1. GENERAL INTRODUCTION

The world’s water ecosystem comprises of freshwater, coastal and marine are among its most productive, yet threatened ecosystems. They ranges from mountain glaciers to open oceans, including areas where freshwater and saltwater combine the near shore coastal waters (UNEP). Marine and freshwater ecosystems cover more than three-quarters of the Earth's surface, providing an array of critical ecosystem services by participating in various biogeochemical cycles and nutrient exchange, to provide natural protection and habitat, to degrade and disperse many environmental pollutants (http://www.enviroliteracy.org/). Two different life zones found in a coastal zone includes an estuary and coastal wetland. Estuaries are enclosed vicinity of coastal water where ocean water combined with freshwater from inland rivers and streams forming briny water. Coastal swamplands are including great expansions of land from which water drains directly into the oceans and are the life zones for various flora and fauna. They also make available as to recreation areas.

1.1. Current State of World Fisheries and Aquaculture

Fish and fish products constitute a major source of income, food and recreation in the global economy. Fish products originate from two main modes of production: harvesting of wild fish (marine and freshwater) and aquaculture. The latter is defined by the Food and Agriculture Organization of the United Nations as “the farming of aquatic organisms as well as fish, molluscs, crustaceans and aquatic flora” (FAO, 2012b). In 2010, wild capture fisheries and aquaculture supplied the world with about 148 million tonnes of fish, worth US$ 217.5 billion. Approximately 128 million tonnes or 86 percent were used for human consumption. Preliminary data for 2011 indicates that production has increased to 154 million tonnes, of which about
131 million tonnes, or 85 per cent, were consumed as food (FAO, 2012a, World Bank, 2010).

Indian Fisheries was a very important economic activity and a flourishing sector with varied resources and potentials. Only after the Indian Independence, has fisheries together with agriculture been recognized as an important sector. The vibrancy of the sector can be visualized by the 11 fold increase that India achieved in fish production in just six decades, i.e. from 0.75 million tonnes in 1950-1951 to 9.6 million tonnes during 2012-2013. This resulted in an unparalleled average annual growth rate of over 4.5 percent over the years which have placed the country on the forefront of global fish production, only after China. Besides meeting the domestic needs, the dependence of over 14.5 million people on fisheries activities for their livelihood and foreign exchange earnings to the tune of US$ 3.51 billion (2012-2013) from fish and fisheries products, amply justifies the importance of the sector on the country's economy and in livelihood security. India is also an important country that produces fish through aquaculture in the world. India is home to more than 10 percent of the global fish diversity. Presently, the country ranks second in the world in total fish production with an annual fish production of about 9.06 million metric tonnes (FAO, 2005).

The threat of disease has now become a primary constraint and risk to growth of aquaculture sector, significantly impeding both economic and socioeconomic development in regions dependant on aquaculture and fisheries. The importance of prevention and control of disease risk as a measure to reduce production losses in commercial, semi commercial and small scale aquaculture systems has thus received increased attention. Many factors have contributed to the health problem currently faced by aquaculture including those of the rural, small scale sector. Parasitic diseases
attributable to obligate or opportunistic eukaryotic pathogens continue to have a major impact on global finfish and shellfish aquaculture, and in many regions they represent a key constraint to production, sustainability and economic viability.

1.2. Parasites

The term ‘parasite’ refers to unicellular or multicellular organisms that derive benefit from a symbiotic relationship at the expense of their host. Despite the fact that parasites are typically much smaller than their hosts, infections often have momentous consequences for host biology. The idea of harm caused to the host is a concept central to many explanations of parasitism that have been proposed. Parasites are generally harmful to their hosts, although the damage they do range widely from minor inconvenience to debilitating or fatal diseases. There is an intrinsic negative effect that a parasite exerts on exploited organisms. Eventually this so called virulence (Day, 2003; De Roode et al., 2005) can trigger the evolution of antagonistic mechanisms against the parasite visible for example in specific immune response of the host (Wakelin, 1996; Claerebout and Vercruysse, 2000).

1.3. Branchiura- Argulids (Fish Lice)

Crustaceans constitute the second largest class in the Phylum Arthropoda and it includes the following subclasses Branchiopoda, Ostracopoda, Copepoda, Branchiura, Cirripedia and Malacostraca. Pavanelly et al. (1998) reported that nearly 25% of the parasites in the marine fishes are crustaceans, especially Copepoda, Branchiura and Isopoda. About 3000 species of ectoparasites that have been documented and their impact on fish health can directly causes mortalities or indirectly acting as vectors for secondary diseases.

