certain food parks. Apart from that also lends its services to warehouses, cold chain and storage infrastructures.
4. Aids marketing federations by offering credit facilities and also provides specialized long-term irrigation and infrastructure development funds for rural India.
5. Developing good banking practices for the backward sections of India and provide training to the handicraft artisans of the country and also help in marketing the products.
6. NABARD developed the SHG Bank Linkage project and is considered as one of the most remarkable micro-finance projects at the international level.
7. NABARD has financed nearly one fifth of the rural population and infrastructure of India. Also the Kisan Credit Card is developed by NABARD.

India sits at the 2nd spot in inland fish production when compared in the world level. Few of the states like Andhra Pradesh and West Bengal produce the highest numbers. In AP, co-operatives are set up for taking up fish farming as an occupation. Varieties of fisheries include: Inland fisheries (fresh water like ponds, rivers etc.) and Marine fisheries (Brackish water and the sea).

Provision of credit from banks and eligible activities for fish farming

Already prevailing guidelines suggest that formulation of project and financing for the same under investment credit; the cost of operations along with the recurring cost for the very first operational cycle will be included in the capital cost. As for the surplus that will be generated within the first cycle should be ideally enough for the following recurring expenses. Another scenario is where the borrower has already availed bank investment credit might require an extra top up of credit for increased working capital operations. Again another scenario, where the fisherman has not availed investment credit but needs working capital assistance. Considering all these situations, the banks assess the requirement of credit on a real time basis and only the real or genuine cases are favoured as per the finance scales provided by the DLTC (District level technical committee).

List of eligible activities that are financed by banks

- Aquaculture related to inland fisheries like fish culture, reservoir fishery, integrated farming, prawn farming, prawn hatchery, ornamental fish breeding, fish seed hatchery and farming.
- Aquaculture related to brackish water like water shrimp farming, shrimp hatchery, brackish water fish farming and fish hatchery.
- Aquaculture related to marine fisheries like edible oyster culture, pearl oyster culture and mussel, seaweed & finfish culture.

National Fisheries Development Board

Funding may address a variety of issues such as environmental monitoring, recirculating aquaculture systems, shellfish farming, alternative feeds for aquaculture, new species research, and offshore aquaculture. The programs below outline NOAA-managed funding opportunities for aquaculture and funding opportunities available through other agencies or venues.Basic Framework of PMMSY Subject: Pradhan Mantri Matsya Sampada Yojana - A scheme to bring about Blue Revolution through sustainable and responsible development of fisheries sector in India 1. Background 1) Fisheries and aquaculture are an important source of food, nutrition, employment and income in India. The sector provides livelihood to about 16 million fishers and fish farmers at the primary level and almost twice the number along the value chain. Fish being an affordable and rich source of animal protein, is one of the healthiest options to mitigate hunger and malnutrition. 2) The Gross Value Added (GVA) of fisheries sector in the national economy during 2018-19 stood at Rs 2,12,915 crores (current basic prices) which constituted 1.24% of the total National GVA and 7.28% share of Agricultural GVA. The sector has immense potential to double the fishers and fish farmers' incomes as envisioned by government and usher in economic prosperity. 3) Fisheries sector in India has shown impressive growth with an average annual growth rate of 10.88% during the year from 2014-15 to 2018-19. The fish production in India has registered an average annual growth of 7.53% during last 5 years and stood at an all-time high of 137.58 lakh metric tons during 2018-19. The export of marine products stood at 13.93 lakh metric tons and valued at Rs.46,589 crores (USD 6.73 billion) during 2018-19. 4) Foreseeing the immense potential for development of fisheries and for providing focused attention to the sector, the Government in its Union Budget, 2019-20 has announced a new scheme, the Pradhan Mantri Matsya Sampada Yojana (PMMSY). 2. PMMSY SCHEME 1) Pradhan Mantri Matsya Sampada has been approved at a total estimated investment of Rs. 20,050 crores to be implemented over a period of 5 years from FY 2020-21 to FY 2024-25

Economics of Aquaculture

Small-scale fisheries and aquaculture make criti cal contributions to development in the areas of *employment*, with over 41 million people worldwide, the vast majority of whom live in developing countries, working in fish production; *food security and nutrition*, with fish constituting an important source of nutrients for the poor and often being the cheapest form of animal protein; and *trade*, with a third of fishery commodity production in developing countries destined for export.

