

Indian palaemonid decapod crustaceans : taxonomic status, research challenges and conservation needs

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ABSTRACT

Prawns and shrimps comprise about 2500 species and are distributed throughout the world. They belong to complex taxonomic groups. The prawns of the family Palaemonidae Rafinesque, 1815 are highly important on both commercial as well as ecological point of view. Extensive studies on the biodiversity and taxonomy of Indian freshwater prawns have been carried out by many and they have recorded 75 species belonging to 8 genera under the subfamily Palaemoninae Rafinesque, 1815 and these prawns inhabit a wide range of habitats from hill top to estuaries. The present paper provides a comprehensive account on various aspects such as diversity of species, state wise distribution of species, taxonomic status and confusion, molecular taxonomy, karyological information, distribution based on their habitat, present level of utilization of diversity, research challenges and also *ex situ* and *in situ* conservation methods and needs of palaemonid prawns of India.

Key words: Biodiversity, Decapoda, Distribution, Palaemonidae, Utilization

Prawns and shrimps comprise about 2500 species distributed throughout the world. They belong to complex taxonomic groups. Extensive studies on the taxonomy and biodiversity of palaemonid prawns of the world have been carried out by many (Chace & Bruce, 1993; Holthuis, 1950; 1952; Jayachandran, 2001a, for review).

Our knowledge on the Indian palaemonid decapod crustaceans are mainly from the research work of Anantha Raman *et al* (1978), Bate (1868), Chopra & Tiwari (1949), Dutt & Ravindranath (1974), Holthuis (1950), Jaliha *et al*. (1988), Jayachandran (1987- 2007), Jayachandran & Joseph (1982-1992 a-b), Jayachandran & Raji (2004 a-b), Jayachandran *et al*. (2003; 2007), Kemp (1913-1925), Nobili, (1903), Sankolli & Shenoy (1979), Tiwari (1947–1963), Tiwari & Pillai (1973). These studies have recorded 75 species of inland prawns. The present paper provides a comprehensive account on various aspects such as diversity of species, state wise distribution of species, taxonomic status and confusion, molecular taxonomy, karyological information, distribution based on their habitat, present level of utilization of diversity, research challenges and also *ex situ* and *in situ* conservation methods and needs of palaemonid prawns of India.

MATERIALS AND METHODS

The present study has been made based on the research

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work of Kemp (1913–1925), Tiwari (1947–1963), Tiwari & Pillai (1973), Dutt & Ravindranath (1974), Sankolli & Shenoy (1979), Jaliha *et al*. (1988), Jayachandran (1987–2007), Jayachandran & Joseph (1982–1992 a–b), Jayachandran & Raji (2004 a–b), Muphy & Austin (2005), Jayachandran *et al*. (2003 – 2007), Min-Yun Liu *et al*. (2007).

RESULTS AND DISCUSSION

Diversity of Indian Palaemonid Decapods

The family Palaemonidae is a large complex group of prawns. So far 96 genera and more than 720 valid species have been recorded under this family. They belong to two subfamilies, namely, Palaemoninae Rafinesque, 1815 and Pontoniinae Kingsley, 1878. The prawns belonging to former subfamily inhabit inland water bodies and the latter in the marine habitats.

Genera and species under the subfamily Palaemoninae Rafinesque, 1815

More than 300 species under 21 genera have been described under this taxon.

Genera

Out of the 21 genera reported so far under the subfamily, 8 genera have been found to represent India comprising of 75 species (Table 1) and are grouped according to habitats. The different species in different Indian states are given in Table 2. The rivers in Kerala, have a rich resource of 30 species.