Investigations on continental and regional scales prove that the subphylum Crustacea Brunnich was the most successful taxonomic cluster of aquatic alien
invaders (defined by Engelkes and Mills, 2011) across the world (Devin et al., 2005; Karatayev et al., 2009). Biogeographic analyses of Branchiura were made by Fryer (1969) with reference to Dolops, which displays a Gondwanan distribution (South America, Africa, and Tasmania) and the biogeography of African species of Argulus, Chonopeltis and Dolops was talk about by Fryer (1968). Chonopeltis and Dipteropeltis are common to Africa and South America, respectively. Diminutive information’s are available on the biogeography of this group. Argulus japonicus (Thiele, 1900) has been imported from East Asia and Southeast Asia to all other continents excepting Antarctica. Indigenous species do not occur across great distances in most cases except for a few species in the Afrotropical province, namely Dolops ranarum (Stuhlmann, 1891) and A. africanus (Thiele, 1900) (Fryer,1968) and for A. foliaceus (Linne, 1758) in the Palearctic region. Definitive discussions about species distributions cannot be made awaiting additional species are described and further collecting and taxonomic study reveal exact diversity more precisely.

Fish lice, argulids or branchiurans form a tiny subclass of crustaceans. They can be very hurtful to fishes mainly those in hatcheries and culture facilities. About 150 species have been described under 5 genera, more than 120 in the genus Argulus. They are relatively large parasites varying from a few to 20 millimeter long (Williams and Lucy Bunkley-Williams, 1996).

Most branchiurans take place in fresh water but a few species of the genus Argulus are ectoparasites on the skin of marine fish. Branchiurans are predominantly ectoparasites of fishes but rarely recorded from the tadpoles of amphibians. They live mainly in fresh water environments both running and stagnant water and may occur at high density in artificial water bodies such as ornamental fish ponds, fish farms and reservoirs. A few species of Argulus infect the marine, coastal and estuarine fishes but
they do not take place in oceanic waters. In Chile and Canada infestations with argulus have been stated from marine fish farming systems and they can cause mortality in farm salmonid stocks (http://www.vims.edujjef/biology/parasitic%20crustaceans.pdf)

A specimen of *Argulus* taken from the body surface of the marine perch *Psammoperca waigiensis* (Cuvier) caught from the Palk Bay near Mandapam has been found to be a new species. Species and subspecies of the genus *Argulus Muller* so far recorded from India are *A. indicus* Weber, *A. giganteus* Ramakrishna, *A. bengalensis* Ramakrishna, *A. siamensis* Wilson, *A. siamensis peninrularis* Ramakrishna and *A. puthenveliensis* Ramakrishna. The post embryonic development of *A. puthenveliensis* has been dealt by Thomas (1961). Thomas and Devaraj described two new species, namely *A.fluviatilis* and *A. Cauveriensis* collected from the river Cauvery. (Devraj and Ameer Hamza, 1977).

**1.4. Problems in Aquaculture Caused by *Argulus* spp.**

Several alien Crustacea have been moved unintentionally for long distances outside their native ranges as “contaminants” of commodities. Amphipods, Branchiurans, Decapods, etc. may infect the fish stocks or stocks of other taxa. For example, the branchiuran fish louse *A. japonicus* Thiele has a worldwide distribution being moved with koi carp, *Cyprinus carpio* (L.) and other farmed fish from the Orient (Lester and Roubal, 1999).

Fish farmers fear branchiurans above other parasites and of all the branchiuran parasites *Argulus* is said to be the most feared possibly because the pathogenic effects caused by *Argulus* are relatively more severe when compared to other branchiuran genera (Reichenback- Klink and Elkan, 1965).
Branchiuran parasites of fishes were typically found in the walls of the branchial chamber and are not eternally attached to their hosts, but they can move gradually on outer surface of the body and slowly swim to depart from one fish to another. Sexual dimorphism is not marked. There is only way to prevent the *Argulus* infection was to refute parasites contact to cultivable fishes. Since both adults and larval phases were energetic swimmers, it was difficult to prevent them from entering the pond. Suitable filter designs might prove more efficacious to check the degree of infestation (Jithendran *et al.*, 2008).

