



Role of ICT in Fish Disease Diagnosis and Management to curb the spreading of various dreadful diseases in different species of fishes

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Abstract: *Diagnosis is the identification of the nature an illness or other problems by examination of the symptoms. Fish diseases are the result of interaction between a pathogen, a fish (host) and a stressful environment. Even if the pathogen is present a disease outbreak will not occur unless the environment becomes stressful for the fish. Diagnosis is a label given for a medical condition or disease identified by its signs, symptoms, and from the results of various diagnostic procedures. The term "diagnostic criteria" designates the combination of signs, symptoms, and test results that allows the scientist to ascertain the diagnosis of the respective disease. Disease Diagnosis and management is defined as "the recognition of a disease or condition by its outward signs and symptoms," or "the analysis of the underlying physiological/biochemical cause(s) of a disease or condition." Disease diagnosis refers to various procedures and techniques used to identify the nature of disease and to precisely pinpoint the primary and secondary pathogens involved. Proper diagnosis leads to accurate therapies and avoid indiscriminate use of chemotherapeutics. Disease diagnosis is an integral part of aquatic health management. The key to disease diagnosis & management is sharing of information related to disease diagnosis & management across the globe. The emergence of Information & Communication Technology has helped in this objective of sharing information within scientific community across the globe effectively and efficiently. ICT plays vital role in effective management of data related to disease diagnosis of various species of fishes. The information related to diseases that are susceptible on various fish families is made available to fisheries sector with adequate information to manage fish farms efficiently. This paper gives an insight into the role of ICT in disease diagnosis & management of animals in general and fishes in particular.*

I. Introduction

Parasites are hazardous to a number of fish species in different water bodies. Frequency of infestation and distribution of parasites within different organs of the fishes is influenced by age and diet of the fish and abundance of parasites within the host fish (Snieszko, 1983). Since parasites are sensitive to environmental change, others are more resistant than their hosts and tend to increase in numbers in polluted conditions (Sures, 2004); they are now regarded as a useful indicator of aquatic health. Fish harbor a variety of parasites viz., protozoans, cestodes, trematodes and acanthocephalans (Ali, 1990) and the degree of damage by infection is influenced to a large extent by the type and numbers of parasites present (Bauer, 1941). The distribution of parasites varies not only in different species of fish but also seasonally and from one water body to other. The pathogenicity of parasitism has been reported to cause extensive damage to the host leading to the lower production of the fish (Rai, 1986). In certain studies the parasite has been found to be responsible for the death of the host (Bookmer *et al.*, 1981). The relationship of parasitism and pollution is not simple and involves a double edged phenomenon in which parasitism may increase host susceptibility to toxic pollutants or pollutants may result in an increase or decrease in the prevalence of certain parasites. The need of the hour is to establish a better IT enabled infrastructure so that better, efficient and fast communication channel can be established to facilitate the fisher man or aquarium owners with up-to-date information regarding the spreading, symptoms and preventions to avoid animal loss. ICT is regarded to provide all these functionalities to act scientifically if there happens to be any kind of susceptibility to diseases.

II. Major groups of Fish Parasites and the diseases caused by them with Diagnosis.

The majority of the fish parasites which cause disease in fish include protozoal parasites. Protozoal parasites on the skin, fins or scales only, (i.e., not affecting the gills) usually do not result in death, unless they are accompanied by a secondary bacterial infection. The more common protozoal parasites are listed below.

1. Ciliates

Most of the protozoans identified by aquarists will be ciliates. These organisms have tiny hair-like structures called cilia that are used for locomotion and/or feeding. Ciliates have a direct life cycle and many are common inhabitants of pond-reared fish. Common ciliate species that infest fish are given below:

A) *Ichthyophthirius multifiliis*:

The disease called "Ich" or "white spot disease" has been a problem to aquarists for generations. The white spot disease or 'ich' is a common disease of freshwater carps. Fish infected with this organism typically develop small blister-like raised lesions along the body wall and/or fins. If the infection is restricted to the gills, no white spots will be seen. The gills will appear swollen and be covered with thick mucus. Identification of the parasite on the gills, skin, and/or fins is necessary to conclude that fish has an "ich" infection.

Diagnosis: Fish with a cutaneous infection will "flash", i.e., turn over and expose their white underside, whereas fish with a gill infection will "pipe", i.e., come to the surface of the water and "breathe" through their mouth. Gill lesions include epithelial hyperplasia with the presence of mature trophonts within the gills. Cutaneous lesions also exhibit focal epidermal hyperplasia with parasites being located beneath the hyperplastic epidermis.

B) *Trichodinina* sp:

There are three genera which form the Trichodina complex: *Trichodina*, *Trichodonella* and *Tripartiella*, however, all three are commonly referred to as "Trichodina". All are approximately 100 µm in diameter and have a saucer to "frisbee" shape and are ringed with cilia around its entire surface.

Diagnosis: Fish with severe gill infections of trichodina will have respiratory and osmoregulatory difficulty and may "pipe" as well as "flash" if there is cutaneous involvement. Fin erosions and/or ulcerations can be observed in chronic cutaneous infections. .

