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Review Article

Overview of Aquatic Animal Diseases in Andaman and Nicobar Islands

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ABSTRACT

Saravanan K, Baruah A, Praveenraj J, Anuraj A, Angel JRJ, Thakur VR, Sivaramakrishnan T, Kumar KL, Kumar PP, Sankar RK and Roy SD (2015). Overview of aquatic animal diseases in Andaman and Nicobar Islands. *J. Immunol. Immunopathol*. **17**(1): 17-24.

Andaman and Nicobar Islands are pristine in nature and blessed with a variety of species diversity in general as well as aquatic resources in specific. The three facets of aquatic environment namely, freshwater, brackishwater and marine resources are not fully tapped to the potential and therefore have further scope for improvement. At present, only freshwater carp farming is being practiced in the Bay Islands while brackishwater aquaculture and mariculture are the identified areas for development. Diseases are the major constraints for the development in aquaculture sector. The present study reviews the work carried out till date on the disease aspects of aquatic animals. Abdominal dropsy from freshwater fishes, pop-eye disease, trematode and cestode infestations from marine fishes, White Spot Syndrome Virus (WSSV) and luminescent vibriosis from crustaceans and necrotic patches, yellow spot disease, pink line syndrome, white line syndrome, white plague, black band disease, tissue lesion, ring line syndrome and abnormal growth from corals have been reported from Andaman and Nicobar Islands. It is interesting to find that the pathogens like virus, bacteria, fungi and parasites were reported from these aquatic animals in the Island ecosystem. This is in contrast to our perception considering the virgin status of the Island. The scanty information available at present on the aquatic animal diseases itself has listed out all the possible diseases which would serve as a base for further studies in future. Therefore, it is the need of the hour to carry out a systematic study on the aquatic animal diseases of Bay Islands. Early detection of the diseases and rapid response to the identified diseases are critical for the effective management of aquatic animal disease emergencies in the Island ecosystem.

Keywords: Aquatic animal, Disease surveillance, Pathogens, Health management, Andaman and Nicobar Islands, Biosecurity, Aquatic quarantine

INTRODUCTION

The Andaman and Nicobar group of Islands is situated between 6° to 14°N and 92° to 94°E in the Southeast of Bay of Bengal. It consists of 572 Islands and has an aggregated coastline of 1,912 Km, which is about a fourth of the total coastline of India. The continental shelf area is very limited with an estimated area of 16,000 km^2, and the sea is very deep within a few kilometres from the shore. The Exclusive Economic Zone (EEZ) around the Islands encompasses around 0.6 million km^2, which is around 30% of the EEZ of India (Arif, 1983; Alagaraja, 1987).

Biogeographically, Andaman and Nicobar Islands are very rich, harbouring unique endemic life forms. Apart from having a varied and well-developed range of terrestrial ecosystems, these Islands also have rich marine ecosystems, such as coral reefs, mangroves and seagrass beds. The Islands are unique compared to the mainland India in terms of the scope they offer for integrated development of all sectors of culture fisheries namely, freshwater, brackishwater and mariculture apart from the abundant resources of self-recruiting species (SRS) and small indigenous species (SIS) in the inland water bodies.

The coastline of the Islands is fringed with numerous bays and inlets apart from the vast expanses of oceanic waters available around the Islands with varying depths and substrata. Mullets, milk fish, sand whiting, rabbit fish, snappers, groupers, sea bass and so on inhabit in these Island waters. The subduction of the Islands due to the massive earthquake on 26 December 2004, and the subsequent Tsunami has resulted in creation of additional area and thereby scope for brackishwater aquaculture. Sustainable brackishwater fish farming in the tidal inundated areas of 600–1,000 ha is a viable development option in Andaman Islands, which has been identified based on selective criteria.

The potential resources of freshwater are rivers and nallahs in the Bay Islands that are 37 km and 78.8 km in length, respectively. There are no perennial rivers except Galathea in the Great Nicobar and Kalpong in the North Andaman. On an average, the Island produces about 193 t/year of freshwater fishes. At present, the Island consists of 2,237 freshwater fish ponds with a total water spread area of 152.98 ha used for pisciculture purpose and 367 ha of reservoir area (7 numbers) (*Source:* Directorate of Economics and Statistics, Andaman and Nicobar Administration, 2012–2013).

