

## Survey on Penaeidae Shrimp Diversity and Exploitation in South East Coast of India

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Received date: February 25, 2014; Accepted date: August 28, 2014; Published date: September 05, 2014

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### Abstract

The assessment of Penaeidae species diversity in a particular region is very important in formulating conservation strategies. In the present study, the survey on diversity of Penaeidae species in south east coast of India has been assessed on the basis of landing of variety of species in this group. Penaeidae species were collected from various main landing centers of south east coast of India for three years. Identification and nomenclature was done based on previously published literature. Among the 59 species observed, the *Penaeus semisulcatus*, *Penaeus monodon* and *Fenneropenaeus indicus* were found mostly in all landing centers. As first and foremost, the *Metapenaeus papuensis*, *Metapenaeus anchistus*, *Metapenaeopsis wellsii*, *Parapenaeopsis sinica* (*Kishinouyepenaeopsis amicus*), *Parapenaeopsis hungerfordi*, *Parapenaeopsis venusta*, *Parapenaeopsis coromandelica*, *Parapenaeopsis gracillima*, *Trachysalambria longipes* and *Parapenaeus lanceolatus* landed in south east coast of India. As far as Penaeidae shrimp diversity is good in south east coast region of India, and needed the fishing site and mesh size regulation to protect the juvenile and adult of Penaeidae from inshore and offshore catching.

**Keywords:** Penaeidae; Diversity; Nomenclature; Exploitation; Conservation

### Introduction

Biodiversity performs a number of ecological services for mankind that have commercial and recreational or resources management purpose. Globally, more than 30,000 marine crustacean species have been reported. Crustacean fishery is one of the major resources of India that includes the commercially important shrimps, prawns, lobsters and crab which are important in the tropical food chain of marine ecosystem. Penaeidae, a family of marine crustacean in the suborder Dendrobranchiata, often referred to as penaeid shrimp or penaeid prawn with 48 recognized genera, 23 of them is known only from the fossil record. Total averaged Penaeidae catching at world level was 1.21 million tons per annum for the year 2008-10. The Penaeidae shrimp constitute the backbone of Indian seafood export industry as the major foreign exchange earner as well as source of livelihood for millions of fishermen in the country. India exported US \$ 2.8 billion worth marine products in 2010-11, of which shrimp contributed 3.09% in volume and 69.5% in value of the total export [1].

South east coast mainly is situated on the south east of Peninsular India covers an area of 1,30,058 Sq.km. The length of its coastline is about 1050 km with its significant portion on the east coast bordering Bay of Bengal. Increase in human population and demand for shrimp in the world market has resulted in over exploitation of shrimp from Indian coastal waters. This is believed to have caused over fishing of all stock and population of shrimp by the use of banned gears and methods [2,3]. In general decline in resource availability as evidenced by decline in catches and catch rate and incidence of large proportion of juveniles and young fish in the landings and decrease in average

length at capture of many of the targeted species. Considerable volume of discards of non-target edible fishes by the multiday trawlers is also a serious concern. The intensive fishing of prawns at 50 m depth line persistently over the past several years and the destruction of habitats occur during the process of exploitation caused by various kinds of human activities adversely affecting the crustacean fauna and their resources [2,4-8]. The substantial portion of the penaeid catches by indigenous gears such as fixed bag nets ('Dol'), seines, gill nets etc. which operate in the inshore areas. A number of innovative gears such as ring seines, trammel nets and minitrawls operated by motorized country crafts are being increasingly employed along the coasts of India which state led to state of over exploitation.

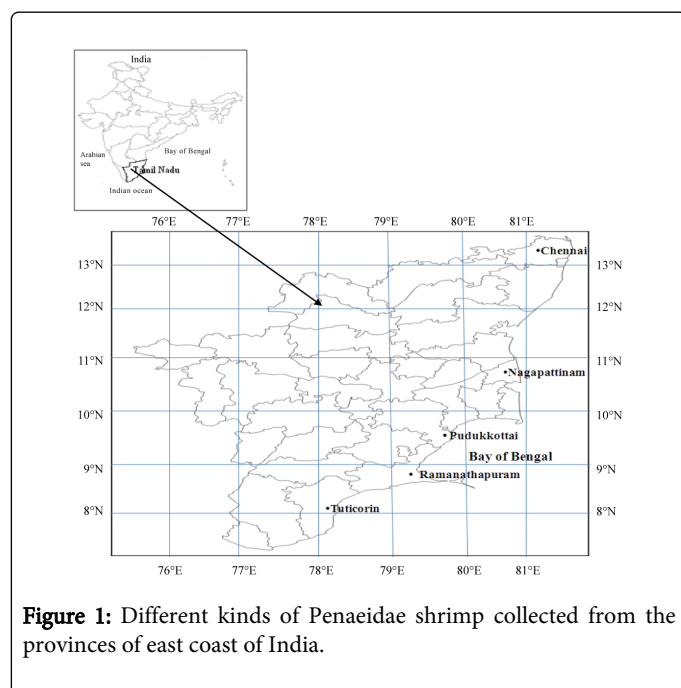
Many researchers have been surveyed on penaeid species exploitation by using variety of gear in India [9,10-22]. The juvenile destruction in the marine environment in the Palk Bay where young ones of *P. semisulcatus* are indiscriminately captured by 'Thalluvalai' a kind of small conical bagnet dragged along the shallow near-shore areas, if allow fully grown to them could get crores of money [23,24]. Damaging practice commonly found in the estuarine systems is the widespread removal of young shrimp for aquaculture purpose. 97% of the shrimp fry are destroyed or thrown on the land during the collection of only 3% seed of tiger shrimp for culture. During wild collection of 1 million *P. monodon*, an estimated annual loss of 75 million non-target fin and shellfish larvae occurs [3].

