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Aquatic and Avian Biodiversity of Pulicat Brackish Water Lake and Ecological Degradation

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Abstract: The Pulicat Lake avifauna, aquatic and mudflat faunal diversity were described. During the years 2007-2009 about 31 bird species visited Pulicat Lake feeding grounds. During monsoon season about 75-85% of zooplankton belong to copepoda and decapoda. Due to tectonic upliftment of lake bed West of Rayadoruvu sea mouth, Attakanithippa and Weynadu areas a shallow water regime persists. This is responsible for rich biodiversity namely crustacean plankton, juvenile shrimps and migratory fishes from sea to lake and vice versa acting as food for Pelicans, Flamingoes and a variety of waders unlike near Pulicat Village south end sea mouth due to deep water regime. It is opined that the avifaunal and aquatic faunal diversity and density depends upon Pulicat Lake water level and water resident time. This is in turn dependent on sea mouth width and monsoon rainfall amounts. Loss of avifaunal and aquatic faunal diversity were attributed to quick drying up of lake in January due to less flow of sea water from constricted sea mouths even before the migratory bird season which lasts up to March. A few important fishes and shrimps which migrate from sea to lake and vice versa were described. The causes of ecodegradation is discussed.

Key words: Pulicat Lake % Avian diversity % Migratory fishes % Shrimps % Aquatic fauna

INTRODUCTION

The Pulicat lagoon extending between 13° 20' and 13° 40' N lat. and 80° 14' to 80° 15' E log. and formed out of backwater of the Bay of Bengal. It is the second largest brackish water lagoon having an area of approximately 600 km^2 and has three sea mouths Tupilapalem, Rayadoruvu and near Pulicat Village [1-4]. Satellite remote sensing complimented by ground level field work revealed that Sea mouths of Pulicat Lagoon are life supporting corridor systems for migration of fauna from sea to lake and vice-versa and particularly after breeding or spawning in fishes and crustaceans [2,3]. Besides, the sea mouths are gateways to entry of lake water during high tide and for entry of lake water during low tide [2,3]. This process is a rhythmic and ecochronobiological process for ecosustainability of lake fauna and flora [1,2]. Hence, an attempt was made to list faunal diversity, both qualitatively and quantitatively at sea mouths and also in Pulicat Lake. The avifauna observed in Pulicat Lake is also listed. Aquafaunal and avifaunal diversity and its sustainability is at peril due to gradual closure of three sea mouths by sand deposition due to blowing of wind towards north [2,3]. The degree of closure of Tupilipalem and Rayadoruvu sea mouths of Andhra Pradesh is greater than the Pulicat Lake village sea mouth located in Tamil Nadu due to deep water [3]. Due to tectonic lake bed upliftment, the water level is shallow beyond Rayadoruvu sea mouth namely at Attakinithippa and Weynadu located towards West of Sriharikota Island [3]. This area consists of mudflats during monsoon rainy season also and is responsible for shallow water, which is a boon for biodiversity and also natural feeding ground for Flamingoes, Pelicans and a variety of waders and other birds which feed on mudflat worms and molluscs (Table 1; Fig. 1). Gradual closing of sea mouths in Andhra Pradesh would affect aquatic faunal feed required for more than 150 bird species [5] over a period of many years in the past which also include local and long distant migrants. But, due to closure of sea mouths and quick

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Table 1: Mean density of zooplankton in Pulicat Lake near Attakanithippa, Weynadu and Pulicat Village during premonsoon and monsoon period from 2007-2009

Zooplankton Mean density (No./100CFT)					
Attakanithippa		Weynadu		Pulicat Village	
Premonsoon June-Sept	Monsoon Oct-Dec/Jan	Premonsoon June-Sept	Monsoon Oct-Dec/Jan	Premonsoon June-Sept	Monsoon Oct-Dec/Jan
Dry Nil	8,59,100	Dry Nil	28,330	11,340	20,000

Values are mean of six observations at six random locations on monthly basis

Fig. 1: Flamingoes, Pelicans, Waders and Painted storks

drying up of lake in several parts 61 species wintering birds recorded earlier [5] has come down to 31 species in 2009-2010 as recorded in this research paper. Qualitative listing of aquatic and avifauna in the present context would be useful to assess the state-of-the-art biodiversity of Pulicat Lake. Satellite remote sensing data without field work reported earlier by Nageswara Rao *et al.* [6] might not reveal ecobiological changes in field, species number, ecomorphology unlike the data combined with ground level field work reported recently [2-4].

