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Range extension of a vulnerable Sea horse *Hippocampus fuscus* (Actinopterygii: Syngnathidae) on the north-eastern Bay of Bengal coast

Debasish Mahapatro[1], R. K. Mishra[2*] and S. Panda[3]

Abstract

The study describes the range extension of the sea horse Hippocampus fuscus from the south to north east coastal waters of the India, Bay of Bengal. After 99 years since initial discovery, the Hippocampus fuscus was reported within the southern sector of the Chilika Lake. The extension range may be due to the East India Coastal Current of the Bay of Bengal and the predominance of extensive sea grass meadows within the southern sector of Lake.

Keywords: Sea horse, *Hippocampus fuscus*, Gopalpur coast, Chilika lake, Range extension

Introduction

Sea horses are predominantly found in Indo-Pacific regions, covering approximately 45°S to 45°N (Froese & Pauly, 2014; Sreepada et al., 2002). The International Union of Conservation of Nature (IUCN, 2014) reported 38 species of sea horse worldwide, out of which about 50% of the total dominate the coastal region of the Indian sub-continent. The habitats of sea horses pertain to various coastal ecosystems, such as seagrass meadows, mangrove, estuaries, lagoons, and coral reefs (Froese & Pauly, 2014; Kendrick & Hyndes, 2003; Sreepada et al., 2002; Lourie et al., 1999). Sea horses are also found in association with other animals, like gorgonians, sponges and sea quirts, exhibiting wide ranging adaptations to different environmental conditions and locations. Sea horses were observed ubiquitously as little as 10 years ago (Lourie et al., 1999; Sreepada et al., 2002; Froese & Pauly, 2014). However, in recent times the scenario has changed dramatically, due to illegal poaching and hunting for Chinese medicines, as well as Korean and Japanese recipes. As a result, the global sea horse population has undergone significant decline, causing the IUCN to give sea horses as endangered, threatened vulnerable statuses (Baillie & Groombridge, 1996; Vincent, 1996; Sreepada et al., 2002; IUCN, 2014). In India, the Ministry of Environment and Forests banned the exportation of Syngnathids in 2001, also conserving them under Schedule I of the Indian Wildlife Protection Act (1972) (Sreepada et al., 2002). Sea horses mostly belong to the genus *Hippocampus,* within the family "Syngnathidae" (Froese & Pauly, 2014; Lourie et al., 1999). *Hippocampus* species have very peculiar body shapes, consisting of five different features:(i) head and neck resembles a horse- hence the name "Sea horse", (ii) the middle body portion looks like a fish (because of the presence of dorsal and pectoral fin rays), (iii) the tail portion looks similar to the tail of a monkey, (iv) body colour changes according to the surrounding environment, like a chameleon and (v) existence of brood pouches, like kangaroos.

For protection from predators, sea horses are able to change body colour rapidly and frequently, bringing about short and long term changes in body colour. Thus, these organisms are regarded as the "masters of camouflage" in the marine environment (Project Sea horse, 2014). Rapid changes in body colour are also noticed during mating, which depends upon age and the surrounding oceanic environmental conditions. Therefore, the proper identification of species of sea horse is considered difficult. The male sea horse brood pouch

* Correspondence: rajanimishra@yahoo.com
[2]National Centre for Antarctic and Ocean Research, Ministry of Earth Sciences, Government of India, Goa, India
Full list of author information is available at the end of the article

helps to incubate fertilized eggs laid by the female until the young are able to swim. This form of paternal care is a rare phenomenon amongst marine organisms (Project Sea horse, 2014; Froese & Pauly, 2014; Lourie et al., 1999). Considering future climatic changes, resultant environmental changes could have significant impacts on the sources of food such as phytoplankton biomasses and other marine organisms (Fabry et al., 2008; Jena et al., 2013; Mishra et al., 2015). This may trigger cascading effects on sea horse populations, other marine communities and ecosystem dynamics.