C) *Chilodonella* sp:

This is a motile ciliated protozoal parasite which causes disease in the skin and gills of fish. It is typically heart-shaped with the posterior end being broader and slightly notched. It measures approximately 20-40 µm in width and 30-70 µm in length and its surface is covered with cilia. There is a large macronucleus in the posterior portion of this organism and a smaller micronucleus is near or within the macronucleus.

Diagnosis: This parasite has been attributed to death of fish due to respiratory and osmoregulatory imbalances associated with severe gill parasitism. Diagnosis is dependent upon demonstration of the organism within the affected organs by either cytology or histopathology.

2. Myxozoan Parasites

This is a very large group of parasites which can cause disease in a wide variety of fishes. They are obligate parasites of tissue (histozoic forms that reside in intercellular spaces or blood vessels that reside intracellularly) and organ cavities. A few of the more common myxozoan parasites are discussed below.

A) *Myxobolus cerebralis*

This parasite is known for causing "whirling disease" in salmonids. The parasite feeds on cartilage of the axial skeleton and clinical signs are related to this damage.

Diagnosis: This parasite produces spores within the cartilage which are oval to circular and approximately 7-9 µm in diameter and 6-7 µm long with a thick mucoid envelope on the posterior half of the spore. Histologically, myxozoan parasites within the cartilage of the axial skeleton, with morphological characteristics of *Myxobolus cerebralis*, must be observed to confirm the diagnosis.

3. *Platyhelminthes*

It is composed of three taxonomic classes: Turbellaria, Trematoda, and Cestoda. The Turbellaria are all free-living and have no association with fish diseases. All members of the other two classes live in close relationship with host animals. The trematodes are commonly known as *flukes*, whereas the cestodes are known as *tapeworms*.

A) *Mongenetic Trematodes*

This is a group of trematodes which complete their entire life cycle on the host. The adults attach to the host by a *haptor* or *opishaptor* which is a specially adapted structure on the posterior end of the parasite. This organ has hooks which allow the parasite to attach firmly to the host fish. The two most common monogenetic trematodes include: *Dactylogyrus* and *Gyrodactylus*.

B) *Digenetic Trematodes*

This group of parasites has a complex life cycle with several successive larval generations, alternating sexual and asexual generations and changes of hosts to develop into the adult in its primary host. The life cycles of trematodes involving fishes may either use fishes as the primary hosts or as intermediate hosts. Adult trematodes may infest the intestine or gall bladder of fishes.

C) *Nematodes*

Nematodes, also called roundworms, occur worldwide in all animals. They can infect all organs of the host, causing loss of function of the damaged area. Three common nematodes affecting fish are described.

Camillanus: *Camillanus* is easily recognized as a small thread-like worm protruding from the anus of the fish.

Capillaria: *Capillaria* is a large roundworm commonly found in the gut of angelfish, often recognized by its double operculated eggs in the female worm.

4. Parasitic crustacea

Parasitic crustacea are increasingly serious problems in cultured fish and can impact wild populations. Most parasitic crustacea of freshwater fish can be seen with the naked eye as they attach to the gills, body and fins of the host. Three major genera are *Ergasilus* and *Lernaea*,

III. Commonly preferred techniques for disease diagnosis:

1. Histological techniques:

Histology and have a central role in disease diagnosis. Microscopic examination of thin stained tissue sections in order to study their structure and function. It determine changes that occur in the tissues due to pathogens and disease Histopathology can be used as diagnostic tool for identifying a variety of pathological conditions associated with many of the disease conditions. Immunohistochemical methods are also used to detect specific pathogens in tissue sections.

2. Direct microscopical observation of the pathogen in the tissue sample:

Many of the parasites are detected primarily by their movement. The preparations of skin scrapings and gill are examined under the microscope and examined for the presence of for parasites.

3. Direct culture of the infectious agents and identification:

The pathogen can be identified using standard biophysical characteristics, biochemical tests, immunological or nucleic acid based diagnostic techniques.

4. Immunodiagnostic techniques:

Antigen — Antibody reactions are highly specific and sensitive. This forms the basis of immunodiagnostics. These tools are used for the qualitative and quantitative estimation of the pathogens and/or the protective antibody.. This method has the advantage over other traditional method in that it can detect sub-clinical/latent/carrier state of infection and can also discriminate the antigenic differences. Although there is an array of polyclonal and monoclonal antibody-based diagnostics available for various aquatic animal pathogens.

1. Agar Gel Precipitation Test,
2. Agglutination Test,
3. ELISA,
4. Dot ELISA,
5. Latex Agglutination Test and
6. Fluorescent Antibody Test.