With most capture fisheries worldwide considered fully exploited or overexploited, aquaculture will be central to meeting fish demand, which will continue to increase with population growth, rising incomes and increasing urbanisation. As aquaculture develops, however, governments will need to manage its potential ecological and social impacts. African aquaculture, which has grown much more slowly than in other regions, faces numerous challenges, including resource conflicts and difficulties in accessing credit, quality seed and feed, and information. Also key to meeting growing demand will be improvements in post-harvest processing to reduce fish losses.

Both fisheries and aquaculture are often neglected in national development policy and donor priorities, as policy makers often do not have access to data which reflect the importance of fisheries and aquaculture to development. Appropriate policies and regulation remain important, how- ever, both in managing capture fisheries and ensuring that aquaculture development is pro-poor and sustainable.

Despite the significant contributions that fisheries and aquaculture make to employment, nutrition, and trade in the developing world, they are rarely included in national development policy and donor priorities. This is largely due to problems with valuation of small-scale fisheries, as policy makers often do not have access to data which reflect the importance of fisheries and aquaculture to development.

The stagnation or decline of capture fishery production in many parts of the world under- scores the importance of fisheries policy, how- ever, as the current state of stocks can be at least partially attributed to the difficulties of regulating fisheries and preventing their overexploitation. Even with improvements in regulation, however, pressures on capture fisheries will remain, due to continued population growth. Further development of sustainable aquaculture and improvements in the post-harvest sector to reduce losses could help to maintain fish supply and the contribution of fish to development.

While the number of people employed in fisheries and aquaculture in developing countries has been growing steadily, it has been stagnant or declining in most industrialised countries. This decline has been most pronounced in capture fisheries, while employment in aquaculture has increased in some industrialised countries. Millions of women in developing countries are employed in fisheries and aquaculture, participating at all stages in both commercial and artisanal fisheries, though most heavily in fish processing and marketing. In capture fisheries, women are commonly involved in making and repairing nets, baskets and pots, baiting hooks, setting traps and nets, fishing from small boats.

In addition to affecting food supply, the status of fish stocks in capture fisheries is likely to threat- en the livelihoods of small-scale fisherfolk and traditional fish processors as competition for limited resources increases. Larger-scale operators with greater access to capital and gear are already emerging in many areas, leading to changes in the structure and location of post-harvest activities and concentrating ownership and control of resources. In India, for example, fishing practices are changing with rising investment, and higher levels of mechanisation and motorisation are leading to greater centralisation of landings and competition over the catch. In the past, small-scale traders were able to purchase fish from local fishers at decentralised beach-based landings, some- times accessing fish through husbands or taking the fish on credit and paying once they had sold it. The increasing centralisation of landings, how- ever, has led to fierce competition at landing sites, favouring those with greater access to credit and infrastructure and marginalising traditional fish processors and petty traders.

Production and consumption

Data on fisheries in developing countries often do not fully account for artisanal and subsistence production, as the magnitude of the landings of these fisheries is not generally known by the responsible fisheries administration. It seems clear, however, that capture fisheries worldwide are currently being fished at or near capacity, and that further growth in fish production will come primarily from aquaculture. FAO (2006) estimates that marine capture fisheries production will remain between 80 and 90 million tons per year, and freshwater fisheries, which face environmental degradation and competition for use of freshwater resources from other sectors such as hydropower and agriculture, are unlikely to expand significantly either. Per capita fish supply in low-income food deficit countries (LIFDCs) (excluding China) has increased from 5.0 to 8.3 kg since 1960, due primarily to the growth of aquaculture and to increased production from inland capture fisheries in developing countries. In sub Saharan Africa, however, per capita fish supply is declining, dropping from a peak of 9.9 kg in 1982 to 7.6 kg in 2003. This is due to rapid population growth, stagnant capture fishery production, and the slow expansion of aquaculture in the region.