Parasites which infest fish under natural conditions are less of a threat than to those under artificial conditions (Walker *et al.*, 2004). There are three major groups of parasitic crustaceans disturbing the commercially important aquaculture species namely Branchiura, Copepoda and Isopoda. Most of them are external parasites. Members of Branchiura and Isopoda are comparatively large and both sexes were parasitic, while copepods the most common crustacean parasites are usually minute to microscopic with both free living and parasitic phases in their wheel for life (Jithendran *et al.*, 2008). In closed systems (ponds, fish farms, ornamental fish tanks) argulid species can pose a substantial hazard to fish health and survival. Under artificial environment *Argulus spp.* are known to cause large monetary loss in fish farms where they are able to demolish fish very quickly. The planktonic larvae and motile matured forms were infest the farmed fishes from natural populations and neighboring farms but their progeny are then released from the net pens into the surrounding atmosphere where they may transmit a disease to untamed hosts. India losses US$ 1428 per hectare per year in carp culture due to argulosis (Sahoo *et al.*, 2013).
A. *mugilis* has been reported from a mullet in Kiangsu Province in China (Wang, 1964), and A. *funduli* and A. *chesapeakeensis* from *Mugil cephalus* along the Southeastern Atlantic coast of the United State (Rawson, 1973b; Skinner, 1974). *A. jiavescens* Wilson and *A. jioridensis* infest mullet along the Gulf Coast of the United States (Cressey, 1972). In Mississippi (Overstreet, 1974) what was apparently a rather host-specific species. Since species of *Argulus* can easily decimate stocks in confined areas, they should be considered a threat to mullet in aquaculture. Ljaiman (ascited by Sarig and Lahav, 1959) reported that argulids kill fry and fingerlings by the thousands. In Israel during the summer, marketable carp are stored for up to several weeks in 0.5-2.4ha ponds at densities up to 10000fish/ha. Infestations of argulids and *Lernaea cyprinacea* cause ugly wounds, loss in weight and an unmarketable product. Such infestations are now controlled with periodic treatments with pesticides (Sarig, 1968).

### 1.5. Effect of Human by *Argulus* Species

Most of the fishes have parasites, it’s not only serve as the host for different parasites but also serve as carrier of many larval parasitic forms that mature and cause serious diseases in many vertebrates including man. The parasites of fishes cause decrease in growth rate, weight loss and emaciation, affect yield of fish products (liver oil etc), spread human and animal diseases and postpone sexual maturity of fish and mortalities of fish (Chandra, 2006)

Fish lice can infect the eyes of humans and bite careless handlers of live fishes. They are the only crustacean fish-parasites known to infect humans. Others may bite or attack humans, but only *Argulus* spp. penetrate, survive in, and cause diseases in humans. Hargis (1958) reported the first case of human argulosis in a child infected by *A. laticauda* while swimming in salt water off the Atlantic coast of the
USA. One of these argulids was splashed into her face and lodged between her eye and the orbit. It caused severe irritation and minor tissue damage for 24 hours before it was discovered and removed.

Parasites are studied for several reasons but one of the main driving forces behind parasitology studies is the effects they have on humans. This can be either directly in the case of parasites infecting humans or indirectly by infecting livestock in both terrestrial and aquatic farming operations. When factors such as parasite distribution and relative lack of host specificity are considered, the genus *Argulus* can be regarded as one of the most widespread and economically important groups of crustacean ectoparasites affecting freshwater fish around the globe (Bower-Shore, 1940; Menezes *et al.*, 1990; Shafir and Oldewage, 1992; Taylor *et al.*, 2006). Whilst, morbidity is not always linked to infections of *Argulus* spp. the direct and indirect results of louse infections can still be significantly costly to aquaculture and sport fishing operations (Menezes *et al.*, 1990; Northcott *et al.*, 1997; Taylor *et al.*, 2006). In addition to the deleterious impacts resulting from parasitic feeding and attachment, secondary infections from bacteria and fungi (Stammer, 1959; Shimura *et al.*, 1983; Singhal *et al.*, 1990) are very common and argulids have also been shown to act as vectors for other pathogens including nematodes (Moravec, 1994; Molnar and Szekely, 1998) and viruses (Dombrowski, 1952; Ahne, 1985; Cusack and Cone, 1986).

Recent spreading of parasites throughout the world has been expedited during insufficient of veterinary control in import of fish. Control of various major parasitic infections is still far from being satisfactory and advance research is needed. Using of chemotherapy has restrictions and novel efficacious but eco friendly narcotics should be developed. A very assuring area of future explore give the impression to be studies
on resistance in parasitic diseases, make use of molecular techniques in diagnostics and improvement of novel drugs against the most pathogenic parasites and its associated secondary microbial infections.