5. Microscopic diagnosis

Microscopy can be done quickly, most specimens are treated with stains that color pathogens, causing them to stand out from the background, although wet mounts of unstained samples can be used to detect fungi, parasites (including helminth eggs and larvae) and motile organisms. **Motility test**

Histological techniques enable the description of tissue pathology and highlight the sequence of cellular changes and their progression caused by infectious and noninfectious diseases. There are three methods to see the motility of the bacteria and they are

- i. Hanging Drop Method
- ii. Semi Solid Agar Method (Craigie)
- iii. Three Coverslip Method

6. Molecular diagnosis

Molecular techniques are potentially faster and more sensitive than culture, serology, and histology methods that are traditionally used to identify fish pathogens. During the last 15 years or so, molecular techniques have been increasingly employed to diagnose fish diseases.

IV. Role of ICT in diagnosis and disease management:

Information and communication technology is playing an indispensable role in almost all modern day activities ranging from small scale house hold operations to highly complex operational activities where peta bytes of data are processed routinely. ICT is providing its service in various sectors of agriculture in general and fisheries in particular to establish better & efficient communication and improvised management to cater the inevitable needs of fishermen, entrepreneurs and aquarium owners to safe guard their culture (Lal, 1999; Rao, 2004; Abraham, 2007; Barba-Sanchez, 2007; Abdul Razaq et al., 2009 and Bahaman et al., 2009). There have been a number of modern day technological modalities of ICT in use which facilitate fishermen and end-user in various aspects like assessment, capture, culture, commercialization, communication etc. The most commonly used ICT tools are given in Table 1.

ICT is only used to provide the services mentioned in Table 1 rather ICT can be properly guided to help and decipher the various symptoms that can prove out to be fatal for fish culture and simultaneously ICT has the potential to help the farmers in diagnosing the disease which will result in formulation of the treatment regimes and communicate it to corresponding effected sites connected with centralized ICT enabled fisheries or aquarium management system.

In centralized ICT enabled fisheries diagnostic management center, the central laboratory is used to monitor various pooled fish species at different scales with different conditions. Fisheries professionals specialized in their respective domains render their service by closely monitoring the life cycle and different cultural cycles. In case any untoward evidence in the culture is noticed more related professional and veterinary scientists are delegated to find the conclusion that whether any harmful occurrence is there or not. In case there happens to be any disease all such information like: the fish species, the parasite type, diagnostic symptoms with adequate visuals, preventive measures etc are disseminated across the connected sites to rush for the preventive task to avoid any harmful occurrence in the culture. This whole profile of the diseases, its symptoms and preventive approaches is communicated with the aid of ICT. This communication is instant and simultaneously helps farmers to safeguard their fisheries cultures or aquariums.

Table 1: Various ICT tools and their respective benefits

ICT Tools	Functions/benefits
GPS	Marking the spots of the fish location, it can assist the fishermen to return exactly to the right place whether its daylight or dark. It will provide information such as latitude, longitude, altitude, surface speed, sunrise and sunset times, odometer and accuracy warning system.
Sonar	Through sonar, fishermen can get a complete, immediately up to date, available map of the whole fishing area showing the exact location, extend, density, depth, movement, species and size of all fish shoals. In addition, information regarding sea bottom such as depth, contours, slopes and stones can easily be gained.
Wireless set	It enhances the security aspects of the fishermen. If anything happens to them at the sea they can communicate with other vessels and the responsible agencies so that immediate action can be taken. On top of it, they can immediately share information regarding the fishing spots with the others. Moreover, through wireless set they can deal a better price with the dealer even when they are still on the sea.
Computer	For record purposes (ex: profit and loss, species caught, weather condition, markets, etc)
Internet	To seek, disseminate and share fisheries related information such as market price, online applications, weather conditions, professional advices, loan services, business opportunity, etc among/between colleague and related agencies
Mobile phone	To seek, disseminate and share fisheries related information such as market price, online applications, weather conditions, professional advices, loan services, business opportunity, etc among/between colleague and related agencies. Moreover, through mobile phone they can deal a better price with the dealer even when they are still on the sea.

There are different strategies which are in place to facilitate better management of fisheries and they can be well equipped with slight technological changes to service the functions being provided by centralized fisheries diagnostic management center. These techniques are mentioned as under (Yumlembam Jackie Singh / Huirem Bharati, 2010):

- Agricultural technology information centres (ATIC)
- Kisan Call Centre
- Aqua service centres
- One stop aqua shop
- Aqua choupal
- Rural Knowledge Centre
- Cyber extension

V. Conclusion

Every animal species existing at present on earth are prone to various disease or natural happenings. The need of the hour is to mitigate the impact of any disease that occurs and management of the disease diagnosis process throughout the lifecycle of an animal. Information & Communication technology is facilitating the scientific community in sharing the information related to disease diagnosis management instantly across the globe which results in prevention of disease by taking appropriate preventive measures. ICT tools facilitate in exploring new species and vigil them across the horizontals and verticals of water planet but is playing vital and versatile role in managing fisheries in proper form and as per the international standards. ICT is guiding at every nook and corner to educate farmers or end-users of any unavoidable situation that may arise. ICT helps to communicate the preventive measures, symptoms and proper diagnostic regime to farmers instantly to safeguard culture. ICT can help in facilitating a scientist in implementing the policy of “prevention is better than cure” provided ICT is used in letter and spirit for the benefit of society in general and nature in particular.

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