The maintenance and management of our rich biodiversity requires accurate and continuous updating of data, identification of biological organism and documentation of biological diversity is a primary step towards any research work, management and conservation [1,25]. Sudarsan stated that specimen of prawns had often catches and as such a special survey for prawn resources have to be undertaken [26]. The pioneering survey work on penaeid species diversity in north east coast of India such as Andaman and Nicobar Islands 12 littoral species

[17]. Chanda and Bhattacharya described three new species of shrimp from Indian waters [27-29]. The survey of trawl fishing of Penaeidae shrimp species in the Northern Mandapam Coast of Palk Bay has been described by Siva Rama Krishnan [30]. Radhakrishnan reported annotated checklist of the penaeoid, Sergestoid, Stenopodid and Caridean prawn fauna of India [1]. Not much inventory work has been carried of this penaeidae diversity and details of species exploitation in south east coast of India. Conservation of penaeidae diversity is the urgent need of the hour in order to maintain the balance of nature and support the availability of natural resources for future generation. Assessment of biodiversity of a particular region is very important to formulate conservation strategies [31]. Therefore, the present study on the Penaeidae diversity and exploitation of the east coast on the basis of landing from inshore and offshore water. The objectives of present study are to report the diversity of penaeidae, new species availability in the south east coast of India for a period from April 2010- April 2013. In addition report the pattern of exploitation and preventive strategies to protect Penaeidae diversity in the study area.

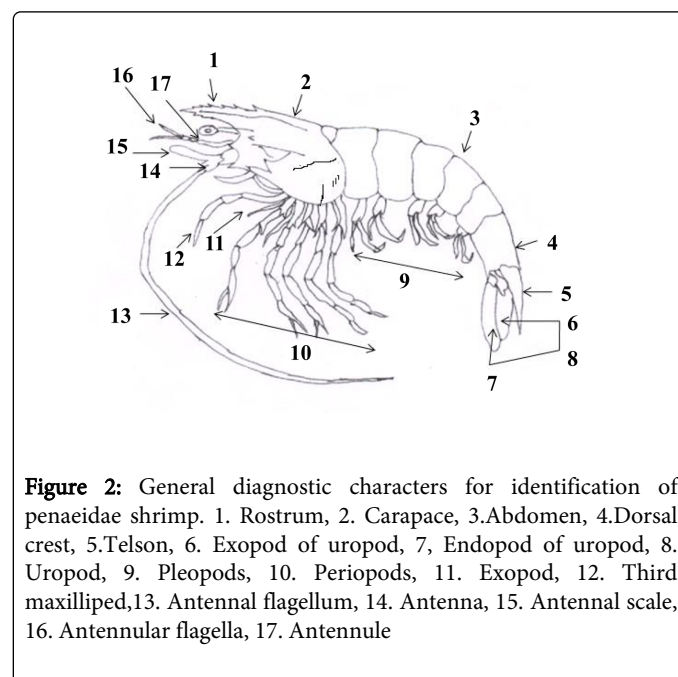
## Materials and Methods

Different kinds of Penaeidae shrimp were collected from the landing centers of Chennai, Nagapattinam, Pudukkottai, Ramanathapuram, and Tuticorin of south east coast of India in Figure 1. The collection of species for three years from April 2010- April 2013. Collected shrimps were kept in ice pack, brought to the laboratory. All species were identified and grouped according to published literature [32-35] and nomenclature of Penaeidae based on the availability of published literature present in the form of research articles, monographs, books, species checklist and technical reports. The WoRMS Register, ITIS Standard Search and the Carideorum catalogus also have been referred for confirmation of the genera and species [36].



## General diagnostic characters for identification of penaeidae shrimp (FAO Species identification guide for fishery purposes, 1998)

The major criteria used to identify penaeidae shrimp are as follows:- Penaeidae rostrum is well developed and generally extending beyond eyes, always bearing more than 3 upper teeth. No styliform projection at base of eyestalk and no tubercle on its inner border. Both upper and lower antennular flagella of similar length, attached to tip of antennular peduncle. Carapaces lacking both post orbital and post antennal spines. Generally cervical groove are short, always with distance from dorsal carapace. All 5 pairs of legs are well developed, fourth leg bearing a single well-developed arthrobranch (hidden beneath carapace, occasionally accompanied by a second, rudimentary arthrobranch). In males, endopod of second pair of pleopods (abdominal appendages) with appendix masculine only. Third and fourth pleopods divided into 2 branches. Telson sharply pointed, with or without fixed and/or movable lateral spines. Colour: body colour varies from semi-translucent to dark grayish green or reddish, often with distinct spots, cross bands and/or other markings on the abdomen and uropods; live or fresh specimens, particularly those of the genus *Penaeus*, can often be easily distinguished by their coloration. General diagnostic characters for identification of penaeidae shrimp is given in Figure 2.