The current trend in aquaculture development is towards increased intensification and commercialisation of aquatic production with lack of proper health management measures. Thus, the aquaculture industry has been overwhelmed with its share of diseases and problems caused by viruses, bacteria, fungi, parasites and other undiagnosed and emerging pathogens. Disease is now a primary constraint to the culture of many aquatic species, impeding both economic and social development in many countries (Bondad-Reantaso *et al.*, 2005). Further, the improper use of chemicals and antibiotics raises concerns regarding human and environmental safety (Seng *et al.*, 2006).

Aquatic animal diseases are a major risk and a primary constraint to the growth of the aquaculture sector in many of the Asian countries including India. The epidemic spread and devastating impacts of aquatic animal diseases such as Epizootic Ulcerative Syndrome (EUS) in freshwater fish, Viral Nervous Necrosis (VNN) in marine fish, White Spot Syndrome Virus (WSSV) in penaeid shrimps, White Tail Disease (WTD) in *Macrobrachium rosenbergii* and the emerging Taura Syndrome Virus (TSV) in *Litopenaeus vannamei* in Asia have clearly demonstrated the vulnerability of aquaculture systems to infectious disease emergencies (Mohan, 2009).

Infectious disease emergencies may arise within a country in a number of ways, for example, via incursions of known exotic diseases, through sudden changes in the behaviour of existing endemic diseases or by the appearance of previously unrecognised diseases. Early detection and rapid response are critical to the effective management of such disease emergencies (Arthur *et al.*, 2005).

At present, only freshwater carp farming is being done in the Andamans while brackishwater aquaculture and mariculture are the identified areas of development in the aquaculture sector. To some extent, the Island farmers import carp seeds from the mainland thus paving way for the entry of pathogens into this relatively virgin ecosystem. Many of the already existing serious diseases and pests of fish and aquatic invertebrates described elsewhere have not been reported from the Andaman and Nicobar Islands and are thus exotic. In addition, many genera are present which are host to a wide range of exotic diseases. As there are few research reports on the incidence of diseases in the Bay Islands, it is necessary to conduct a systematic investigation on the present state of health of the finfish and shellfish of Andaman and Nicobar Islands. This paper would review the work, which has been carried out so far on the aquatic animal diseases in Andaman and Nicobar group of Islands.

FRESHWATER FISH DISEASES

In Inland waters, freshwater fishes like the Indian major carps (*Catla catla*, *Labeo rohita* and *Cirrhinus mrigala*) are mainly cultivated in ponds. The causative agent of severe abdominal dropsy in Indian major carp, *C.mrigala* in South Andaman was investigated, and the etiological agent was identified as a highly virulent strain of *Aeromonas hydrophila*. This investigation further indicates that the cause of outbreak was acute infection by a highly virulent strain of *A. hydrophila*, which produced heat-stable enzymes, toxins, dermonecrotic and cytotoxic factors probably contributing to its virulence. The study also pointed out about the unique somatic antigen for developing a diagnostic kit to distinguish the most virulent serotypes (Shome *et al.*, 1996).

In Andaman, during 1996–1998, many sporadic cases of death in mature catla due to a milder and chronic form of a disease with thinning of musculature giving big head appearance, fluid accumulation in the abdomen without haemorrhagic ulcers and erosion of the scales were observed. Even though all the three species of Indian major carps were stocked in the ponds, this typical infection was exclusively observed in catla fishes. The bacteriological investigation of this chronic form of disease and comparison of the etiological agent with *A. hydrophila* causing acute dropsy showed that the present isolate was a different strain than the earlier reported one causing acute infection. Unlike earlier reports on catla suffering from dropsy infection, an ulcerative infection and septicaemia due to *A. hydrophila* infection, the atypical chronic form of dropsy described in this study was caused by a different strain of *A. hydrophila*, specifically infecting *C. catla* (Shome, 1999).