MATERIALS AND METHODS

Plankton collection and density was estimated by the method described by Trivedy *et al.* [7] as adopted by Nanda Kumar *et al.* [3]. The fish catch was made by fishermen at sea mouth and Pulicat Lake. The fishes and other aquatic marine plankton of lake bed (sediment) organisms were identified as described by Srivastava [8], Newell and Newell [9] and Sanjeeva Raj [10]. The sea mouths include Tupilapalem, Rayadoruvu and Pulicat Village mouth located on northern middle and southern portions of 600 km^2 area of Pulicat Lake, [2,3]. The avifauna was identified [4] as described by Salim Ali and Ripley [11]. Types of avifauna and their habitats found in different locations were also described.

RESULTS AND DISCUSSION

Sea Mouth Zooplankton Diversity Estimation and Importance: The plankton analysis was made near sea mouth where lake water or sea water enters into sea or lake, respectively; as sea mouth is an important biocorrider for maintenance of biodiversity of Pulicat Lake [3]. The microplankton which drifts passively into lake, from the Neretic province, is an important trophic level II organisms which browse on submerged weeds, algae, microorganisms and act as food for trophic level III organisms namely fishes, shrimps swimming invertebrates and among avifauna Flaminoges (Fig. 1) and variety of waders. The tropic level IV of food chain includes migratory birds such as Pelicans, Painted storks, White Ibis etc (Fig. 1) as listed in Table 2. The zooplankton commonly found near sea mouth is not permanent plankton unlike plankton found in mid lake. They belonging to various phyla viz., Protozoa, Coelenterate, Chaetognatha, Anneldia, Arthropoda, Mollusca, Fish eggs etc. The plankton density shows seasonal differences. The above plankton analysis showed that 75 to 80% plankton belongs to order Copepoda and Decapoda. The following are plankton which were identified in sea mouth which drift towards lake during high tide and drift to sea during low tide. Plankton biodiversity which drift at three sea mouths Tupilipalem, Rayadoruvu and Pulicat Village of Pulicat Lake Brackish water lagoon are: Protozoa: Ceratium, Nocticula; Coelenterate: Aurelia sp; Copepods: Calanoids, Harpacticoida; Malacostraca: Decapods, Amphipods, Ostracod, Cladocera, Gastropoda, Gastropod larvae, Chaetognatha; Sagitta; Fishes: Fish egg; Polychaeta: Polychaete larvae (Fig. 2). The plankton density at a given time at sea mouth is lower than mid lake due to flowing water at sea mouth. The plankton density and diversity as observed in decreasing order through out the year are Copepods > Decapods > Fish eggs. The mean density of plankton is 10,123; 11,840; 10,400/100 CFT for the years 2007, 2008 and 2009 at Tupilipalem, Rayadoruvu and Pulicat Village sea mouths respectively.

Table 2: Biodiversity of avifauna of Pulicat Lake in 2009 and 2010

S.No.	Name of the family	Common Name and Common feeding area	Scientific Name
1	Pelicanidae	Grey pelican (shallow water)	Pelicanus philippensis
2	Phoenicopteridae	Flamingo (shallow water)	Phoenicopterus ruber
3	Scolopacidae	Common sand piper (mud flat) Little stintStringa totanus Curlew	Tringa hypoleucos Calidris minuta Red shank Numenius arquata
4	Anatidae	Shoveller (deep/shallow water) Spot billed duct Common teal (mud flat)	Anas clypeata Anas poicilorhyncha Anas crecca
5	Rallidae	Common coot (deep water)	Fulica atra
6	Ardeidae	Little egrets Cattle egrets (shallow water) Grey heron (shallow water/mud flat) Large egrets Pond heron	Egretta garzetta Bubulcus ibis Ardea cinerea Ardea elba Ardeola grayil
7	Recurvistridae	Black winged stilt (shallow water/mud flat)	Himantopus himantopus
8	Threskiornithidae	White ibis (deep water / shallow water) Spoon bill (mud flat)	Threskiornis aethiopica Platalea leucorodia
9	Podicepitidae	Little grebe (shallow/deep water)	Tachybaptus ruficollis
10	Charadridae	Little ringed plover (mud flat/shore) Red-Wattled lapwing	Charadrius dubius Vanellus indicus
11	Ciconidae	Open bill stork (mud flat) Painted stork (shallow water/mud flat)	Anastmous oscitan Mycteria leucocephala
12	Phalacrocoracidae	Little cormorant (deep water/ shallow water) Large cormorant	Phalacrocorax niger Phalacrocorax carbo
13	Laridae	Black-headed gull (mud flat/shallow water) River tern	Larus ridibundus Sterna aurantia