## Genus wise diagnostic characters followed for penaeidae shrimp identification (FAO Species identification guide for fishery purposes, 1998)

The major criteria used to identify penaeidae shrimp genus wise are as follows: Fifth leg with exopod, carapace without longitudinal or vertical sutures; second leg with ischial spine; eyes small: *Atypopenaeus* (Figure 3a). Third maxilliped with epipod; male petasma asymmetrical: *Funchalia* (Figure 3b). Telson without large subapical fixed lateral spines, body densely covered with short hairs, with grooves and crests on carapace obscure; petasma asymmetrical: *Metapenaeopsis* (Figure 3c). Rostrum without lower teeth, third

maxilliped without epipod; male petasma symmetrical, benthic, fifth leg without exopod (carapace without longitudinal or vertical sutures), third maxilliped without epipod; male petasma symmetrical benthic: *Metapenaeus* (Figure 3d and e). Rostrum with lower teeth, abdomen glabrous and smooth: *Penaeus* (Figure 3d), grooved carapace (*Penaeus-Melicertus*), non – grooved carapace (*Penaeus- non Melicertus*) (Figure 3f). Body almost naked, with crests and grooves on carapace distinct; petasma, symmetrical, Carapace with longitudinal and vertical sutures telson without movable lateral spines: *Parapenaeus* (Figure 3g and h). Carapace with both longitudinal and vertical sutures second leg without ischial spine; eyes large body naked, with crests and grooves on carapace distinct; longitudinal suture usually long third leg without epipod: *Parapenaeopsis* (Figure 3j). Carapace lacking longitudinal and vertical sutures telson with movable lateral spines, rostrum extending far beyond eye; pterygostomian spine present, deep water: *Penaeopsis* (Figure 3c and i). Carapace with both longitudinal and vertical sutures, second leg without ischial spine; eyes large body usually hairy, with crests and grooves on carapace obscure, longitudinal suture short; third leg generally with epipod: *Megokris*, *Trachysalambria* (Figure 3k). The coloration of the uropods of Megokris are yellowish with grey or brown margins and centre is red or reddish brown with golden margin but in *Trachysalambria* the colouration of uropods are red or reddish brown, with conspicuous white margin.

## Results

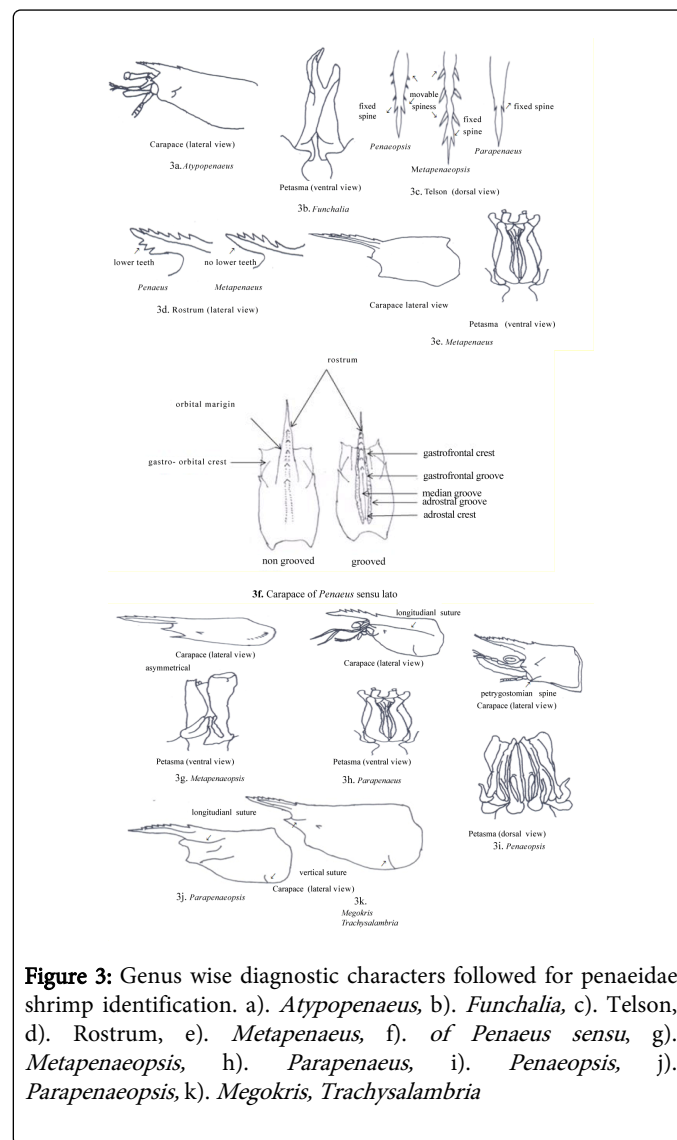
### Morphological and seasonal variation of Penaeidae species