India is a hotspot of sea horse abundance and diversity; thus reflected in the past research activities (Lipton and Thangaraj 2002; Sreepada et al., 2002; Thangaraj & Lipton 2007; Lipton & Thangaraj 2013). However, detailed taxonomic research on sea horses within India is sparse. The first reliable documentation on sea horses within an Indian context is by Choudhury (1916) from the Chilika Lake. Subsequently, major research programmes have not been carried out in this particular region to substantiate the distribution, diversity, biology, and population size of this vulnerable species. The sea horse species documented by Choudhury (1916) from Chilika Lake was known as *Hippocampus brachyrhynchus* Duncker 1914, later on identified as *H. fuscus* Rüppell 1838 (Bailly, 2015). Furthermore, Bailly (2015) states that this particular species only breeds in the lake, but is mostly found within the lagoon's southern sector (i.e. mouth of the Rambha bay).

Marichamy et al.(1993) report two new records of sea horses (*H. kuda* and *H. trimaculatus*) from Palk Bay. Since, Lipton and Thangaraj (2002) have added *H. fuscus* to the Palk Bay record. Simultaneously, Balasubramanian (2002) reported another species *H. kellogi* from the southeast coast of India. Sreepada et al. (2002) communicate a detailed review on the sea horse status in India, highlighting the key issues of sea horse use in medicine. This basic information pertained to their threats and conservation, trade and commerce in India and the world.

Thangaraj & Lipton (2007) note the occurrence of a Japanese sea horse *Hippocampus mohnikei* from the Palk Bay. Murugan et al., (2008) describe the presence of five species of sea horses along the south-eastern coast of India. Significant work on morphological characterization was carried out by Thangaraj & Lipton (2011) on species such as *Hippocampus fuscus, H. kelloggi, H.kuda* and *H. trimaculatus* within the Gulf of Mannar. A similar study was also made by Lipton & Thangaraj (2013) at Tamilnadu and Kerala coasts of India, observing six sea horse species named *Hippocampus fuscus, H. kelloggi, H. kuda, H. histrix, H. mohnikei* and *H. trimaculatus*. Among them, *H. fuscus, H. kuda* and *H. trimaculatus* are common and widely distributed across the south-eastern coast of India. However, Gopalpur of India's north-eastern coast is still being deficient in the incidence of sea horses. Therefore, the present study is carried out on the evidence of any re-occurrence of *H. Fuscus* and its range extension from the south to the northeast coast of India, in Chilika Lake and the adjoining of Bay of Bengal (BoB).

Materials and methods

Study area

The Gopalpur coast is situated between 19^0 256′ 381"N and 84^0 909′ 366"E on north-eastern coast of India, approximately 160 km south of Paradip and 260 km north of Visakhapatnam. It's 4 km coastline extends with sandy beaches, whilst the adjacent areas are covered with casuarinas vegetation. The beach is covered with sand dune vegetations. On the northern side, a 7 km long backwater creek exists, known as Haripur creek. The climate is tropical, receiving southwest and northeast rainfall with an average of 8.6 mm per month. The East India Coastal Current (EICC) of the BoB travels from the south to the northeast coast of India during January to October touching to it. The region is highly susceptible to tropical cyclones (Mahapatro et al., 2015b) (Fig. 1a).

Lake Chilika is situated between 19^0 28'N and 19^0 54'N and 85^0 05'E and 85^0 38'E on the east coast of India (Fig. 1b). Chilika is a pear shaped brackish water lagoon, with length of 64 km and width varying between 2 and 20 km. The lagoon is divided into four ecological sectors, namely the northern-fresh water sector, central-brackish water sector, southern-brackish to marine sector and outer channel, which is solely marine. The outer channel is 32 km long, orientated parallel to the coastline, and terminating in the BoB through two inlets. The tidal amplitude is semi-diurnal. The salinity of the southern sector is marine throughout the year, in contrast to the lagoon average. During the southwest monsoon, Chilika's average surface salinity approaches to zero because of the influx of fresh water from the rivers and channels connected to the Lake from the northern and western catchments (Panda et al., 2008). The southern sector connects to the Palur Canal (16 km long channel), which transports marine waters during high tide periods, from Bay of Bengal along with the transport sof and or sandy-clay substratum. This condition supports the growth of sea grass meadows such as *Halophila ovalis*, *Halophila ovata*, *Halophila beccari*, *Halodule uninervis* and *Halodule pinnifolia* (Panda et al., 2008).

