

Range extension of a mantis Shrimp *Harpiosquilla harpax* (Family: Squillidae) in the Chilika Lagoon

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The present study describes the first live occurrence of a species of mantis shrimp i.e. *Harpiosquilla harpax* from the Chilika lagoon. It was a new record to Chilika after the opening of natural inlet due to super cyclone *Phailin* during October 2013 and range extension from Visakhapatnam coast. However, concrete information regarding its population and spatio-temporal distribution is certainly not known. since it was caught as by catch. Food and feeding behaviour and morphological structure of the compound eye and ommatidia was also studied.

[Key words: Range extension, New record, Chilika lagoon, food and feeding, compound eye, ommatidia]

Introduction

Globally, a total of 450 species of mantis shrimp were reported till date belonging to 17 families and 7 superfamilies^{1,2}. Although, most of them are common in tropical and subtropical waters, but detailed information about each species in relation to their habitat, food and feeding habit and ecological link requires more research attention^{1,2}. Out of these 450 species, about 115 species were reported from Indo-pacific region comprised to 27 genera and 4 families³. Although, real diversity of stomatopod and their distribution in present day context is clearly not known in general and to the North-East Indian Ocean province in particular.

Chilika lake also known as lagoon is one of the important brackish water ecosystem in the world enriched with great biodiversity^{4,5}. Kemp⁶ made the first systematic study on stomatopod. He reported three species namely *Cloridopsis immaculata* Kemp, 1913, *Cloridopsis scorpio* Latreille, 1825 and *Oratosquilla interrupta* Kemp 1913. This information is further validated by Ghosh⁷. Then after, Rath and Mishra⁸ added another species named *Harpiosquilla raphidea* which was recorded first time from the outer channel area of Chilika lagoon after the opening of the artificial inlet during 23rd September 2000. Since then substantial observations regarding live occurrence of stomatopod species in the lagoon

premises has not been recorded till date. Since stomatopod plays a pivotal role in the lagoonal food chain and shallow water ecosystem because the fishes namely ray fish including electric rays and sharks, birds such as cormorants and shorebirds are directly depended on it for their nourishment. Therefore, it provides the energy to the higher-level trophic strata from bottom to the top in the complex lagoonal food chain.

Although, in the recent past lagoon has faced many of the natural and anthropogenic pressure^{4,5}. However, the impact of such changes on the faunal biodiversity in general and benthic communities in particular has not been completely understood yet. In order to fill this research gap the present study describes the new occurrence and range extension of a stomatopod namely *Harpiosquilla harpax* from the Chilika lagoon which is previously restricted to Vishakhapatnam waters only (Fig. 1a)

Materials and Methods

Chilika lagoon is the largest brackish water coastal ecosystem in Asia and second largest in the world located at 19° 28'-19° 54'N and 85° 05'-85° 38' E flanked at the east coast of India adjoining to the Bay of Bengal (Fig. 1b). It has a well described scientific exploration encompassing 100 years or more covering biology, biodiversity and hydrochemistry years^{4,5}. It is

a well designated Ramsar site declared during 1981. Chilika is an important biodiversity hotspot of the world and an ideal tourist destination too. Chilika has unique assemblage in the four *ecotones* such as northern freshwater, central brackish water sector, southern sector with marine to brackish water condition and outer channel area is entirely of marine region, as it is connected to the sea with couple of inlets^{4,5}. Towards the later part of the 20th century the Bay of Bengal–lagoon interaction decreased drastically. To revive this situation, a new mouth was opened by dredging during 23rd of September 2000. Since then the ecology of the lagoon is favouring to an array of flora and fauna in its premises which is evidenced through the massive fisheries output.

On the routine environmental sampling survey to Chilika lagoon the survey team encountered one specimen of stomatopod on dated 2.11.2013 during tropical cyclone *Phailin* that had stroked the lagoon 12th October 2013 (Fig. 1b). After collection, the specimen was preserved in 10 % formalin solution. Steps were taken to identify up to the species and deposited in the WRTC,Badkul, Khordha, Odisha, India with the Specimen ID no. Stomatopod-DM/5/2.11.2013/OC (Fig. 2).

