India is bestowed with a rich fauna of edible crustaceans, several of them supporting the commercial fisheries. At present, around 150 species of this group form the major part of the commercial catches either on regular basis or as occasional inclusions (Suseelan, 1996). During the past 3-4 decades, exploitation of edible crustaceans along the Indian coast has increased, due to their sustainable demand in the international markets. The extension of fishing activities into deeper waters and the capturing of non-conventional species, have added up more number of species into the above faunistic list of commercially important crustaceans. Among them, brachyuran crabs form the most important group.

Brachyuran crabs or the true crabs are characterized by a hard exoskeleton and a reduced abdomen, which is most often referred to as its short tail, which is entirely hidden under the thorax. Hence, they got the name Brachyura, which means short-tailed. They are armed with a single pair of massive chelae, which is often used for prey capture, communication, mating, defense and offense. They vary in size from a few millimeters width as in the pea crabs to 4 meters leg span (13 feet) as in the Japanese spider crab.
Crabs are adapted to survive in almost every habitat of earth, except the air and the polar ice caps. They are found to exist in various biotopes, such as marine, estuarine, fresh water, intertidal and even terrestrial habitats. They are even found to inhabit the abyssal zone, hydrothermal vents, river swamps, rain forests, mountain tops and the deserts. However, certain landscapes exhibit domination of certain group of crabs. For instance, mangrove habitats are usually dominated by Sesarmids and Ocypodids, the coral reefs by Xanthid crabs and their kin, the tropical forests by the terrestrial Gercarcinids, and the fresh water systems by Potamids and their allies (www.nio.org).

Crabs often show marked sexual dimorphism. The most conspicuous among the sexual dimorphism being the shape of the abdominal flap. In males, abdominal flap is narrow and triangular in shape, while in females it is broader, rounder abdomen, enabling them to brood the fertilized eggs on their pleopods or the abdominal appendages. In some group of brachyurans, males possess larger claws than the females. This type of sexual dimorphism is particularly pronounced in the fiddler crabs of genus *Uca* belonging to the family Ocypodidae. The male fiddler crabs possess unequal chelipeds, one of the chelae greatly enlarged into pincers, which they primarily use for communication. They exhibit waving displays to attract females towards them for courtship.

Crabs are generally omnivorous, feeding on both plant matter and animal matter depending on their availability. However, some groups of brachyura, for instance the mangrove crabs exhibit herbivory. They feed on the leaf litter from the mangroves. Some crabs like grapsid crabs are
found to be detritivorous, feeding on the decaying plant matter present in the sediments (Ajmal Khan and Ravichandran, 2009).

Biologists find brachyurans as very interesting creatures, due to their typical and complex behavioral pattern, particular modes of life, association with other invertebrates etc. Crabs typically walk sideways, which can be attributed to the peculiar articulation of their legs, which makes a sidelong gait more efficient. However, some crabs including the Raninids are capable of forward or backward movement.

Usually, they are found to be aggressive towards each other and it is observed that the males often fight over the females. On rocky seashores, crabs also fight among themselves over hiding holes. Some crabs like the *Uca*, exhibit waving displays of chelate legs, some crabs can even produce sound, by stamping their feet or banging their pincers on the ground.

The brachyurans are also found to retain commensal association with many organisms including algae, sea weeds and invertebrates like sponges, coelenterates, barnacles, holothurians and bivalves.

Brachyuran crabs are of appreciable importance in the present scenario due to its economic and ecological value. Crabs support a sustenance fishery in India, even though its present status is not comparable to that of shrimps and lobsters. Annual landings of crabs in the Indian waters are estimated to be 13,000 tonnes (www.mpeda.com/mudcrabreports.pdf). The most important species contributing to the fishery are *Scylla serrata, S. olivacea, Portunus pelagicus, P. sanguinolentus*, and *Charybdis feriata*. Crabs are being exported
to foreign countries on a large scale in the form of crab meat, cut crab as well as in live condition. Live mud crabs are exported to Singapore and Hong Kong, which fetch better prices than the swimming crabs belonging to Portunus spp. India earns about 18 million US$ as foreign exchange from the export of live mud crabs (www.mpeda.com/mudcrabreports.pdf).