Sample collection

A trawl net was hauled at a depth of 4 m on 9th March 2009, within in the Gopalpur coastal waters for fishing purposes. During these activities, a sea horse was caught and kept for later analysis. The sample was identified

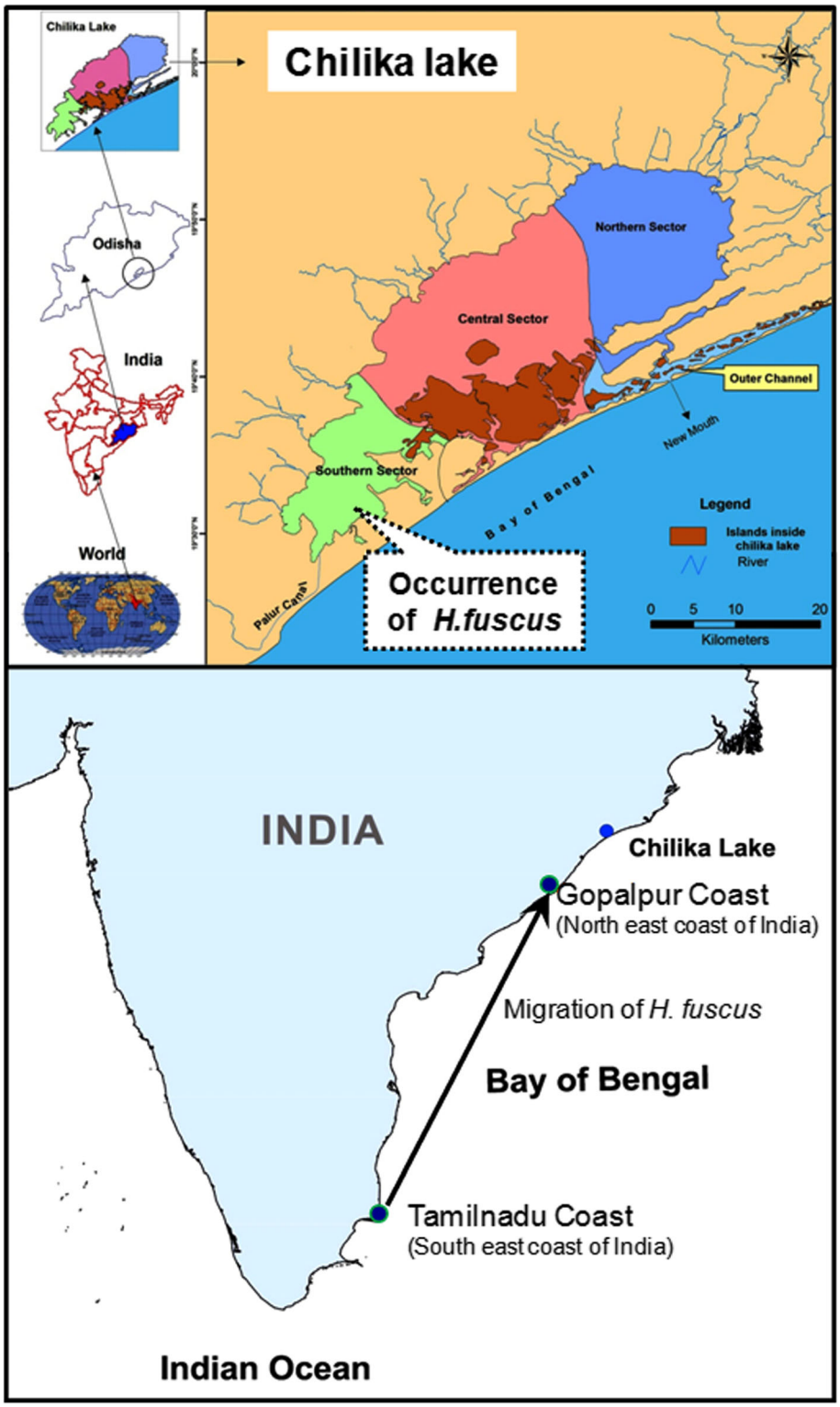

Fig. 1 Map showing the occurrence of H. fuscus in the Chilika lake (*upper*) and the migration route of H. fuscus from southeast Bay of Bengal to northeast Bay of Bengal, Gopalpur coast (*lower*)

carefully and photographs were taken immediately. A second sample was collected during a macrobenthic sampling program, using a sediment grab sampler (surface area 0.04 m^2) from the sea grass meadow region of the southern sector of Chilika Lake on 22nd March 2009. After initial observation, the sample was photographed and preserved. The specimen was then identified up to the species level by following the standard method of Lourie et al., (2004).

Results

Identification

The *Hippocampus fuscus* obtained from Gopalpur and Chilika has the following morphological features: body length equals14 cm, with 34 tail rings, 11 trunk rings, 16 dorsal fin rays and 15 pectoral fin rays. The coronet was lowly raised and slightly curved, the head was large compared to body, and