

1. GENERAL INTRODUCTION

The wetland vegetation and intertidal areas act as enormous natural filters removing much of the nutrients, sediments and pollutants from the catchments area. This filtered water benefits human and marine life in the estuary (Turner and Riddle, 2001). Coastal wetlands directly support millions of people and provide goods and services to the world outside the wetland. People use wetlands for various purposes like agriculture, fishing, timber and food, wood collection and recreation (Mitsch, 1998). The most variable aquatic environments on earth are estuaries and are known to be more productive than adjacent freshwater and marine environments (Woodwell *et al.*, 1973; Haedrich and Hall, 1976). The productivity is comparable to that of a tropical forest and about four times as productive as good ryegrass pasture (Knox, 1980). The conservation of biodiversity and management of aquatic environments has become a major concern in recent years. Estuaries are important nursery areas for juveniles of many species of estuarine and marine fishes (Dando, 1984; Wallace *et al.*, 1984).

The term estuary is derived from the Latin word '*Aestus*' meaning tide, and hence, '*Aestuarium*', a tidal arm of the ocean. An estuary is a partly enclosed coastal body of water with measurable quantity of salinity, one or more rivers or streams flowing into it and with a free connection to the open sea (Pritchard, 1967). According to Odum (1971), estuaries are semi-enclosed coastal water bodies that receive fresh water drainage from the surrounding terrestrial environment and have a direct connection with the ocean. Many estuaries are of

the bar-built type, the sandbars may seal the estuary from the sea during the drier months of the year. The estuary is thus only opened when the sand bar is breached either by high riverine discharge or by artificial means. When they are closed for a long period, these estuaries are so-called “blind” estuaries and do not have a free connection with the open sea. In order to accommodate the peculiarities of these systems, Day (1980) redefined an estuary as “a partially enclosed coastal body of water which is either permanently or periodically open to the sea and within which there is measurable variation of salinity due to the mixture of sea water with freshwater derived from land drainage.”

The coast of India is endowed with extensive areas of estuaries, brackish water lagoons, mangroves, coral reefs and sea-grass beds. These coastal habitats are dynamic, high productivity zones, with high species richness and abundance and also serving as nurseries for many species of finfish and shellfish (CICFRI, 2006). Hence, they have great ecological, social and economic significance. The estuaries are a focal point for the full range of human activities. Throughout history man has settled near to the coastline and has used estuaries and rivers as a transport artery to inland areas. Very beginning, the estuaries were places of relative shelter and also provided a source of food and means of transport. When trading between different locations developed, boats and ships offered the simplest form of estuarine transport. Semi enclosed nature of the estuary provide natural harbor for trade and commerce (Venkataraman, 2003).

The estuarine environment is characterized by a constant mixing of freshwater, seawater and sediment, which is carried into the estuary from the sea and land. The fluctuation of salinity, sedimentary conditions from fine sediment to coarse sediments, nutrient input, pollutant and chemical concentration along with estuarine flow imposes challenges to the fauna and the flora of the estuary. Estuaries accumulate soil and plant material from both the catchment area and internal sources. These sediments can bind nutrients and other contaminants, which may be released under certain conditions. The sediments therefore can act as either a sink or source of nutrients to the overlying water. Globally, coastal and estuarine waters are influenced by eutrophication due to excess supply of nutrients from industries and domestic activities (Tsujimoto *et al.*, 2006). Intensive algal production can bring about the internal organic loading, which are capable of inducing heterotrophic conditions and severe oxygen depletion in the downstream sectors (Garnier *et al.*, 1999).

The chemical composition of surface water and its properties in a particular region is basically governed by natural processes such as precipitation rate, weathering processes, soil erosion and anthropogenic effects which is point or non-point sources of pollution such as urban, industrial and agricultural activities (Jarvie *et al.*, 1998; Giridharan *et al.*, 2009; Nouri *et al.*, 2011). In the event of pollution, if the addition of waste input exceeds the self-purifying capacity of the system, it may cause ecological imbalance and result in gross contamination (Abhirosh *et al.*, 2009).

Dissolved nutrients are the raw material for the marine trophic chain and estuaries are the main entry for nutrients from continental drainage to the marine environment (Lalraj *et al.*, 2007). Much of the sediments and pollutants are filtered out when they flow through wetlands, swamps and salt marshes. This filtration process deposits harmful pollutants and then creates an environment for microbial biodegradation of these sediments. Estuarine plants also can absorb tides and storm surges, providing peaceful and stable habitats for wild aquatic life. This natural buffer system helps to prevent erosion and stabilize the coast. The transition character of estuaries provides important research value for scientists. A wide range of problems in biology, geology, chemistry, physics, and sociology are studied in and around estuaries. Estuaries also provide a great deal of aesthetic enjoyment for the people who live, work or recreate in and around them (Leila *et al.*, 2007).