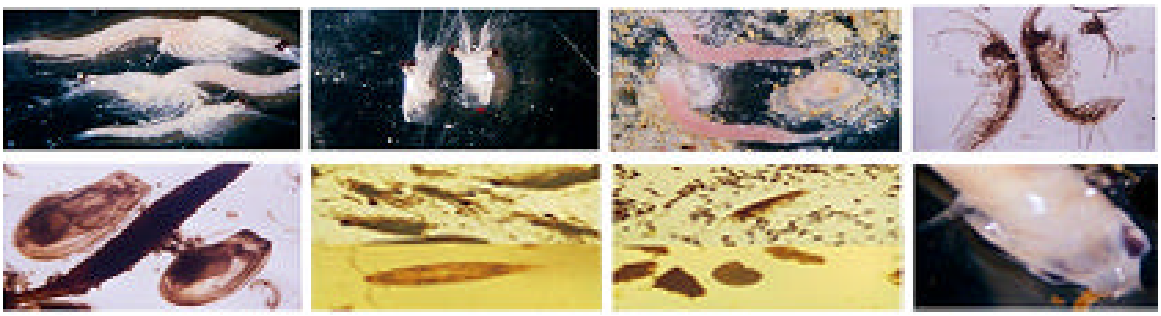

Fig. 2: Zooplankton diversity and larval fish

It has been observed that plankton is not permanent at sea mouth and showed low density and drift to sea or lake vice-versa unlike plankton density in mid lake where water flow current is minimum unlike near sea mouth. The water flow current is maximum due to narrowing and was recorded as 900 meters per one hour as the 660 sq. km area narrows into sea mouth. The water during high tide and low tide shows fast movement i.e. 900-1200 meters/hour. However, it is very important fact to know from our field studies that low density plankton which move along with sea water into lake is responsible for gradual plankton density build up in mid lake. Molluscan larvae, fish eggs, adult larvae, fingerlings, juvenile fishes drift or move from sea mouths and reach their adult hood in mid lake. Subsequently, they drift away by powerful monsoon winds during monsoon season or normal sea breeze towards lake shallow sublittoral or coastal region where Flamingoes and wading birds feed (Fig. 1). Hence, sea mouth is a biocorridor for biodiversity of lake. Qualitative analysis of plankton is very important in this context. Earlier satellite remote sensing data and direct observational data showed that a gradual closure of three sea mouths of lake is taking place due to northern winds [2,3]. Medusae (Jelly fish) are washed ashore near Pulicat Lake Village sea mouth (Fig. 6a). Nanda Kumar *et al.* [3] recommend dredging and construction of groyne at sea mouths to prevent sand bar formation and to allow sea water to flow into lake for ecological sustainability.

Plankton Density and Diversity in mid Pulicat Lake: The plankton density and diversity in mid Pulicat Lake i.e., away from sea mouth at different locations showed seasonal quantitative and qualitative changes i.e., pre monsoon, monsoon and post monsoon. The plankton density during different seasons in three sea mouths Tupilapalem, Rayadoruvu and Pulicat Village is presented in Table 1.

From table 1, it is an established fact that the plankton density in the mid lake and in the sublittoral coastal region is high if compared to plankton density at sea mouths (Fig. 3). The plankton in decreasing order: Copepods > Decapods (adults and larvae) > Dendrobrachiata > Lucifer > Amphipods > Polychaete larvae > Gastropod larvae > Foraminifers > Fish eggs.

Fig. 3: Ball of Plankton collected from net due to plankton bloom

Fig. 4: Migratory fishes and shrimps of Pulicat lake (Migration: Sea-Lake-River)

Fig. 5: Fish catch at Pulicat lake village

The plankton which are abundant during monsoon season are Decapoda, Calanoida, Harpactioida, Amphipoda, Mysidacea, Euphausiacea, Fish eggs, moderate level are Cladocera and less abundant are Polychaete larvae and Sagitta (Fig. 3). Rich plankton found in shallow water are feeding grounds of migratory birds (Fig. 1).

Adult fishes and fish larvae migrate from sea to Pulicat Lake during October to January (Fig. 4). However, the larval forms of fish were found throughout the year during 2007 due to heavy rainfall with water inflow into lake. The fish catch was high compared to the year 2008 and 2009. The following are the migratory fishes from sea which grow from small larval form and small size to larger size in Pulicat Lake [11] and also observed by the investigators. *Silage sp, Chanos sp* (larval migration to lake from sea), *Eutroplus suratensis*, *Gerres sp* (adults in lake), *Hemirhampus sp* (breed in lake shallow water), *Siganid sp* (juveniles), *Mystus sp* (breed in lake and lay eggs), *Triacanthus sp, Platycephalus indicus*, *Plotosus canius*, *Sardinella sp, Hilsa kelee*, *Liza parsia*, *Epinephelus sp, Latzanus sp, Mugil sp* (larval migrate to lake from sea), *Hemirhampus far, Lates calcarifer*, *Silago sp, Megalops ciprinoides* (Fig. 4). The book written by S.R. Munro on "The Marine and Fresh Water Fishes of Ceylon" and summarized by Sanjeevaraj [10] and Balasubramanian [12] listed 168 species of fishes belonging to different orders and families. However, the fishes which were mostly found near sea/lake mouth up to 2km which migrate from sea to lake and vice-versa is listed. The fish catch has come down by 40% from 2008-2010 due to closure of sea mouths, less rainfall or late monsoon rainfall and sedimentation (Fig. 5).