Demand for fish continues to increase in most of the world in line with population growth as well as increases in consumption of animal protein associated with urbanisation and rising incomes. In developed countries, demand for highvalue carnivorous species such as salmon and shrimp has also increased, largely due to in- come growth and urbanisation, as well as a shift.

Trade

A large portion of fish production is destined for export, around 40 percent of global production being traded internationally, and exports from developing countries accounting for some 60 percent of this. They are now net exporters of fish to developed countries, having shifted dramatically from being net importers (over 1.2 million metric tons in 1985) over the past two decades Over 30 percent of fishery commodity production in developing countries is destined for export (FAO 2005a), and it is an important source of foreign exchange for many countries, including Chile, Mozambique, Senegal, and Thailand. While industrial fishing activity continues to produce a significant portion of fisheries exports in some countries, much of the recent in- crease in exports from developing countries has come from small-scale fisheries. Much of this is driven by rising demand for high-quality demersal fish in developed countries. An increasing amount of trade in fish products is between developing countries, however, rather than from developing to developed countries. Demand for fish in developing countries continues to grow, due both to population growth and increased per capita consumption, while overall demand in developed countries (including the USSR) has stagnated since 1985. While there is increasing demand for higher value fish in developing countries, low-value fish continue to make up the bulk of fish consumed there, and they are projected to remain net exporters of high value finfish and importers of low-value food fish

The Fisheries in Developmental Policy

The contribution of fisheries and aquaculture to development has consistently been under- estimated both in national development and poverty reduction strategies and in international cooperation. FAO (2005b) identify two factors which influence the degree to which fisheries are included in development policy in a given country: the sector's contribution to foreign exchange earnings and its contribution to food security and nutrition (measured by dependence on fish protein). The more reliant a country is on fisheries for its foreign exchange earnings and food security, the argument goes, the more likely that policy makers will recognise their importance and that this will be reflected in development policy. As farming and terrestrial livestock often both generate more foreign exchange and are perceived to make a larger contribution to food security than other renewable resource sectors such as forestry and fisheries, they generally receive much more attention in national development strategies and donor priorities. When faced with resource allocation decisions, many governments prioritise water use for human consumption, agriculture, hydropower, and industry over inland fisheries and aquaculture. This is largely attributable to the perceived contribution of each sector to development, but also to the prevalence of single water-use systems. Encouraging multiple uses of water, however, can increase its productivity and allow for simultaneous development of several sectors.

The Development Aspects of Health and Nutrition

Even when consumed in small quantities, fish often comprises a nutritionally important part of many people's diets in developing countries. Itis a vital source of protein and micronutrients, and improves the quality of protein in largely vegetable and starch-based diets by providing essential amino acids. FAO (2006) has estimated that fish accounts for approximately 20 percent of animal protein consumption in LIFDCs. In some coast- al and island countries (including Bangladesh, Indonesia, Senegal, and Sri Lanka), it provides over 50 percent of animal protein, and reaches 62 percent in Gambia and 63 percent in Sierra Leone and Ghana. It is a particularly important component of the diets of the poor, as it is often the most affordable form of animal protein.

Fish is also rich in iron, zinc, magnesium, phosphorous, calcium, vitamin A and vitamin C, and marine fish is a good source of iodine. Many of these vital nutrients are found only in small amounts, if at all, in staple foods such as maize, rice and cassava which make up the bulk of people's diets in developing countries. Fish are an indispensable source of these nutrients for many people, and small low-value fish, which are largely consumed by the rural poor, provide more minerals than the same quantity of meat or large fish, as they are consumed whole, with the bones intact. Fish also contain fatty acids which are essential for the development of the brain and body, and are particularly crucial for the diets of babies, children, and pregnant and lactatingwomen.

Fish and the Millennium Development Goals

Fish, being a "rich food for poor people", is well placed to make an important contribution to the Millennium Development Goals (MDGs). While the most obvious contribution is in terms of food security and livelihoods, it also has an important nutritional role in reducing child mortality, improving maternal health, and combating HIV/ AIDS and other diseases. Fish also contribute indirectly to several of the other MDGs through improved nutritional status and enhanced livelihoods, and to gender equality through women's fish-related livelihood activities

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