Table 1. Genera and species under subfamily Palaeninae

Sl. No.	Genus	Species	No. of species
1	<i>Allobrachium</i> Jayachandran, 2001@	-	
2	<i>Exopalaemon</i> Holthuis, 1950	<i>styliferus</i> (H. Milne Edwards, 1840)*	1
3	<i>Leandrites</i> Holthuis, 1950	<i>celebensis</i> (De Man, 1881)*	1
4	<i>Leptocarpus</i> Holthuis, 1950	<i>fluminicola</i> (Kemp, 1917)* <i>potamiscus</i> (Kemp, 1917)* <i>kempi</i> Jayachandran, 1992*	3
5	<i>Macrobrachium</i> Bate, 1868	<i>aemulum</i> (Nobili, 1906) *** <i>altifrons altifrons</i> (Henderson, 1893) ***** <i>altifrons ranjhai</i> Tiwari, 1963 ***** <i>andamanicum</i> (Tiwari, 1952) * <i>assamense assamense</i> (Tiwari, 1955) ***** <i>assamense peninsularae</i> (Tiwari, 1955) ***** <i>australe</i> (Guerin-Meneville, 1838) ** <i>banjarae</i> (Tiwari, 1958) *** <i>birmanicum</i> (Schenkel, 1902) *** <i>bombayense</i> Almelkar & Sankolli, 2007 <i>canarae</i> (Tiwari, 1958) *** <i>cavernicola</i> (Kemp, 1924) ***** <i>dayanum</i> (Henderson, 1893) *** <i>divakarani</i> Jayachandran, 2001 * <i>elatum</i> Jayachandran.1989 * <i>equidens</i> (Dana, 1852) * <i>gangenticum</i> Bate, 1868 ** <i>gurudeve</i> Jayachandran & Raji, 2004 ***** <i>hendersodayanum</i> (Tiwari, 1952) ***** <i>hendersoni hendersoni</i> (De Man, 1906) ***** <i>hendersoni cacharensis</i> (Tiwari, 1952) ***** <i>hendersoni platyrostre</i> (Tiwari, 1952) ***** <i>honnaense</i> Thampy, Jayachandran & Arunachalam, 2007 ***** <i>idae</i> (Heller, 1862) *** <i>idella idella</i> (Hilgendorf, 1898) *** <i>idella georgii</i> Jayachandran & Joseph, 1985 *** <i>indicum</i> Jayachandran & Joseph, 1986 ***** <i>javanicum</i> (Heller, 1862) ** <i>jayasreei</i> Jayachandran & Joseph, 1985 ***** <i>johnsoni</i> Ravindranath, 1979 ** <i>josephi</i> Jayachandran, 2001 *** <i>kempi</i> (Tiwari, 1952) *** <i>kistnense</i> (Tiwari, 1952) *** <i>kulkarnii</i> Almelkar & Sankolli, 2007 <i>kulsiense</i> Jayachandran, Lal Mohan & Raji, 2007 ** <i>kunjuramani</i> Jayachandran & Joseph, 1985 ***** <i>lamarrei lamarrei</i> (H. Milne Edwards, 1837)** <i>lamarrei lamarroides</i> (Tiwari, 1952) ***** <i>lar</i> Fabricius, 1798* <i>latimanus</i> (von Martens, 1868) ***** <i>malcolmsonii</i> (H. Milne Edwards, 1844) ** <i>manipurensis</i> (Tiwari, 1952) *** <i>mirabile</i> (Kemp, 1917) *** <i>naso</i> (Kemp, 1918) *** <i>nobilii</i> (Henderson & Matthai, 1910) *** <i>novaehollandiae</i> (De Man, 1908) * <i>ornatus</i> Jayachandran & Raji, 2004 *** <i>peguense</i> (Tiwari, 1952) *** <i>rogersi</i> (Tiwari, 1952) *** <i>rosenbergii</i> (De Man, 1879) ** <i>rude</i> (Heller, 1862) * <i>sankolli</i> Jalihal & Shenoy, 1988 <i>scabriculum</i> (Heller, 1862) ** <i>siwalikense</i> (Tiwari, 1952) *** <i>sulcatus</i> (Henderson & Matthai, 1910) * <i>tiwarii</i> Jalihal, Sankolli & Shenoy, 1988 <i>unicarnatakae</i> Jalihal, Sankolli & Shenoy, 1988 <i>veliense</i> Jayachandran & Joseph, 1985 * <i>villosimanus</i> (Tiwari, 1947)***	59
6	<i>Nematopalaemon</i> Holthuis, 1950	<i>tenuipes</i> (Henderson, 1893)* <i>karnafuliensis</i> (Khan, Fincham & Mahmood, 1980)*	2
7	<i>Palaemon</i> Weber, 1795	<i>concinus</i> Dana, 1852* <i>belindae</i> (Kemp, 1925)* <i>debilis</i> Dana, 1852* <i>pacificus</i> (Stimpson, 1860)* <i>semmelinki</i> (De Man, 1881)* <i>serrifer</i> (Stimpson, 1860)* <i>sewelli</i> (Kemp, 1925)*	
8	<i>Troglindicus</i> Sankolli & Shenoy, 1979	<i>phreaticus</i> Sankolli & Shenoy, 1979*****	1
9	<i>Urocaridella</i> Borradaile, 1915	<i>urocaridella</i> (Holthuis, 1950)#	1