Estuarine and coastal ecosystems (ECEs) are some of the most heavily used and threatened natural ecosystems globally (Lotze *et al.*, 2006; Halpern *et al.*, 2008). Their deterioration due to human activities is intense and 50% of salt marshes, 35% of mangroves, 30% of coral reefs, and 29% of sea grasses are either lost or degraded worldwide (Waycott *et al.*, 2009). The loss of biodiversity, ecosystem functions, and coastal vegetation in ECEs may have contributed to biological invasions, declining water quality and decreased coastal protection from flooding and storm events (Braatz *et al.*, 2007; Cochard *et al.*, 2008).

The health status and biological diversity of Indian estuarine ecosystems are deteriorating day by day through multifarious man-made activities. The dumping of enormous quantities of sewage and industrial effluents into estuaries has resulted in a drastic reduction of shallow water fish populations, increased pollution and ecological imbalance resulting in the large-scale disappearance of numerous fauna and flora (Rajendran *et al.*, 2004). Indiscriminate dumping of industrial wastes into streams and rivers impair the physicochemical composition of the receiving water and ultimately it has an adverse effect on an aquatic life (Rao and Prasad, 2002). Anthropogenic activities could lead to the periodic or permanent elimination of estuarine dependent fish species from estuarine systems (Kennish, 2002). The enrichment of nutrients by human activities shift the aquatic ecosystems toward a eutrophic state (Smith, 2003). Estuaries act as reactor that regulates and modifies natural and anthropogenic materials transferred from the continents to the open sea (Gao and Song, 2005).

Industrial and domestic wastes are released directly into the estuary without treatment (Balachandran *et al.*, 2006; Martin *et al.*, 2008). The aspirations of industry, commerce and navigation to further wealth creation through expansion could possibly have a deleterious effect on the quality of life in and around estuaries. Heavy metals are an important category of pollutants and as such have major detrimental impact on human and environmental health (Ogundiran and Afolabi, 2008). Estuarine and coastal sediments act as ultimate sink for trace elements that are discharged into the aquatic environment (Achyuthan *et al.*, 2002). Many of the trace metals are highly toxic to man and other living organisms due to its bioconcentration in the food chain.

In aquatic environment including estuaries, majority of the bacterial species occupy a key position in the food chain by providing rich nourishment for the next higher level of aquatic life. The distribution, diversity and activities of heterotrophic bacterial are controlled by various hydrobiological factors and nutrient levels present in the aquatic environment and have been well studied in marine environment (Ducklow and Hill, 1985). The estuary is an important site for bacterial degradation of terrestrial and riverine organic matter associated with particles (Lee and Wakeham, 1988). Natural assemblages of estuarine bacteria rapidly degraded a major portion of the total dissolved organic nitrogen and incorporated it into biomass (Seitzinger and Sanders, 1997). Microorganisms distributed in the marine and brackish environments play an important role in the decomposition of organic matter and mineralization (Hollibaugh *et al.*, 1980). Faecal coliform bacteria exist in both free-living and attached forms in estuarine waters. During sedimentation process these faecal bacteria entered in to the bed of the estuary (Guanghai *et al.*, 2011).

The distribution and activities of heterotrophic bacteria in polluted waters were studied by Keller (1960) and his reports suggested that the number of bacteria in the water body is naturally quite variable and depends on a wide variety of factors. Their distribution, species abundances and activities interact with their physical and chemical environment. Seasonal changes in microbial activity in a temperate environment would be expected to be strongly affected by physical parameters such as notably temperature, which has a direct effect in changes in the activity, species composition and density of the bacteria (Pomeroy *et al.*, 1991). Estuaries and their greenbelts make an immense contribution to

ecosystem resilience and protection from natural disasters. In the light of informations provided above, the present study entitled “Studies on hydrology and microbiology in the estuarine environment of Thengapattinam, Southwest Coast of India” was undertaken.

The main objectives are:

- To analyse the physicochemical parameters of water and their seasonal variations in the selected stations of Thengapattinam estuary.
- To analyse the physicochemical parameters of sediment and their seasonal variations in the selected stations of Thengapattinam estuary.
- To study the monthly and seasonal fluctuations in total viable count of microbes in water and sediment samples.
- To assess the diversity and seasonal variation of denitrifying bacteria in water and sediments and enzymatic bacterial population in sediment samples.