Crab meat is found to be very tasty and in nutritional point of view, it is rich in proteins, vitamins, glycogen and minerals. Crab meat is also believed to stimulate brain cells and also possess some medicinal value. It is believed to cure asthma and chronic fevers (Chopra, 1939; Chidambaram and Raman, 1944). Mud crab meat is effective in curing diarrhea and dysentery, while the swimming crabs Portunus sanguinolentus and P. pelagicus are usually served to people just recovered from malaria and typhoid (www.nio.org).

In addition to this, many small-sized intertidal crabs which are not of direct economic value are being used in the preparation of high energy yielding; cheaper artificial pellet feeds for the cultivation of edible varieties of sea food.

Crabs are the conspicuous members of the mangrove ecosystems (Verwey, 1930, Macnac, 1968) and are ecologically significant in many ways. Crabs have a significant role in detritus formation, nutrient recycling and dynamics of the ecosystem. It is found that their burrows alter the topography and grain size of the sediments (Warren and Underwood, 1986). Their digging behavior enhances aeration and facilitates drainage of mangrove soils (Ridd, 1996). They keep much of the energy within the mangrove forest by burying and consuming the leaf litter. Furthermore, their
faeces form the basis of coprophagous food chain, contributing to mangrove secondary production (Lee, 1997). Hence, crabs are often considered to be the keystone species in the mangroves (Holling, 1992) because of their role in carbon recycling (Schories et al., 2003).

Brachyuran crabs play a very dominant role in the marine food web. These crabs and their larvae feed on lower organisms like algae, molluscs and other crustaceans and the crab larvae are in turn preyed upon by larger predators like omnivorous fishes. Thus they play a vital role in the transfer of energy through the food chain. Robertson et al. (1992) reports that crab larvae form the major food source for the juvenile fishes and the crabs themselves form the food for many carnivorous fishes and birds including many threatened species like the crab plover (Seys et al., 1995).

It is quite surprising that despite of all these facts, this group lacks priority in our investigations and therefore there is an urgent necessity to initiate more works on this group.

Hence an extensive study was undertaken on the brachyuran fauna of the Cochin backwaters, Kerala, India, to have a basic knowledge on their diversity, habitat preferences and systematics. The study provides an attempt to resolve the confusion pertaining in the species identification of mud crabs belonging to Genus Scylla. The objectives set for the study were as follows.
Objectives of the study

- To study the diversity of brachyuran crabs of Cochin backwaters.
- To have a basic knowledge on the habitat ecology, habitat preferences, abundance and distribution of brachyuran crabs of Cochin backwaters.
- To provide a systematic account on the brachyuran crabs of Cochin backwaters
- Revalidation of the commercially important mud crabs of genus *Scylla* using molecular methods to resolve the problems of species ambiguity.

Though several works have been undertaken on brachyuran crabs world–wide as well as within the country, only little have been studied on the brachyuran crabs of Kerala waters. Most of the studies done on the brachyuran fauna were from the east coast of India and a very few works from the west coast. The earliest available record on brachyuran faunal studies from Kerala waters was that done by Pillai (1951) who dealt with the decapods of Travancore waters. Eventually, Antony and Kuttyamma (1971), Rao and Kathirvel (1972), Radhakrishnan and Samuel (1982), Devasia and Balakrishnan (1985), Thomas *et al.* (1987), Kurup *et al.* (1990), Anil (1997) dealt with the brachyuran fauna of the Cochin backwaters. Succeeding them, no further studies were initiated on the brachyuran fauna of Cochin backwaters for a long time till 2008. Roy and Nandi (2008) examined the brachyuran biodiversity of Vembanad Lake and stated that despite its high productive status, the lake support a low brachyuran diversity. They also
pointed out the requirement of a season-wise survey to be conducted on the Vembanad Lake to assess the exact brachyuran diversity of the area. In this context, the present work was undertaken to study the diversity of brachyuran crabs in Cochin backwaters employing a month-wise survey for a period of two years from June 2010- May 2012.