Shome *et al.* (1999a) obtained six *A. hydrophila* isolates from acute abdominal dropsy and ulcerative disease cases of Indian major carps and evaluated their virulence status. Western blot analysis showed a prominent 52 kD immunogenic polypeptide in all the six isolates and appears to be virulence related, as all the isolates caused heavy mortality in farmers' ponds. Earlier reports showed that 52 kD protein has been reported to be a hemolysin gene product which represents as S-layer surface protein and was considered to be one of the virulence factors. However, they also found the same in some of the weakly virulent and avirulent strains and hence finally concluded that there is need for further study to ascertain whether this can be used as an indicator probe to identify a virulent *Aeromonas*.

In another study, samples were collected from freshwater fishes such as Indian major carps (*C. mrigala*, *L. rohita*, *C. catla*), cat fish and grass carp in and around Andaman to study the resistance pattern of the bacterial isolates. A total of 77 (84.61%) bacterial isolates were found to be Gram negative, while only 14 (15.38%) were Gram positive. The most prominent bacteria from freshwater fishes included *Yersinia* spp., *Aeromonas* spp. and *Pseudomonas* spp, while other bacteria namely, *Edwardsiella* spp., *Klebsiella* spp., *Kurthia* spp., *Shigella* spp., *Arizona* spp., *Bacillus* spp., *Listeria* spp., *Staphylococcus* spp., *Aerogenes* spp. and *Proteus* spp. were also found to be present. They have also pointed out a high degree of multiple drug resistance patterns in those bacterial isolates and thus posing a threat to human population through possibility of transferring these resistant genes to other bacteria (Sunder *et al.*, 2006).

A whole cell vaccine was prepared by using formalin killed highly virulent strain of *A. hydrophila* isolated from Indian major carps suffering from acute infectious abdominal dropsy in Andaman (Shome and Shome, 1999). The prepared vaccine was evaluated in *C. mrigala*, *C. catla* and cat fishes by intraperitoneal (I/P) injection and immersion bath. The survivability rate and protective antibody titers clearly showed that the intraperitoneal route of inoculation was better than immersion.

MARINE FISH DISEASES

The samples of marine fishes such as groupers, caranx, triacanthus, bat fish, scorpion fish and so on were obtained from brackishwater fish culture ponds of ICAR-CIARI and fish landing station of different Islands of Andaman to study the resistance pattern of the bacterial isolates. A total of 39 (90.69%) bacteria were found to be Gram negative, while only 4 (9.30%) were Gram positive. *Edwardsiella* spp. was the most prominent apart from *Aeromonas* spp., *Shigella* spp., *Arizona* spp., *Staphylococcus* spp. and *Proteus* spp. bacteria from marine fishes exhibited more drug resistance pattern. They suggested that

the indiscriminate use of antibiotics should be avoided (Sunder *et al.*, 2006).

Shome *et al.* (1999b) investigated the etiological agents of marine ornamental aquarium fishes of Andaman Fisheries Department's marine aquaria suffering from eye disease with symptoms of cataract, exophthalmia, anorexia, dullness and mortality within 3–5 days. The prominent fish species affected by this disease were grouper (*Epinephelus* spp.), *Caranx* spp., *Triacanthus* spp., bat fish (*Platax* spp.), undulata trigger fish (*Balistapus undulatus*), lion fish *(Pterois* spp.), vagabond butterfly fish (*Chaetodon vagabundus*), pearl toby (*Canthigaster margaritata*), tang fish (*Naso* spp.) and snapper (*Lutjanus* spp.). Among the different antibiotics used for treatment, chloramphenicol at 50 mg/kg body weight through intramuscular injection for five days was able to cure the disease. As the disease was cured by antibiotics, and no parasites could be found by microscopic examination, the etiological agent was confirmed to be bacterial species. In this study, 18 out of 19 bacterial isolates belonged to the genus *Vibrio* and thus the causative agent was identified as *Vibrio* species.

Gupta and Madhu (1974) reported four new monogenetic trematodes (Helminth parasites) namely, *Diplectanum blairensis*, *Diplectanum jerbuae*, *Protancyrocephalus rangusi*, *Pseudoalitrematoides bengalensis* from marine fishes namely, *Sillago sihama*, *Terapon jarbua* and *Lutjanus rangus* in Port Blair during 1972. Likewise, already known *Hammatopeduncularia arii* was identified from a new locality that is Port Blair for the parasite.