In all penaeidae species collected in the present study, the female specimens were large size than male specimens. As far as penaeidae species sexual variation, a large copulatory organ on first pair of pleopods in males (petasma), and on posterior thoracic sternites in females (thelycum). In males, endopod of second pair of pleopods was with appendix masculina only. In *Metapenaeus* species in adult male, merus of fifth leg (pereopod) with basal notch followed by prominent keel was present which was absent in females. In *Fenneropenaeus* species dactyl of third maxillipeds had half as long as protopodus. In *Parapenaeopsis hardwickii*, the female rostrum very long with sigmoidal shape with distal half is toothless, extending beyond antennular peduncle, in adult male tooth less portion is absent and slightly curved downward, only reaching middle of the second antennular segment. The specimen colour was varied from place to place, depended the residence environmental condition such as sea weeds and sedimentation. *Penaeus monodon*, *Fenneropenaeus indicus*, *F. merguensis*, *F. penicillatus*, *Parapenaeopsis*, *Metapenaeus*, *Megokris*, *Trachysalambria* species were obtained highly in the North east monsoon season (October-November), *Penaeus semisulcatus* were obtained throughout the year. The more variety of *Parapenaeus species* were obtained in the summer rainy season (April –May) from the south east coast of India. In the present study, Gender number of Penaeidae species were somewhat equal only.

### Distribution of Penaeidae species

In the present study totally fifty nine Penaeidae species were obtained from all landing centers from south east coast of India. The *Penaeus* species like *P. monodon*, *F. indicus*, and *P. semisulcatus* were obtained mostly in all landing centers rather than other Penaeidae species. The species under genus *Penaeus senu lato* (old *Penaeus*), *Melicertus latisulcatus* was available only in southern part of east coast

of India (Ramanthapuram and Tuticorin), and species under genus *Penaeopsis*, *P. jerryi* and *P. rectaculata* also were only in southern part (Tuticorin). The more variety of *Parapenaeus* and *Parapeneopsis* species were landed as by-catch of other Penaeidae species from offshore water in the southern region of south east coast of India (Ramanathapuram).

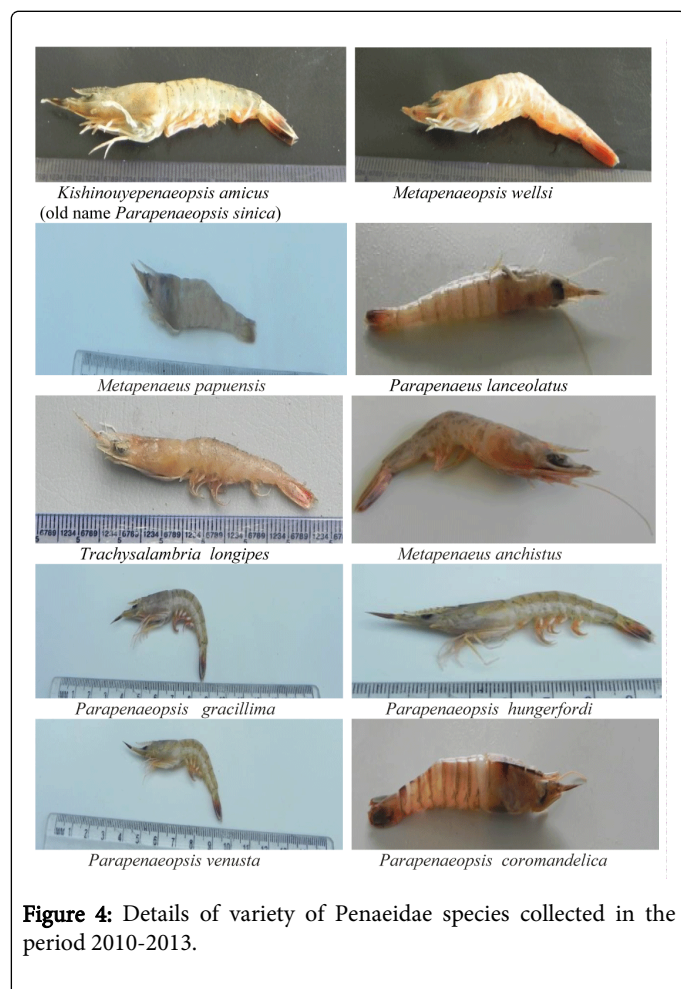


**Figure 3:** Genus wise diagnostic characters followed for penaeidae shrimp identification. a). *Atypopenaeus*, b). *Funchalia*, c). Telson, d). Rostrum, e). *Metapenaeus*, f). of *Penaeus sensu lato*, g). *Metapenaeopsis*, h). *Parapenaeus*, i). *Penaeopsis*, j). *Parapenaeopsis*, k). *Megokris*, *Trachysalambria*

More number of Penaeidae species diversity was seen in central part of south east coast of India (Ramanthapuram and Nagapattinam). *Trachysalambria* and *Megokris* species were mostly landed in southern and northern part of east coast of India (Ramanathapuram, Nagapattinam and Chennai). *P. semisulcatus* landed predominantly in southern regions of southeast coast of India (Tuticorin, Ramanathapuram and Pudukkottai); whereas, *F. indicus* was predominant in northern regions (Nagapattinam and Chennai).