Cochin backwaters is characterized by wide salinity gradient and varying habitat types, like low lying swamps, tidal creeks and the mangrove patches, which enable the backwater to support diverse flora and fauna, including the brachyuran crabs. The distribution of crabs is influenced by habitat characteristics such as vegetation, substratum, food, salinity and the presence of other animals (Aspey, 1978; Icely and Jones, 1978; Rabalais and Cameron, 1985; Ewa-oboho, 1993; Thurman, 1998; Caesar et al., 2005, Pandya and Vachharajani, 2010). Hence, in addition to the diversity assessment, the habitat ecology and habitat preferences of the brachyuran crabs encountered in the Cochin backwaters were also dealt with. Knowledge on the ecology and the habitat type preferred by the crabs is very important to conserve the crab population, since destruction of their habitat is the most important factor responsible for the deteriorating population and diversity of crabs.

Studies related to taxonomy and systematics of crabs is very limited, though numerous works are being carried out in various other aspects. The greater degree of adaptation of brachyuran crabs to different environments and the resulting individual variability within the species as well as population render taxonomic works difficult. Discontinuous distribution, allometric growth pattern which results in dynamic morphology, polymorphisms
and sexual dimorphisms add more confusion in species identification of brachyuran crabs (Sethuramalingam and Ajmal Khan, 1991). Usually, the brachyuran crabs are distinguished based on minor morphological characters like spination – its presence or absence, orientation and arrangement or the number, transverse ridges, specific markings etc. But, in many cases, these characters are influenced by the growth. Therefore, besides the morphological characters, some other powerful taxonomic tools are needed to be employed for the proper identification of species. In the case of brachyuran crabs, first male pleopods or the third maxillipeds can be used as taxonomic tool (Chhapgar, 1957; Sethuramalingam and Ajmal Khan, 1991). The present study provides an extensive systematic account of the brachyuran crabs found in the Cochin backwaters, employing the difference in first male pleopods, shape of the male abdomen and the third maxillipeds.

Mud crabs are commercially important due to their large size and nutritive value. Hence, they are of great demand in the domestic as well as foreign market. Kerala is the biggest supplier of live mud crabs and Chennai is the major centre of live mud crab export (www.mpeda.com/mudcrabreports.pdf). The species identification of mud crabs belonging to genus *Scylla* has been controversial, for many years (Fuseya, 1998). Attempts to identify *Scylla* have led to much confusion because of the subtle morphological differences between the species. Taxonomy of mud crabs of the Cochin backwaters was first dealt with by Kathirvel (1981) and he recorded two species of *Scylla*, from Cochin backwaters; larger species, *Scylla oceanica* and smaller species, *Scylla serrata*. Later in 1982, Radhakrishnan and Samuel reported the occurrence of a subspecies *Scylla*
serrata serrata from Cochin backwaters, which was denied by the other carcinologists (Joel and Sanjeevraj, 1983; Kathirvel and Srinivasagam (1992). They opined that the sub species S. serrata serrata reported by Radhakrishnan and Samuel from the Cochin Backwaters could be S. serrata only. Joel and Raj (1983) and Kathirvel and Srinivasagam (1992) reported that the two species of mud crabs occurring in the Indian waters is S. serrata and S. tranquebarica. However, according to the new reports, (Shaji et al., 2006; Devi and Joseph, 2013 a, b; Mandal et al., 2013, 2014 a, b; Balasubramanian et al., 2014; Devi and Joseph, 2015), the mud crab species that are found to exist in the Indian waters is S. serrata and S. olivacea. Hence, it is very crucial to resolve the problems pertaining in the species identification of genus Scylla, since mud crabs hold appreciable importance in the inland fishery of the Cochin backwaters.