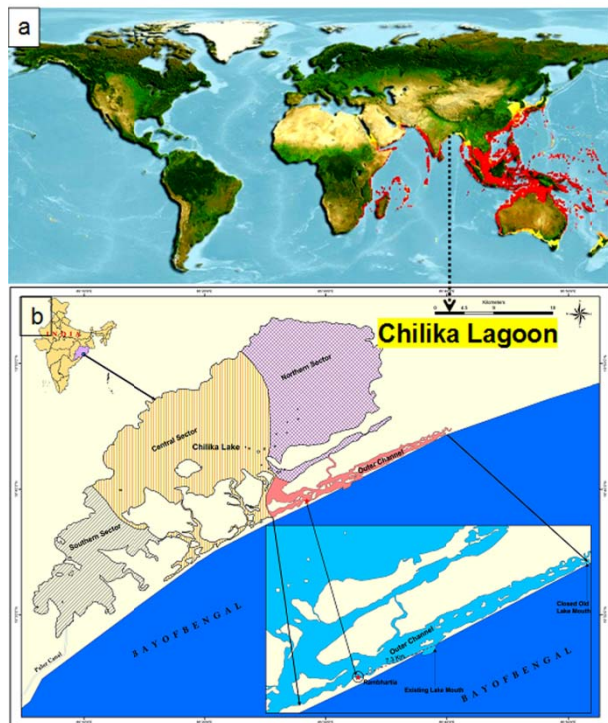


Fig. 1 — a. Global distribution of *Harpiosquilla harpax*. b. Map showing the study area and sampling station in Chilika lagoon from which *Harpiosquilla harpax* was collected.



Fig. 2 — Image showing a stomatopod *Harpiosquilla harpax*- new record from the outer channel region of Chilika lagoon, India from Lat. 19.66185 and Long. 85.49467.

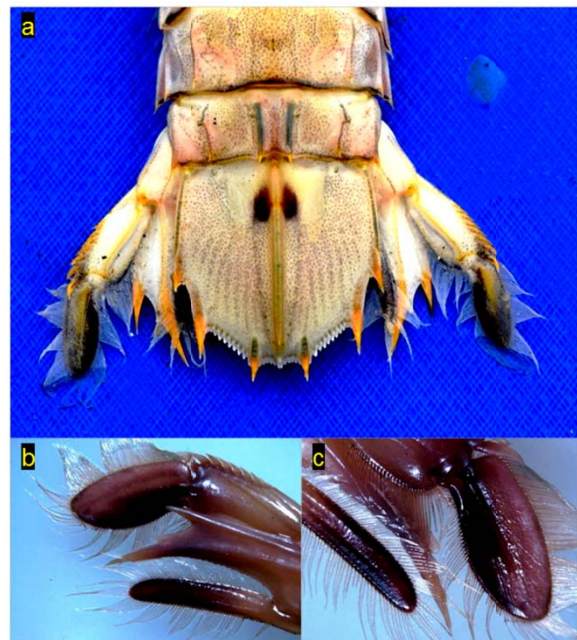


Fig. 3 — a. Image showing Telson and Uropod of *Harpiosquilla harpax* showing spines and hairs, b. Basal prolongation of Uropod and c. Endopod and Exopod with fine hairy arrangements

Result and Discussion

This specimen *Harpiosquilla harpax* was collected at a depth of 1.5 m, during low tide. The sediment composition was sandy mud. The details of the morphological features of the observed specimen in are given in the Table no. 1 while the measurements are expressed in the centimetre. The pictorial evidences of the main organisms and its different parts is given in the Figures 2 , 3 & 4 respectively. Figure 5 showed the structure of compound eye and ommatidia.

Identifying characters:

Eyes dumbbell shaped, stalks long, rostral plate longer than broad, antennular peduncle usually shorter than carapace; carapace with median carina; marginal carina of telson more than twice as long as carina of lateral tooth. Dactylus half than propodus. Second thoracic raptorial claw narrow and well elongated. Telson with six large marginal carinae, minute denticles between the submedian carinae was seen. Also between the submedian and intermediate carinae was recorded. The 5th, 6th, 7th and 8th thoracic somite was shortened, bud-like appendages were observed. However, the major identifying remark was that of the Fifth thoracic somite with a lateral spine and it is rounded laterally. Dactylus of raptorial claw with 8 teeth; indistinct sub median carinae on thoracic and first 5 abdominal somites^{12,13}.

Body colour was pale yellow with minute dark spots. Carapace and raptorial limbs with thoracic and abdominal somites were pinkish in colour. A pair of well marked brown colour round patch was seen on the either side of the base of the mid-dorsal carina of the telson. Spines on abdomen, telson, and uropod were yellow. Telson with grey pits and proximal submedian patches of telson observed maroon as described by Utinomi⁹ (Fig. 3). The observed unidentified species undergone following taxonomic classification.