All over south east coast of India, the most dominant species were *Atypopenaeus stenodactylus*, *Fenneropenaeus indicus*, *Fenneropenaeus merguensis*, *Penaeus monodon*, *Penaeus semisulcatus*, *Melicertus latisulcatus*, *Metapenaeus dobsoni*, *Metapenaeus monoceros*, *Metapenaeus affinis*, *Metapenaeus brevicornis*, *Metapenaeus lysianassa*, *Parapenaeopsis stylifera*,

*Parapenaeopsis hardwickii*, *Megokris granulosus*, *Megokris sedili*, *Megokris pescadoreensis*, *Penaeopsis jerryi*, *Penaeopsis rectaculata*, *Parapenaeus fissures*, *Parapenaeus investigatoris*, *Metapenaeopsis stridulans*, *Metapenaeopsis palmensis*, *Metapenaeopsis moegensis*, *Metapenaeopsis barbata*, *Trachysalambria curvirostris*. Lesser number of species landed were *Fenneropenaeus penicillatus*, *Marsupenaeus japonicus*, *Metapenaeus ensis*, *Metapenaeus stebbingi*, *Funchalia woodwardi*, *Parapenaeopsis cornuta*, *Parapenaeopsis tenella*, *Parapenaeopsis nana*, *Parapenaeopsis sulptilus*, *Parapenaeopsis hungerfordi*, *Parapenaeopsis venusta*, *Parapenaeopsis coromandelica*, *Parapenaeopsis gracillima*, *Kishinouyepenaeopsis maxillipedo* (*Parapenaeopsis maxillipedo*), *Ganjampenaeopsis uncta* (old name *Parapenaeopsis uncta*), *Parapenaeus longipes*, *Parapenaeus fissuroides indicus*, *Trachysalambria aspera*, *Trachysalambria fulva*, *Trachysalambria longipes*. Details of variety and distribution of Penaeidae species in the period 2010 -2013 were collected from south east coast of India are given in Table 1. In the present study, new candidate shrimp in Indian water like *Metapenaeopsis wellsii*, *Kishinouyepenaeopsis amicus* (old name *Parapenaeopsis sinica*), *Parapenaeus lanceolatus* [32], *Metapenaeus papuensis*, *P. gracillima*, *Metapenaeus anchistus*, *Parapenaeopsis venusta*, *Trachysalambria longipes*, *Parapenaeopsis coromandelica*, *Parapenaeopsis hungerfordi* were landed in south east coast of India in Figure 4. The special morphological characters of new species obtained from south east coast of India distinguished from other Penaeidae species are given in Table 2.



**Figure 4:** Details of variety of Penaeidae species collected in the period 2010-2013.

Genus	Species	Common Name (English name)
<i>Atypopenaeus</i>	<i>A. stenodactylus</i> (Stimpson, 1860)	Periscope shrimp
<i>Funchalia</i>	<i>F. woodwardi</i> (Johnson, 1868)	-
<i>Penaeus lato</i>	<i>Penaeus semisulcatus</i> (De Haan, 1844)	Green shrimp Tiger
	<i>Penaeus monodon</i> (Fabricius, 1798)	Jumbo Tiger
	<i>Fenneropenaeus indicus</i> (H. Milne Edwards, 1837)	Indian shrimp white
	<i>Fenneropenaeus penicillatus</i> (Alcock, 1905)	Red tail prawn
	<i>Fenneropenaeus Konkani</i> [28]	-
	<i>Marsupenaeus japonicus</i> (Bate, 1888)	Kuruma prawn
	<i>Melicertus latisulcatus</i> (Kishinouye, 1896)	Western king prawn
	<i>Fenneropenaeus merguensis</i> (De Man, 1888)	Banana prawn
<i>Metapenaeus</i>	<i>M. brevicornis</i> (H. Milne Edwards, 1837)	Yellow shrimp
	<i>M. dobsoni</i> (Miers, 1878)	Kadal shrimp
	<i>M. affinis</i> (H. Milne Edwards, 1837)	Jinga prawn
	<i>M. lysianassa</i> (De Man, 1888)	Bird shrimp
	<i>M. ensis</i> (De Haan, 1844)	Greasy back shrimp
	<i>M. monoceros</i> (Fabricius, 1798)	Speckled shrimp
	<i>M. joyneri</i> (Miers, 1880)	Shiba shrimp
	<i>M. endeavouri</i> (Schmitt, 1926)	Endeavour shrimp
	<i>M. moybei</i> (Kishinouye, 1896)	Moybei shrimp
	<i>M. elagans</i> (De Man, 1907)	Fine shrimp
	<i>M. papuensis</i> (Racek and Dall, 1965)*	Papua shrimp
	<i>M. anchistus</i> (De Man, 1920)*	Spiny greasy shrimp back shrimp
<i>M. stebbingi</i> (Nobili, 1904)	Peregrine Shrimp	
<i>Metapenaeopsis</i>	<i>M. stridulans</i> (Alcock, 1905)	Fiddler shrimp
	<i>M. barbata</i> (De Hann, 1844)	Whiskered velvet shrimp
	<i>M. palmensis</i> (Haswell, 1879)	Southern velvet shrimp
	<i>M. megoiensis</i> (Rathbun, 1902)	Mogi velvet shrimp
	<i>M. wellsii</i> (Racek, 1967)*	-
	<i>M. toloensis</i> (Hall, 1962)	Tolo velvet shrimp