Table 2. State-wise distribution of species under the subfamily Palaemoninae

States	Species reported from India	
	No.	Names of species
Andhra Pradesh	10	<i>M. rosenbergii</i> , <i>M. malcolmsonii</i> , <i>M. idella</i> , <i>M. rude</i> , <i>M. equidens</i> , <i>M. scabriculum</i> , <i>M. dayanum</i> , <i>M. nobilii</i> , <i>M. johnsoni</i> , <i>P. concinnus</i> ,
Arunachal Pradesh	2	<i>M. dayanum</i> , <i>M. hendersoni</i> , <i>hendersoni</i>
Assam	9	<i>M. rosenbergii</i> , <i>M. cavernicola</i> , <i>M. hendersoni</i> , <i>M. altifrons</i> , <i>altifrons</i> , <i>M. assamense</i> , <i>assamense</i> , <i>M. gangeticum</i> , <i>M. birmanicum</i> , <i>M. hendersoni</i> , <i>hendersoni</i> , <i>M. hendersoni</i> , <i>cacharensis</i>
Bihar	5	<i>M. lamarrei</i> , <i>lamarrei</i> , <i>M. malcolmsonii</i> , <i>M. altifrons</i> , <i>altifrons</i> , <i>M. gangeticum</i> , <i>M. birmanicum</i> ,
Chattisgarh	1	<i>M. dayanum</i> ,
Goa	4	<i>M. idella</i> , <i>idella</i> , <i>M. equidens</i> , <i>P. sewelli</i> , <i>P. pacificus</i> ,
Gujarat	1	<i>M. malcolmsonii</i>
Haryana	2	<i>M. altifrons</i> , <i>altifrons</i> , <i>M. siwalikense</i> ,
Himachal Pradesh	1	<i>M. dayanum</i> ,
Jharkhand	1	<i>M. dayanum</i>
Jammu & Kashmir	2	<i>M. dayanum</i> (?), <i>M. siwalikense</i> ,
Karnataka	13	<i>M. rosenbergii</i> , <i>M. lamarrei</i> , <i>lamarrei</i> , <i>M. idae</i> , <i>M. idella</i> , <i>idella</i> , <i>M. equidens</i> , <i>M. scabriculum</i> , <i>M. hendersoni</i> , <i>dayanum</i> , <i>M. kistnense</i> , <i>M. canarae</i> , <i>M. sankolli</i> , <i>M. unikarnatakae</i> , <i>M. tiwarii</i> , <i>M. banjarrae</i> ,
Kerala	30	<i>M. rosenbergii</i> , <i>M. aemulum</i> , <i>M. idae</i> , <i>M. idella</i> , <i>idella</i> , <i>M. idella</i> , <i>georgii</i> , <i>M. indicum</i> , <i>M. rude</i> , <i>M. novaehollandiae</i> , <i>M. equidens</i> , <i>M. sulcatus</i> , <i>M. latimanus</i> , <i>M. scabriculum</i> , <i>M. divakarani</i> , <i>M. elatum</i> , <i>M. josephi</i> , <i>M. canarae</i> , <i>M. sankolli</i> , <i>M. veliense</i> , <i>M. gurudeve</i> , <i>M. jayasreei</i> , <i>M. kunjuramani</i> , <i>P. pacificus</i> , <i>P. belindae</i> , <i>E. styliferus</i> , <i>L. potamiscus</i> , <i>L. fluminicola</i> , <i>L. kempii</i> , <i>L. celebensis</i> ,
Madhya Pradesh	5	<i>M. assamense</i> , <i>peninsularae</i> , <i>M. banjarrae</i> , <i>M. kistnense</i> , <i>M. malcolmsonii</i> , <i>M. assamense</i> , <i>peninsularae</i>