Kingdom: Animalia
 Phylum: Arthropoda
 Subphylum: Crustacea
 Class: Malacostraca
 Subclass: Hoplocarida
 Order: Stomatopoda
 Family: Squillidae
 Genus: *Harpiosquilla*
 Species: *Harpiosquilla harpax* de Haan, 1844
 (Table-1, Fig. 2, Fig. 3, Fig. 4 & Fig. 5)

Habit and Habitat

This cryptic species is commonly seen in the sublittoral zone, shallow areas, in the sandy mud sediment, coral reef bed, molluscan reef bed, muddy shore, mangrove belts. It can accommodate a depth ranged from 0-100 m it prefers a benthic mode of life style. It is a nocturnal animal¹² and feeds on fishes, and benthic macroinvertebrates that include annelids crustaceans, bivalves and gastropods.

Comparison with other species

It can be distinguished from other species of *Harpiosquilla* such as *H. annandalei*, *H. japonica*, and *H. stephensoni* significantly in respect to the presence of apical median projection of the rostral plate. In those species the rostral plate is blunted at

Table 1 — Morphological measurements of *Harpiosquilla harpax* collected from Chilika lagoon (all measurements are in centimetre)

Morphological measurements	in cm
1 Total length	14.4
2 Rostral length	0.7
3 Rostral weadth	0.3
4 Carapace length	3.5
5 Carapace weadth	2.2
6 Abdomen length	10.2
7 Length of the eye	1.2
8 Width of the eye	0.3
9 Eye peduncle	0.4
10 Length of antennular scale	1.7
11 Length of antenna	3
12 Length of antennule	5.1
12 length of mandibular palp	1.7
13 Length of the rapatorial claw (Propus + Dactyle)	6
14 Propus	3
15 Dactyle	3
16 Merus	3.5
17 Length of Pleopod	1.6
18 Length of Pereopods	
1st	2.7
2nd	2.8
3rd	3.3
19 length of Maxillipeds	
3rd	3.4
4th	3.2
5th	3
20 Length of Telson	2.2
21 length of Middle carina	2.2
22 Width of Telson	2
23 Length of the Uropod	3



Fig. 4 — Different parts of used for capturing the live prey a. antennal scale, b. Antennule, c. Antenna, d. Pleopods (swimming legs), e. Pereopods (walking legs), f, g. Maxillipeds, h. Raptorial claw (required for capturing of prey), i. Dactyl, j. Propus.

the apical end, if rounded then obtusely. So far total length is concerned *Harpiosquilla harpax* is a smaller than *H. raphidea*. The intermediate carinae of the last three thoracic somites are armed with spines in *H. raphidea* whereas in *H. harpax* it was unarmed. In *H. harpax*, the lateral process of the fifth thoracic somite is rounded but in *H. raphidea*, it is laterally spined. Besides this two of the species *H. indica* and *H. melanoura* differs from *H. harpax* in respect to have a faded submedian carinae on the abdomen which will distinguish from both new species the latter species lacks the median carina on the carapace. In *H. indica*, the intermediate carinae of the first and second abdominal somites are unarmed; the carinae of the second abdominal somite are always armed in adults of *H. Harpax*¹³.

Distribution:

This species is widely distributed in the Indo-West Pacific from the Red Sea and western Indian Ocean to Taiwan, the Philippines, Vietnam, Japan, New Caledonia and Australia. In Australia, *Harpiosquilla harpax* is known from Joseph Bonaparte Gulf, Western Australia, eastwards to Botany Bay, New

South Wales^{10,11}. In India, this species was reported from the Chennai coast, Arabian sea, Bay of Bengal: Kerala; Narasayapalem; Tamil Nadu; Mandapam; Tuticorin; Andhra Pradesh; Waltair; West Bengal South 24 Parganas etc¹². Four species of the genus *Harpiosquilla* reported from Indian waters namely *H. raphidea*, *H. harpax*, *H. melanoura* and *H. annandalei*. Except *H. harpax* all the three species were have well known distribution

Along the east coast of India, the distribution of *Harpiosquilla harpax* is restricted to the Vishakhapatnam waters¹⁴ and patchy distribution is recorded all along west coast of India. However, there is no definite information related to its distribution along the north east coast of India. In such conditions, the present study confirmed the existence of a live specimen of *H. harpax* in the outer channel area of Chilika that strongly claiming the range extension from Vishakhapatnam coast to further extension towards northeastern region of Indian Ocean and a new record to the Chilika lagoon.

Food and feeding of *H. harpax*

This stomatopod is nocturnal in nature and lives in the burrows made up of sandy mud or in crevices of molluscan shells or in coral reef beds. Published report confirmed that the *H. harpax* usually feeds on small fishes, shrimp, molluscs and *Sepia* by using the raptorial claw. A number of morphological adaptations are responsible for killing the live prey such as raptorial claws and long powerful antennules. The condition of shortage of food enforces this species to show cannibalism¹⁵. Two of the important structures namely of antennule length followed by the optic sensory structure of *H. harpax* are much larger than other mantis shrimp species that favours strongly during the feeding behaviour¹⁶.