Examination of marine food fishes from Port Blair has revealed a number of digenetic trematodes including two new species (Gupta and Miglani, 1976). *Gauhatiana lebedevi* n. sp. and *Hypohepaticola andamanensis* n. sp. were the two new species from intestine of an unidentified teleost. *Ectenurus antipodus* (new geographical record), *Lecithaster indicus* (previously recorded only from an Indian freshwater fish), *Ozakia tropica* and *Waretrema piscicola* (new geographical records), *Gyliauchen ozaki* from *Acanthurus* sp. and *Siganus vermiculatus* (new hosts), *Hexangium sigani* from *Acanthurus* sp. (new host), *Hexangium loossi* from *S. vermiculatus* (new host and new geographical record), *Bucephalopsis exilis* from *Rastrelliger kanagurta* (new host and new geographical record), *Prosorhynchus ozaki* from *Rastrelliger brachyosoma* (new host and new geographical record) were also recovered. Likewise, Hafeezullah and Dutta (1980) reported *Hysterolecithoides frontilatus*, *Hamacreadium interruptus*, *Mehracola ovocaudatum* and *Bivesicula australis* from the marine teleosts.

In an another study, marine fish samples collected from the off-shore fisheries vessels and local market of Andaman showed trematode infestation, *Elongoparorchis* sp. from the *Tachysurus* sp. and cestode infestation, *Bothriocephalus* sp., from *Saurida tumbil* (Dutta and Rao, 1983). Based on these study, it is clearly found that the parasites infesting marine fishes of Andaman and Nicobar Islands were monogenetic and digenetic trematodes and cestodes.

CRUSTACEAN DISEASES

Crustacean samples namely, tiger shrimp (*Penaeus monodon*), mud crab (*Scylla serrata*) and banana shrimp (*Fenneropenaeus merguiensis*) were collected from North and South Andaman Sea including different landing centers and hatcheries to find out the prevalence of WSSV in Andaman waters during the year 2006–2007. Among the 255 samples analysed, tiger shrimp, mud crab and banana shrimp showed 25%, 18% and 8% prevalence of WSSV infection, respectively, leading to an overall prevalence of 17% in this area (Sethi *et al.*, 2011). Similar results were demonstrated in preliminary survey conducted by ICAR-CIBA during 2004 which showed 25% prevalence of WSSV in *P. monodon* and 13% prevalence to other crustaceans like *Penaeus merguiensis* and *Portunus pelagicus.*

A detailed investigation on luminous bacteria (LB), *Vibrio harveyi* isolated from *P. monodon* larvae reared in a small prawn hatchery unit of CIARI, Andaman was carried out by Shome *et al.* (1999c). The investigation revealed high bacterial counts in intake source of sea water, filter bed filtered sea water, maturation and larval rearing tanks and low bacterial counts in slow sand filtered-UV-radiation treated again slow sand filtered sea water. The main source of LB infection was pointed out to intake sea water.

Bacterial isolates were found to be sensitive to seven antibiotics namely, neomycin (30 µg), rifampicin (5 µg), chloramphenicol (30 µg), kanamycin (30 µg), chlortetracycline (30 pg), nitrofurantoin (300 µg) and norfloxacin (10 pg); however, the sensitive antibiotics when used either as prophylactic or therapeutic agents did not have appreciable effect on LB population. The non-effectiveness of the antibiotics might be related to the tendency of *V. harveyi* forming biofilms in rearing tanks. The processing of intake sea water by filtration followed by UV treatment and again refiltration, thorough cleaning of the tanks and other equipments at regular intervals to avoid biofilm formation and avoid abuse of chemotherapeutics were suggested as an effective way to reduce the bacterial count or *V. harveyi* load in the hatchery unit.