Maharashtra	15	<i>M. rosenbergii</i> , <i>M. lamarrei</i> , <i>lamarrei</i> , <i>M. idella</i> , <i>idella</i> , <i>M. equidens</i> , <i>M. scabriculum</i> , <i>M. kistnense</i> , <i>M. hendersoni</i> , <i>dayanum</i> , <i>M. malcolmsonii</i> , <i>M. bombayense</i> , <i>M. kulkarni</i> , <i>P. serrifer</i> , <i>E. styliferus</i> , <i>L. potamiscus</i> , <i>N. tenuipes</i> , <i>T. phreaticus</i> ,
Manipur	4	<i>M. lamarrei</i> , <i>lamarrei</i> , <i>M. lamarrei</i> , <i>lamarroides</i> , <i>M. dayanum</i> , <i>M. manipurensis</i>
Meghalaya	2	<i>M. dayanum</i> , <i>M. rogersi</i>
Mizoram	1	<i>M. dayanum</i>
Nagaland	1	<i>M. dayanum</i> (?)
Orissa	10	<i>M. rosenbergii</i> , <i>M. lamarrei</i> , <i>lamarrei</i> , <i>M. rude</i> , <i>M. equidens</i> , <i>M. scabriculum</i> , <i>M. dayanum</i> , <i>M. nobilii</i> , <i>M. malcolmsonii</i> , <i>E. styliferus</i> , <i>U. urocaridella</i>
Punjab	3	<i>M. siwalikense</i> , <i>M. dayanum</i> , <i>M. malcolmsonii</i>
Rajasthan	1	<i>M. lamarrei</i> , <i>lamarrei</i>
Sikkim	0	
Tamil Nadu	14	<i>M. rosenbergii</i> , <i>M. lamarrei</i> , <i>lamarrei</i> , <i>M. malcolmsonii</i> , <i>M. aemulum</i> , <i>M. idae</i> , <i>M. idella</i> , <i>idella</i> , <i>M. rude</i> , <i>M. latimanus</i> , <i>M. scabriculum</i> , <i>M. peguense</i> , <i>M. nobilii</i> , <i>P. pacificus</i> , <i>P. belindae</i> , <i>N. tenuipes</i> ,
Tripura	4	<i>M. rosenbergii</i> , <i>M. malcolmsonii</i> , <i>M. scabriculum</i> , <i>M. kempii</i> ,
Uttarkhand	1	<i>M. dayanum</i>
Uttar Pradesh	6	<i>M. altifrons</i> , <i>altifrons</i> , <i>M. gangeticum</i> , <i>M. kulsiense</i> , <i>M. kistnense</i> , <i>M. birmanicum</i> , <i>M. assamense</i> , <i>peninsularae</i>
West Bengal	17	<i>M. rosenbergii</i> , <i>M. lamarrei</i> , <i>lamarrei</i> , <i>M. rude</i> , <i>M. equidens</i> , <i>M. mirabile</i> , <i>M. scabriculum</i> , <i>M. assamense</i> , <i>assamense</i> , <i>M. birmanicum</i> , <i>M. lar</i> , <i>M. javanicum</i> , <i>M. placidulum</i> (?), <i>M. villosimanus</i> , <i>M. kempii</i> , <i>E. styliferus</i> , <i>L. fluminicola</i> , <i>N. tenuipes</i> , <i>N. karnafuliensis</i>
Andaman & Nicobar Islands	6	<i>M. australe</i> , <i>M. andamanicum</i> , <i>M. lar</i> , <i>M. latidactylus</i> , <i>P. debilis</i> , <i>U. urocaridella</i>