	<i>M. novaeguineae</i> (Haswell, 1879)	Northern velvet shrimp
<i>Parapenaeopsis</i>	<i>P. hardwickii</i> (Miers, 1878)	Spear shrimp
	<i>P. stylifera</i> (H. Milne Edwards, 1837)	Kiddy shrimp
	<i>P. cornuta</i> (Kishinouye, 1900)	Coral shrimp
	<i>P. tenella</i> (Spence Bate, 1888)	Smooth shell shrimp
	<i>P. acclivirostris</i> (Alcock, 1905)	Hawknose shrimp
	<i>P. nana</i> (Alcock, 1905)	Dwarf shrimp
	<i>P. venusta</i> (De Man, 1907)*	Adonis shrimp
	<i>P. coromandelica</i> (Alcock, 1906)*	Coromandel shrimp
	<i>P. gracillima</i> (Nobili, 1903)*	Thin shrimp
	<i>P. sculptilis</i> (Heller, 1862 a)	Rainbow shrimp
	<i>P. hungerfordi</i> (Alcock, 1905)*	Dog shrimp
	<i>P. uncta</i> (New name <i>Kishinouyepenaeopsis uncta</i> Alcock, 1905)	Uncta shrimp
<i>P. maxillipedo</i> (Alcock, 1905) New name <i>Kishinouyepenaeopsis maxillipedo</i>	Torpedo shrimp	
<i>P. sinica</i> (Liu and Wang, 1987) New name <i>Kishinouyepenaeopsis amicus</i> (V.C.Nguyễn, 1971)*		
<i>Megokris</i>	<i>M. sedili</i> (Hall, 1961)	Malayan rough shrimp
	<i>M. granulosus</i> (Haswell, 1879)	Coarse shrimp
	<i>M. pescadoreensis</i> (Schmitt, 1931a)	Big head Sand Prawn
<i>Trachysalambria</i>	<i>T. curvirostris</i> (Stimpson, 1860)	Southern rough shrimp
	<i>T. aspera</i> (Alcock, 1905)	-
	<i>T. fulva</i> (Dall, 1957)	-
	<i>T. longipes</i> * (Paul'son, 1875)	Long legged rough shrimp
<i>Penaeopsis</i>	<i>P. jerryi</i> (Perez Farfante, 1979)	Gondwana shrimp
	<i>P. rectaculata</i> (Spence Bate, 1881)	Needle shrimp
<i>Parapenaeus</i>	<i>P. investigatoris</i> (Alcock & Anderson, 1899)	Explorer rose shrimp
	<i>P. longipes</i> (Alcock, 1905)	Flamingo Shrimp
	<i>P. fissuroides indicus</i> (Crosnier, 1986a)	False rose shrimp.
	<i>P. fissurus</i> (Spence Bate, 1881)	Neptune Rose Shrimp
	<i>P. sextuberculatus</i> (Kubo, 1949)	Domino shrimp

	<i>P. lanceolatus</i> * (Kubo, 1949)*	Lancer rose shrimp
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**Table 1:** List of species availability in south east coast of India 2010-2013. \*New species in the south east coast of water.

Penaeidae species	Morphological features
<i>Metapenaeus anchistus</i>	Rostrum distinctly directed upward, bearing 10 to 12 teeth along entire upper margin, almost straight and slightly curved downward at tip; rostrum extending to about distal segment of antennular peduncle. Postrostral crest is low. Branchiocardiac crest, distinct. First leg with distinct ischial spine. Telson with 3 pairs of large movable spine, Body covered with fine pubescence. In males, a narrow space between distomedian projections of petasma; in females, lateral plates of thelycum without raised posterior edge and continuous to posterior transverse ridge.
<i>Metapenaeus pauensis</i>	Look like a <i>Metapenaeus elagens</i> , rostrum armed with teeth along entire upper border, armed 8-12 upper teeth, in males, distomedian projection of petasma directed forward, their inner margin almost parallel, tubercle on merus of fifth leg slightly bent inwards, in female, ridges on lateral plates of thelycum curved outward posteriorly.
<i>Metapenaeopsis wellsii</i>	Posteriolateral carapace no stidulating ridges, pterygostomial spine very strong, rostrum not forming crest.
<i>Parapenaeopsis gracillima</i>	Rostrum short, not extending beyond eyes, first leg without basal spine.
<i>Parapenaeopsis coromandelica</i>	Rostrum sigmoid shape, half-length toothless, telson armed with 1 or 2 pairs of fixed lateral spines.
<i>Parapenaeopsis hungerfordii</i>	Rostrum long and exceeding antennular peduncle, longitudinal suture extending almost to posterior carapace.
<i>Parapenaeopsis venusta</i>	Rostrum short and extending just beyond eyes, longitudinal suture only reaching as far as level of hepatic spine.
<i>Kishinouyepenaeopsis amicus</i> ( <i>Parapenaeopsis sinica</i> )	Rostrum usually with 9 or 10 upper teeth, third leg with a basal spine. The end of the rostrum upward with black dot, absence of dark band in the last abdominal segment as seen in <i>Kishinouyepenaeopsis maxillipedo</i> .
<i>Parapenaeus lanceolatus</i>	Rostrum extending beyond second segment of antennular peduncle, branchiostegal spine present.
<i>Trachysalambria longipes</i>	Look like <i>Trachysalambria curvirostris</i> , rostrum straight and armed with 8 to 11 upper teeth, fourth and fifth abdominal segments without posteromedian incisions fifth leg extending beyond antennal scale, posterior plate of female thelycum without distinct notch.