CORAL DISEASES

Surveys were conducted in Ross Island, North Bay and Marina Park in the vicinity of Port Blair, Andaman Islands to assess the health status of corals. In this survey, Ravindran *et al.* (1999) reported the necrotic lesions of *Porites* sp. in Marina Park to be extremely prevalent. About 90% of corals in these beds comprising specimens of 15–30cm in size were affected. A very high incidence of bleaching was noticed in July 1998 of which more than 90% of the massive corals and more than 75% of the branched ones were affected in the three sites. While more than 85% of corals near Ross Island and Marina Park exhibited partial bleaching, upto 10% were totally bleached. They isolated a number of fungi from coral colonies with the corals showing necrotic lesions, bleaching and also from healthy colonies as well. Finally, they suggested for regular monitoring programmes to help in assessing reef health and evolving long-term strategies for preservation and protection.

Five species of corals from the Andaman Islands have been regularly found to have single or multiple necrotic patches. From a systematic collection of corals from Andaman and Lakshadweep Islands, Raghukumar and Raghukumar (1991) reported *Scolecobasidium* sp. from five corals (*Porites lutea*, *Porites lichen*, *Montipora tuberculosa*, *Goniopora* sp. and *Goniastra* sp.). This fungal pathogen was found to cause necrotic patches on these five of the seven corals examined. The fungus formed a distinct dense brown to black zone of 0.5–1.5 cm width immediately below the surface of the corals. In terms of biomass, the fungus was estimated to contribute 3–5 mg cm^{-3} of coral skeleton. Such patches ranged from 9% in *M. tuberculosa* to 54% in *Goniopora* sp. in the Andaman Islands.

Andaman sea witnessed a few bleaching events during 1998, 2002 and 2005. A study was taken up to assess the extent of bleaching due to increased sea surface temperature (SST) during 2010 in selected reef sites of Andaman and found that the fully bleached corals as a percentage of total coral cover were maximum at Havelock Island (69.49), followed by South Button Island (67.28), Nicolson Island (56.45), Red Skin Island (43.39), North Bay (41.65) and Chidiyatapu (36.54). Branching corals namely, *Acropora formosa*, *Acropora nobilis*, *Acropora robusta*, *Acropora breuggemanni* and *Acropora grandis* were the worst affected, whereas the massive corals were found to have relatively withstood the elevated SST. It is only hoped that the affected corals in the current bleaching event in the Andaman would recover to their original status, given the prevailing favourable environment, following the onset of monsoon (Krishnan *et al.*, 2011). All the reported aquatic animal diseases in Andaman and Nicobar Islands are given in Table 1.

Based on a survey conducted at Burmanallah coast of Andaman Islands, it was found that *Porites* species was affected with an array of diseases like yellow spot disease, pink line syndrome, white line syndrome, white plague and black band disease (Ramesh *et al.*, 2014). Among all these reported diseases, the *Porites* species was found to be highly affected by pink line syndrome. Besides these diseases, ring line syndrome was found only in *Acropora humilis* and *Acropora monticulosa* and abnormal growth was observed in *A. humilis* and *Porites* sp. They pointed out that diseases observed in this study may be due to *Vibrio* sp. which causes black band disease, white syndrome, yellow band disease and tissue lesions while increased CO_2 concentration causes pink line syndrome.