State wise distribution of species under the subfamily Palaemoninae

The available information on the state wise distribution of prawns is given below which indicates the lacuna on this aspect (Table 2).

Taxonomic ambiguities

The genus *Macrobrachium* contains more than 200 valid species. Since this genus contains too many species with wide range of variations there were attempts to separate the species and placed under two or more taxa. A new genus *Allobrachium* was proposed by Jayachandran (2001) to accommodate around 30 species which are at present treated under the genus *Macrobrachium*. However, this was disagreed by Min-Yun Liu *et al.* 2007. Similarly many species possess characters which are narrow for elevation to species level.

Molecular Taxonomy

The chromosomal information of palaemonid prawns are limited to a few species only (*M. idella*, *M. nipponense*, *M. rosenbergii*, *M. scabriculum*, *M. siwalikense*, *M. superbum*, *M. lamarrei lamarrei*) (Jayachandran, 2006 for review).

Some studies have established that barcode regions of COI has considerable potential as the foundation for a DNA barcoding identification system for crustaceans (Costa *et al.*, 2007). Murphy *et al.* (2005) have analysed 16S rRNA sequences from 30 species of *Macrobrachium* for establishing phylogenetic relations.

The author also has done some studies in penaeid prawns and similar studies have been undertaken at College of Fisheries, KAU, Cochin on *Macrobrachium*. The college welcomes associations of institutions in this regard for similar studies. It is absolutely essential for establishing the species and phylogenetic status of highly complicated group of palaemonid prawns.

Evidences for Gondwana

Jayachandran and Joseph (1988; 1992a) provided new evidences in support of Gondwana land.

Grouping of prawns on the basis of habitat

The prawns of the subfamily Palaemoninae can be categorized into the following groups based on their habitat preferences

- * Prawns living and completing their larval life cycle in saline water.
- ** Prawns living in upper regions of estuaries and/or lower stretches of rivers with or without tidal influence, but completing their larval life cycle in saline water.
- *** Prawns living in freshwater and with or without estuarine larval phase.
- **** Prawns living in interior water logged areas (ponds

and lakes) with limited distribution and completes larval life cycle in freshwater.

***** Prawns living in hill streams without down stream breeding migration and abbreviated larval development.

***** Prawns living in caves or subterranean life # Marine.

Present Utilization of the resources

At present the resources are utilized in the following ways:

Species of capture importance

A few species are reported to be commercially important in different states of India. These prawns are either marketed locally or exported. *M. rosenbergii*, *M. malcolmsonii*, *M. gangeticum*, *M. idella idella*, *M. idella georgii*, *M. divakarani*, *M. equidens*, *M. sulcatus*, *M. dayanum*, *M. lamarrei lamarrei*, *M. lamarrei lamarroides*, *M. mirabile*, *M. scabriculum*, *M. rude*, *M. villosimanus* belong to such group. Catch data for most of the states and water bodies are lacking.

Vembanad Lake is the natural abode for *M. rosenbergii*. Catch data of the species collected from the lake for the years – 1997 to 2004 is given below.

Year	Landings (kg)
1997	186 685
1999	330 095
2000	390 444
2001	490 748
2002	489 502
2003	232 929
2004	266 068

It is disappointing to note that during the peak breeding season (June to December) nearly 40% to 60% of the catch constituted berried females. This single factor is the major threat to the wild population of the species in the lake. Personal observation is that the population size of the lake is dwindling alarmingly and the present catch revival reports were mainly due to the artificial stocking of hatchery produced seeds by Government agencies. Conservation measures are discussed elsewhere.

Species of Aquaculture importance : Though the species diversity of the genus is rich, only a few species are at present utilized for aquaculture production. The species of importance include: *M. rosenbergii*, *M. malcolmsonii*, *M. gangeticum*. Mass larval production attempts were successful to an extent with regard to these species.

There are different types of aquaculture practices going on in Kerala, namely, monoculture, polyculture, integrated culture of freshwater prawns. Of these special mention has to be made about Paddy cum prawn culture ('Oru Nallum oru Meenum' – in Malayalam or One rice – One fish programme). This programme was developed by Kumarakom

Research Station, Kerala Agricultural University (Padmakumar, 2006). He has designated it as the win – win Land Use model. In this system the rice and fish are grown alternatively or in sequence. Joseph (2003) also revealed that yield and returns (per ha) in Paddy-prawn rotational farming system is highly profitable (cost : benefit ratio is 1.46).

The advantages of this system are:

- a. It enriches the soil, thus increases the rice production.
- b. It helps to control insect pests and aquatic weeds.
- c. Large areas of paddy fields utilizing for such fish culture do not demand any major modifications in its natural physiography.
- d. Such fields are more suitable for rice farming.
- e. Such fields are ecological harmonious.
- f. More productive and profitable than popular crop rotations.
- h. Generates employment opportunities.

Species having aquaculture potential, but unutilized: *M. josephi*, *M. villosimanus*, *M. latimanus* are potential species which can be utilized for aquaculture because they grow to bigger size. Practically very little information is available on various aspects of biology and management of these species.