Shrimps and Molluscans: The most common shrimps found in Pulicat Lake are *Panaeus indicus, Panaeus monodon, Panaeus semisulcatus* (Fig. 4). A few edible molluscans (shell fishes) of Sepia and Loligo sp found in Pulicat Lake are shown in Fig. 6a. A variety gastropod molluscans found on the sea mouth sand bar and lake

Fig. 6(a): Sepia species, carbs and Medusae (Jelly fish)

Fig. 6(b): Gastropod diversity

Table 3: Mudflat diversity

S.No	Name of the Family	Species	Source
1	Aphroditidae	*Harmothoe ampullifera*	Sanjeeva Raj, [10]
2	Pisionidae	*Pisione complexa*	
3	Phyllodocidae	*Eteone barantollae*	
4	Hesionidae	*Hesione intertexta*	
5	Nereidae	*Lycastis indica*	
6	Nereidae	*Nereis chilkaensis*	
7	Nereidae	*Tylonereis fauveli*	
8	Eunicidae	*Diopatra neapolitana*	
9	Eunicidae	*Marphysa gravely*	
10	Eunicidae	*Lumbriconereis simplex*	
11	Eunicidae	*Lumbriconereis polydesma*	
12	Glyceridae	*Glycera alba*	
13	Spionidae	*Nerine cirratulus*	
14	Spionidae	*Prionospio krusadensis*	
15	Spionidae	*Polydora ciliate*	
16	Capitellidae	*Branchiocapitella singularis*	
17	Capitellidae	*Barantolla sculpta*	
18	Maldanidae	*Euclymene annandalei*	
19	Maldanidae	*Euclymene insecta*	
20	Ampharetidae	*Amphecteis gunneri*	
21	Sabellidae	*Laonome indica*	
22	Sabellidae	*Potamilla leptochaeta*	
23	Serpulidae	*Hydroides norvegica*	

coast are shown in Fig. 6b. The prawns of *Panaeid* group breed in sea, some in shallow water and others off-shore. Breeding begins after north east monsoon and lasts several months (October to January) in low salinity brackish water [3]. Fecundity being high small demersal eggs numbering a few thousands is laid. Post larvae of *Panaeid* prawns migrate to brackish water Pulicat Lake. This forms food for Flamingoes and waders. Due to late monsoon or low rainfall the density of plankton was less in the year 2008 and 2009 and the lake at shallow water regime (Attakanithippa and Weynadu) dried up in January itself increasing salinity [3]. The Flamingoes were not observed in these areas unlike in the past. Interestingly about 30 Flamingoes and a few Pelicans were found near Kudiri, a fresh water body, adjacent to Pulicat Lake in January 2010 and their stay was limited to 8-15days only.

Avian diversity: The migratory birds which were observed from October to March/April are listed below; which feed an above mentioned plankton, molluscs, shrimps, fishes and organic debris (Fig. 1).

Biodiversity at Kudiri Fresh Water Body Proximal to Pulicat Lake: Kudiri is fresh water body fed by Kalingi rivulet between Sullurpet and Pulicat Lake. Kudiri is an ideal fresh water body act as a secondary microhabitat and life supporting system only when heavy rainfall

Fig. 7: Thermal death of fishes

occurs more particularly during late monsoon (December) (Fig. 1). The rain and river fed Kudiri water body with fishes, shrimps and molluscans are ideal food for Pelicans, Painted storks, Open bill storks, Pin tails, coots and other waders. For the year 2007 and 2010 only migratory birds were found in Kudiri and in 2008 and 2009 year in January and February the Kudiri was dry.

Mud Flat/sand-silt/shallow Water Bed: The mud flats both exposed and partly submerged, shallow water Pulicat bed are habitat of many polychaetes. Sanjeeva Raj [10] reported 13 families of class polychaetes and the common species found in Pulicat Lake. The Table 3 gives the polychaetes recorded in Pulicat Lake by Sanjeeva Raj [10].

It is concluded that the number of migratory avifauna species and aquatic fauna which includes fishes, shrimps and zooplankton recorded in 2008 and 2009 are relatively less compared to earlier records of Madras Natural Society [5] Census. The loss of biodiversity is due to gradual closure of sea mouth [2,3] quick drying up of Pulicat Lake in January itself [3] whereas migratory birds season lasts upto March. Sea mouth being biocorridor for fish and shrimp migration, drying up of lake and thermal death of fishes (Fig. 7) in January itself in 2008 and 2009 [3] also a major factor for biodiversity loss. The plankton and nekton dependent avifauna numbers also seem to vary depending upon aquatic faunal density.

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