Table 1: Aquatic animal diseases in Andaman and Nicobar Islands

Disease	Causative Agent	Affected Aquatic Animal	Reference
Freshwater fish diseases			
Acute form of abdominal dropsy	*Aeromonas hydrophila*	*Cirrhinus mrigala* (Mrigal)	Shome *et al.* (1996)
Atypical chronic form of abdominal dropsy	*Aeromonas hydrophila*	*Catla catla* (Catla)	Shome (1999)
Marine fish diseases			
Pop-eye disease	*Vibrio species*	*Epinephelus* spp. (Grouper), *Caranx* spp. (Jack), *Triacanthus* spp. (Tripod fish), *Platax* spp. (Bat fish), *Balistapus undulatus* (Undulata trigger fish), *Pterois* spp. (Lion fish), *Chaetodon vagabundus* (Vagabond butterfly fish), *Canthigaster margaritata* (Pearl toby), *Naso* spp. (Tang fish) and *Lutjanus* spp. (Snapper)	Shome *et al.* (1999b)
Monogenetic trematode infestation	*Diplectanum blairensis*, *Diplectanum jerbuae, Protancyrocephalus rangusi*, *Pseudoalitrematoides bengalensis* and *Hammatopeduncularia arii*	*Sillago sihama* (Silver whiting), *Terapon jarbua* (Tiger perch) and *Lutjanus rangus* (Sweetlip snapper)	Gupta and Madhu (1974)
Digenetic trematode infestation	*Gauhatiana lebedevi* n. sp., *Hypohepaticola andamanensis* n. sp., *Ectenurus antipodes*, *Lecithaster indicus*, *Ozakia tropica*, *Waretrema piscicola*, *Gyliauchen ozaki*, *Hexangium sigani*, *H. loossi*, *Bucephalopsis exilis*, *Prosorhynchus ozaki*, *Hysterolecithoides frontilatus*, *Hamacreadium interruptus*, *Mehracola ovocaudatum* and *Bivesicula australis*	Marine fishes mainly *Acanthurus* sp. (Surgeon fish), *Siganus vermiculatus* (Vermiculated spinefoot), *Rastrelliger kanagurta* (Indian mackerel), *Rastrelliger brachyosoma* (Shortbodied mackerel)	Gupta and Miglani (1976), Hafeezullah and Dutta (1980)
Trematode and cestode infestation	*Elongoparorchis sp. Bothriocephalus sp.*	*Tachysurus* sp. (Marine catfish) and *Saurida tumbil* (Lizard fish)	Dutta and Rao (1983)
Crustacean diseases			
White spot syndrome disease	White Spot Syndrome Virus (WSSV)	Tiger shrimp (*Penaeus monodon*), Mud crab (*Scylla serrata*) and Banana shrimp (*Fenneropenaeus merguiensis*)	Sethi *et al.* (2011)
Luminescent vibriosis	*Vibrio harveyi*	Tiger shrimp (*Penaeus monodon)*	Shome *et al.* (1999c)
Coral diseases			
Necrotic patches	Fungi mainly *Scolecobasidium* sp.	Corlas mainly *Porites* viz., *Porites lutea*, *P. lichen*. Others like *Montipora tuberculosa*, *Goniopora* sp. and *Goniastra* sp.	Ravindran *et al.* (1999), Raghukumar and Raghukumar (1991)

Table 1 cont.....

Disease	Causative Agent	Affected Aquatic Animal	Reference
Bleaching of corals	Elevated Sea Surface Temperature (SST)	*Acropora formosa*, *Acropora nobilis*, *Acropora robusta*, *Acropora breuggemanni* and *Acropora grandis*	Krishnan *et al.* (2011)
Yellow spot disease, pink line syndrome, white line syndrome, white plague, black band disease, tissue lesion, ring line syndrome and abnormal growth	*Vibrio* sp. and increased CO_2 concentration	*Porites* sp. *Acropora humilis*, *Acropora monticulosa*	Ramesh *et al.* (2014)

CONCLUSION

The aquatic environment of Andaman and Nicobar Islands when compared to mainland is also infested with some of the aquatic pathogens. On the other hand, no systematic study on the disease status of wild and cultured fishes has been carried out to know the present health status of the aquatic animals of the Bay Islands. In this background, ICAR-CIARI has initiated a project on surveillance of aquatic animal diseases and would also develop the management strategies to combat the identified diseases. Active and passive surveillance would be carried out in this project to identify the diseases that infect the aquatic animals. The outcome of the project would deliver baseline information on the disease status of the commercially important fishes of Bay Islands and also develop the ability to manage aquatic animal health issues in the Islands.

Further in the light of the local administration's keen interest to promote brackishwater aquaculture and mariculture in the Islands, ICAR-CIARI's ambitious programme on biosecurity and aquatic quarantine will be of immense value for the Islands to control the entry of pathogens from the mainland which inturn will be useful for the carp farmers to get good quality seeds for the aquaculture purpose. Detailed information on the aquatic animal diseases would lead to the development of policies and plans to check the introduction and spread of diseases into this relatively virgin ecosystem. Ultimately, disease free aquaculture practices and healthy aquatic ecosystem leads to the improved production for the famers and sustains its resources for the future generation.

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