**Table 2:** Morphological characters of new species obtained from south east coast of India during 2010-2013

## Exploited Penaeidae species

*Marsupenaeus japonicus*, *Melicertus latisulcatus*, *P. monodon*, *P. semisulcatus*, *F. indicus*, *F. merguensis*, *F. penicillatus* in *Penaeus* genus, *M. dobsoni*, *M. monoceros*, *M. brevicornis*, and *M. ensis* in *Metapenaeus* genus, and *P. stylifera*, *P. hardwickii* in *Parapenaeopsis* genus were commercially exploited along the south east coast of India. Also the by-catch species like *Parapenaeopsis*, *Parapenaeus*, *Penaeopsis*, *Metapenaeopsis*, *Atyopenaeus*, *Megokris*, *Trachysalambria*, *Trachypenaeus*, both juvenile and adult from offshore water were thrown as waste are shown in Figure 5. Particularly *Penaeus semisulcatus* juvenile populations were exploited by fishing from inshore water are given in Figure 6.



Figure 5: Exploited Penaeidae species



Figure 6: *Penaeus semisulcatus* juvenile populations were exploited by fishing from inshore water.

## Discussion

### Diversity of Penaeidae species

The structure of decapod crustacean assemblages on the continental regions is different by spatial differences in environmental and oceanographic conditions particularly by depth, bottom type and characteristic of the water masses [37-43]. In the present study, the south east coast of India from Tuticorin to Chennai, 59 species of Penaeidae were landed, this high number of species availability shows that the good environmental and oceanographic conditions for living of these species. The main species landed were *P. semisulcatus*, *F. indicus*, *P. monodon*, *M. latisulcatus*, *P. stylifera*, *P. hardwickii*, *M. dobsoni*, and *M. brevicornis*. In addition the following deep sea shrimps observed were *Penaeopsis jerryi*, *Penaeopsis rectaculata*, *Parapenaeus investigatoris*, *Parapenaeus fissures*, *Atyopenaeus stenodactylus*, and *M. stridulensis* were landed in south east coast of India. According to the Central Marine Fisheries Research Institute [44], in south east coast particularly in Tamilnadu, the inshore Penaeidae shrimp comprised of 25 species, of which *P. semisulcatus*, *F. indicus*, *Melicertus latisulcatus*, *Parapenaeopsis maxillipedo*, *Ganjampenaeopsis uncta* (Old name *Parapenaeopsis uncta*) and *Metapenaeus dobsoni* are predominant and other species of deep sea prawns were *Parapenaeus fissuroides*, *Penaeopsis jerryi*, and *P. investigatoris*.

According to Suseelan [21], predominant Penaeidae species in the Indian coast are, *F. indicus*, *P. monodon*, *P. semisulcatus*, *F. merguensis*, *F. penicillatus*, *M. dobsoni*, *M. monoceros*, *M. affinis*, *M. brevicornis*, *P. stylifera*, *Metapenaeus moyebi*, *Metapenaeus kutchensis*, *P. hardwickii*, and *P. sculptilis*. In the present study, *F. indicus*, *P. monodon*, *P. semisulcatus*, *F. merguensis*, *F. penicillatus*, *M. dobsoni*, *M. monoceros*, *M. affinis*, *M. brevicornis*, *P. stylifera*, *Metapenaeus moyebi*, and *P. sculptilis* was landed. *P. semisulcatus*, *P. monodon* and *F. indicus* were obtained mostly all landing centre, which indicates the three species are the major commercial species in south east coast of India. The *M. latisulcatus* landed mainly in southern most regions (Tuticorin and Ramanathapuram) which consistent with geographical location of this species as reported by Rao et al. and indicate geographic specific distribution of *Melicertus latisulcatus* [45].

In the present study, *Penaeopsis jerryi* and *Penaeopsis rectaculata*, landed southern region only (Tuticorin), which could be the environmental condition favors such as temperature and substratum sand with mud in deeper region for these two species as reported by John and Kurien, and Radhika Rajasree [46], that the *Penaeopsis* species, *Metapenaeopsis andamanensis* to be showing strong preference towards slightly higher water temperature and a substrate demarcated by mixture of sand and mud.

Kurian and Sebastian reported that the *Parapenaeus longipes*, *Parapenaeus fissures*, and *Parapenaeus investigatoris* in Indian water landings were by the long trip deep sea trawls from the depth of 70-90m [47]. In present study, the *P. fissures*, *P. investigatoris*, *P. longipes*, *Parapenaeus sextuberculatus*, *P. fissuroides indicus*, *Metapenaeopsis barbata*, *Metapenaeopsis stridulans*, and *Atyopenaeus stenodactylus*, were caught in the south east coast water by long trip deep trawls catching. This observation indicate that the depth profoundly influences the assemblage structure of deep sea prawn and the hydrographic features and the fishing intensity can affect the distribution and abundance of marine species such effect on the

species diversity and species richness as stated by Radhika Rajasree [46].