The gut content analysis of the *H. harpax* observed during the present study showed the preference of benthic crustacean communities (68%) followed by remaining of the molluscan community (20%), fish remaining (7%) and unidentified digested food materials of (5%). Parasad & Rao¹⁷ reported regarding the food preference of this species while working on the Vishakhapatnam harbour. They reported that fish is the most favoured food of *H. harpax* that contributed the major percentage of the total gut content followed by crustaceans, cephalopods, sand, digested matter, plant material, polychaetes, echinoderms and molluscs.

Compound eye of *Stomatopod vis-a-vis H. harpax*

Stomatopods are regarded as one of the aggressive benthic organisms endowed with pedunculated eyes formed by thousands of ommatidia, therefore, stomatopods are regarded as benthic crustaceans having powerful visual sensory organs as compared to other crustaceans and benthic invertebrates¹⁸. Since stomatopods are visual predators therefore, the eye is well developed, designed with a variety of shape and size with respect to different families and their surrounding habitat.

Some of the squillid species showed minute bilobed corneas of *Clorida* with dwarf stalk to the enlarged T-shaped structure of *Harpiosquilla*. The eye of *Hemisquilla* and *Odonodactylus* are either ovoid or spherical¹⁹. Stomatopodian eye is consisting of three distinct region two hemispheres and a middle band. This middle band contains specialized ommatidia designed for the greater potential for visualisation of the prey and surrounding habitat. It is present in all the three super families however absent in genus *Bathysquilla* belonging to the superfamily Bathysquilloidea. The middle band is two facets wide in species of *Squilla*, *Meiosquilla*, *Harpiosquilla* and members of two families in the superfamily Squilloidea. The representatives of the family Gonodactyloidea showed the middle band with six facets. This is exclusively observed among the genus of their respective families namely *Gonodactylus*, *Pseudosquilla*, *Hemisquilla* and *Odontodactylus*. *Lysiosquilla* also exhibited six facet middle band belonging to superfamily Lysiosquilloidea and family Lysiosquilloidea. The basic difference in the ommatidium of Gonodactyloids and Lysiosquilloids is the former shows rectangular facets whereas later exhibited either hexagonal or spherical facets.

In this study the details of the eye structure of *H. harpax* along with the structure of ommatidia and its arrangement over the mid band can be viewed (Fig. 5). Findings revealed that the cornea the observed specimen is bi-lobed and cylindrical having black patches at both the poles. 2800 ommatidia arranged in 80 rows observed on each cornea. The cornea is well place up on the peduncle. Two facet mid band can be viewed from the image indicated with yellow arrow mark. The microscopic view of ommatidium clearly showed many light and dark patches. In *H. harpax* the middle band is composed with large sized ommatidia arranged in two parallel row. However there is a progressive decrease in the

size of the ommatidia from the middle band region (110 μ) towards pole regions (65 μ) on the horizontal plane.

Studies revealed that the mid band and other two halves of the *H. harpax* showed only one type photoreceptor. In contrast to it there are 16 anatomically different photoreceptor recognised in superfamilies of Gonodactyloidea and Lysiosquilloidea. Out of 16 photoreceptor 14 are instantly found on the mid band region and other 2 types are seen in the ommatidia of dorsal and ventral hemispheres. The ommatidia size and the photoreceptive pigment found of the two hemispheres in general and mid band region in particular directly indicates whether the species is diurnal or nocturnal, food and feeding behaviour etc. In *H. harpax* only one type of photoreceptor cell is observed in the mid band which denotes that this species prefers a nocturnal mode of life and avoids strong light intensity. Reduced two row mid band region having one type of photoreceptor cell is the characteristic feature of the representatives of the super family of Squilloidea and