In addition to the above species, there are a few species which are to be considered for ecosystem based as well as cultivation at rural areas. *M. idella*, *M. dayanum*, *M. equidens*, *M. sulcatus*, *M. rude* are medium sized species to be considered in this respect. *M. idella* for example establishes itself in the freshwater as well as low saline areas without any intervention from man. Therefore management of such species is important for augmenting production in rural areas. One advantage of this method is that production can be achieved without altering the prevailing ecology. This species is quite acceptable to people. To mention an example for this is China's cultivation of *M. nipponense*, a lesser sized species of high acceptance.

Species with ornamental value : Recently Jayachandran (2006 a; b; 2007) and Jayachandran *et al.* (2006) have made pioneering attempt to introduce 8 species of ornamental prawns of the genus *Macrobrachium* to the aquarium (Figs. 1-11). This is the first step in this direction. The species of ornamental value include – *M. canarae*, *M. latimanus*, *M. ornatus*, *M. gurudeve*, *M. rosenbergii*, *M. kulsiense*, *M. assamense*, *M. rogersi* and *M. sulcatus*. This is a novel method of utilization of biodiversity, but judicious exploitation from the wild is necessary for which regulatory measures are to be urgently taken up to protect them from over exploitation. This programme will certainly improve the livelihood security of rural people. Not much work has been carried out in these lines.

A new concept in Aquaculture: Cultivation of lesser species along with *M. rosenbergii*, *M. malcolmsonii*, *M. gangeticum* etc. proved beneficial. The lesser species will act as forage. This is a novel approach of organic farming.

This is being practiced under the supervision of the author. The advantages of the present practice are; improved health of cultivating species, reduction of disease problem in species under cultivation and drastic reduction of feed inputs and maintenance of good water quality.

Value addition: College of Fisheries, K A U has attempted to develop a number of products utilizing the lesser species of *Macrobrachium*. The products developed are Prawn Pickle, prawn cutlet, prawn stick (Pavunny *et al.*, 2007). The other products that can be produced include – flavour extract and chitin and chitosan production from shell waste.

Research Challenges

As per account given above, it is very clear that only a few biological studies have been undertaken on majority of species and hence information is available about them is scanty. For the successful management of this highly valuable resource, it is essential to concentrate on research on the following aspects. College of Fisheries, KAU, Cochin extends their willingness to associate in these lines.

- a. State-wise/wet land wise prawn genetic resource of India has to be ascertained.
- b. Biological studies such as the role played by each species in maintaining micro-climatic conditions, breeding nature, interrelationship with co-habitants have to be undertaken.
- c. Prawns are basically scavengers/detritivores. But there are smaller sized species which consume periphyton and algae. Research should be oriented in these directions.
- d. Judicious exploitation of resources should be enforced.
- e. Utilization of diversity of prawns for non-edible purposes like ornamental use, as forage etc. has to be worked out
- f. DNA Barcoding, 16S rRNA sequencing are to be undertaken. Some studies are going on at the College of Fisheries, KAU.
- g. Ethno-zoological information on prawns should be undertaken and patented under IPR.
- h. Karyotyping of prawns necessary for hybridization programmes for the production of new varieties
- i. Background information and policy formulation for transplanting species out of natural habitat is essentially required and worked out.

Conservation Needs

Due to habitat deterioration of wet lands population size of many species are reported to be on the decline. Commercial species like *M. rosenbergii*, *M. malcolmsonii*, *M. gangeticum* are over exploited. Many species are already under threat of extinction. An emerging area of biodiversity utilization is ornamental trade of freshwater prawns. Already there are exports of prawns from the wild without knowing to which species they belong. Considering all the factors there is a need

to develop a country status of freshwater prawns and initiate action plans for *in-situ* and *ex-situ* conservation for the prioritized species based on the evaluation of threatened species.

Some of the conservation efforts carried out for *M. latimanus* by College of Fisheries, KAU include:

- Collecting young and juveniles from the hilly regions which are under the threat of drying up during summer months. These were grown under captivity to the berried condition and subsequently released them back at the spot from where they were captured.
- Collecting berried females and young ones which are locked up in endangered temporary pools and ponds formed in hill streams and released in the streams so as to save the prawns due the conditions during summer months.
- Producing larvae under captive conditions and releasing them back to the spot where mother prawns were captured.

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