Previously, many new Penaeidae species has been reported like *Parapenaeopsis hardwickii*, *Atypopenaeus compressipes*, *Parapenaeopsis acclivirostris*, *Metapenaeopsis novae-guineae*, and *Trachypenaeus curvirostris* from west coast of India [48], *Penaeopsis eduardoi* from Indo-west pacific region, *Penaeopsis jerryi* from Indian Ocean [49], and *Parapenaeus fissuroides indicus* from west coast of India [50]. In the present study, new Penaeidae species of *Metapenaeopsis wellsi*, *Kishinouyepenaeopsis amicus* (old name *Parapenaeopsis sinica*), *Parapenaeus lanceolatus*, *M. papuensis*, *P. gracillima*, *Metapenaeus anchistus*, *Parapenaeopsis venusta*, *T. longipes*, *P. coromandelica*, and *Parapenaeopsis hungerfordi* were landed in south east coast of India. These Penaeidae species were not reported previously in Indian coasts; hence the present report would give the novel insight on Penaeidae diversity in the east coast of India.

### Exploitation of Penaeidae species

The total landing of Penaeidae prawn in India was 2,72,969 tons in 2011 in which trawlers account for about 60% and the indigenous gears 40%. The annual report for 2011-12 meant the Penaeidae species participated 7.1% in total marine fish catches, and catches (35,200 t) declined by 1.3% as compared to 2010 [44]. As far as south east coast of India (Tamilnadu) about 20,163 t of penaeid prawns were landed, accounting for 54.8% of the crustacean landings in 2011. About 85.4% of this was landed by trawl nets. The catch of non-penaeid prawns was relatively meager, accounting for 3.4% of the prawn landings. Prawn fishery along south Tamil Nadu coast (off Tuticorin) is done by mechanized trawl, indigenous trawl and gillnet (mainly in the estuarine areas). Mechanized trawls landed 119 t of prawns from inshore waters and 468 t of deep sea prawns. Indigenous trawl landed 46t of prawns while gillnets landed 13t [44]. In the present study, *Penaeus* species *Marsupenaeus japonicus*, *Melicertus latisulcatus*, *P. monodon*, *P. semisulcatus*, *F. indicus*, *F. merguensis*, *P. penicillatus* species and among the *Metapenaeus* species, *M. dobsoni*, *M. monoceros*, *M. affinis*, *M. brevicornis*, *M. ensis*, *M. endovori*, *M. lysianassa*. *Parapenaeopsis* species *P. stylifera*, and *P. hardwickii*, which grow to a large size, were commercially exploited by Mechanized large-scale operation of ring seines, mini-trawls, trammel net and indigenous gears in south east coast of India.

In deep shrimp trawling, the juvenile and seldom adult of *G. uncta*, *P. cornuta*, *K. maxillipedo*, *P. sulptilis*, *P. tenella*, *M. granulosus*, *M. sedili*, *T. curvirostris*, *Parapenaeus*, *Metapenaeopsis*, *Penaeopsis* species are exploited as by-caught, and are considered less economic value and thrown as waste. Thus deep shrimp exploitation affects the penaeidae and also marine species biodiversity. Limiting the operation of fixed nets like stake nets, dip net etc. together with appropriate mesh size restrictions, and a ban of export of count sizes of shrimps below a fixed minimum level would be the methods for conserving the penaeidae shrimp.

As far as the *Penaeus semisulcatus* juvenile stage in the shallow inshore water seagrass ecosystem is the nursery ground for *P. semisulcatus* which have restricted distribution and are facing depletion. It is estimated that about 2500 indigenous fishing units are engaged in this type of fishing in 0-4 m depth and over 3000 t of the juveniles of the species are exploited every year [20]. In the present observation of *P. semisulcatus* highly landed in southern region, in the inshore water at juvenile stage is major exploitation of this species. In order to protect the juvenile population of these valuable species,

minimum legal size may also be fixed for the capture fishery. A restriction on the export of undersized prawns will discourage capture of smaller size groups of these resources by commercial nets and this will go a long way in improving their fishery.

The fast developing brackish water prawn farming in the country depends on the nature of seeds of fast growing species like *P. monodon* and *F. indicus*. Therefore it is essential to establish adequate number of shrimp hatcheries and legally prohibit seed collection from estuaries. It may be seen from the foregoing account, the penaeidae species which brings considerable foreign exchange to the country are threatened by several ways. For their sustained survival and productivity in the natural habitats. The activities of man and appropriate methods to conservation measures should be implemented before further damage is inflicted on the fauna and its environment.

### Conclusion

In present study reports 59 different Penaeidae species landed showed that the healthy diversity of Penaeidae species in south east coast of Indian water. The indiscriminate exploitation of juvenile at inshore areas and deep sea Penaeidae species like *Parapenaeus*, *Metapenaeopsis*, *Penaeopsis*, *Atypopenaeus*, and selected species of *Parapenaeopsis*, *Megokris*, and *Trachysalambria* are thrown as waste which reducing the diversity of Penaeidae. Therefore, the conservation measures generally adopted for this Penaeidae species include restriction of fishing effort, imposition of closed seasons for fishing, allotment of catch quotas, cod-end mesh regulations for fishing nets, and restriction on capturing juveniles from nursery grounds of entire coastline of south east coast of India to protect the prevailing Penaeidae diversity in south east coast of India.

### Acknowledgement

The authors express their special thanks to the Department of Science and Technology, New- Delhi, India, for financial assistance from DST-PURSE.

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