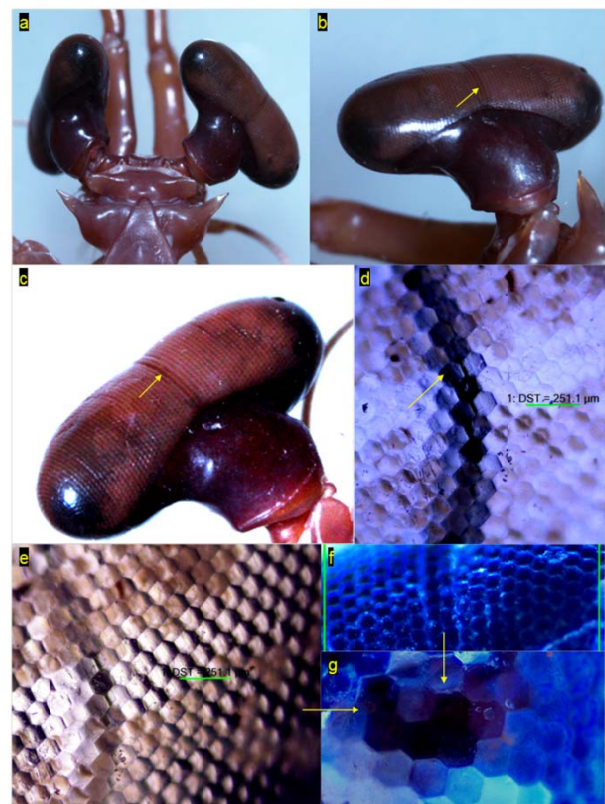


Fig. 5 — a. pair of compound eye of *H. harpax* showing peduncle and rostral plate, b. Cornea c. Cornea showing the middle band, d-g. microscopic view of middle band and hexagonal shaped ommatidia of *H. harpax*.

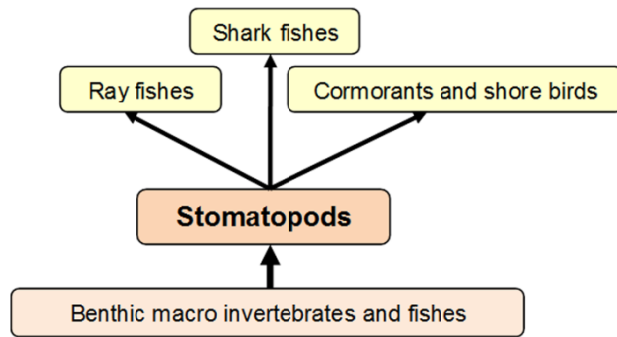


Fig. 6 — Food chain of stomatopod in a coastal lagoon.

Bathysquilloidea²⁰. Therefore, compound eye of the stomatopod plays a vital role regarding the taxonomic identification and further describes its habit, habitat, food, and feeding type.

After opening of the lagoonal inlets coupled with the occurrence of natural catastrophic events such as, tropical cyclones etc. have influenced positively on the marine biodiversity of the Chilika lagoon in general and on the benthic macroinvertebrate community in particular. Many of the publications are noticed mentioning the new occurrence of marine species in the Chilika lagoon premises, specifically in the outer channel area as described by Mahapatro⁴ and Mahapatro *et al.*,²¹⁻²⁶.

Presently, a total of eight species are recorded from Chilika lagoon including *Harpiosquilla harpax* namely *Harpiosquilla raphidae* Fabricius 1798, *Cloridopsis immaculata* Kemp 1913, *Cloridopsis scorpio* Latreille, *Oratosquilla nepa* Latreille 1828, *Oratosquilla fabricii* Holthuis 1941, *Oratosquilla interrupta* Kemp 1911 and *Squilla mantis* Linnaeus 1758 as described by Mahapatro⁴. Some of these species namely *Oratosquilla interrupta*, *Cloridopsis scorpio*, *Oratosquilla nepa*, *Squilla mantis* recorded as by catch and caught dead during the period of 2007 to 2010. Stomatopods in general and *H. harpax* in particular is regarded as the important ecological link since it grazes up on benthic macroinvertebrates, fishes and predated by carnivorous fishes, cormorants shore birds, sharks and rays as reported elsewhere (Fig. 6).

The outer channel is well connected with Bay of Bengal through couple of inlets therefore its salinity is almost equal to the range i.e. 25-32 psu of the nearby sea. The sediment is also mixed type in the shoreline and pure sandy on the profoundal region⁴. The mixed sediment of the shoreline of outer channel area supported this *H. harpax* species and other

squillid species to thrive⁴. However continues change in the geomorphology of the sand bar may cause hindrance to their population and reproductive ability.

Conclusion

Present study is unique in four significant aspects such as i) *H. harpax* is newly occurred stomatopod species in Chilika whose range has been extended from Vishakhapatanam waters to Chilika, (ii) the mid band of compound eye of stomatopod can be used as potential tool for the taxonomic identification, (iii) the lagoon is conducive enough to sustain newly occurring species and iv) presence of benthic invertebrates and fishes in the gut content of *H. harpax* signifies that the outer channel area is much richer with this type of benthic macrofauna. It appears that the outer channel becomes hotspot of biodiversity that needs regular scientific exploration to understand possible change in the marine biodiversity due to climatic variability on spatio-temporal scale.

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