the colour of the body was pale yellow to light green. The spines are slightly developed with smooth texture. After systematic analysis, both species were identified as *Hippocampus fuscus* Rüppell 1838. This specimen undergoes the following taxonomic classification (Lourie et al., 2004).

SYSTEMATICS
Class ACTINOPTERYGII
Order SYNGNATHIFORMES
Family SYNGNATHIDAE
Genus HIPPOCAMPUS (Cuvier, 1816)
Hippocampus fuscus (Rüppell 1838)

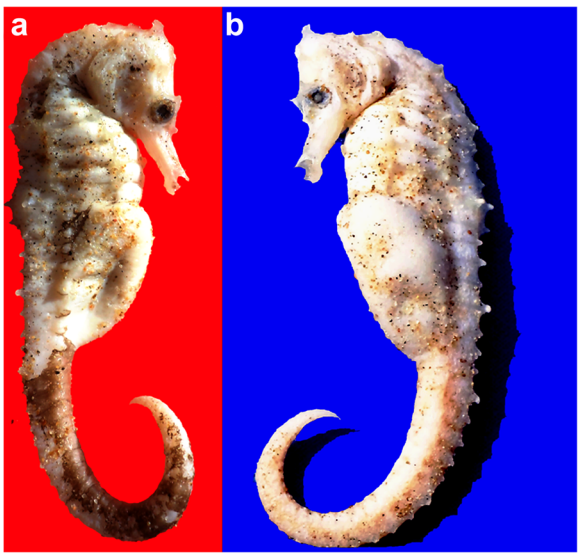

Fig. 2 Figure showing the specimen of *H. fuscus* from (**a**) Gopalpur Coast & (**b**) from Chilika Lake

(Figure 2 a from Gopalpur Coast & b from Chilika Lake) (Lourie et al., 2004).

Remarks

A coronet crown like bony crest is considered as one of the key identifying features. The body characters of this identified species were found relatively similar to three other species, namely: *H. borboniensis, H. hippocampus* and *H. kuda. H. borboniensis* has more tail rings, enlarged, knob-like spines and a better-developed coronet. Also, *H. borboniensis* has a larger head with two prominent eye spines. In contrast, the eye spine of the collected *H. fuscus* was entirely absent. The body of *H. borboniensis* was much shallower compared to the *H. fuscus*, formulating the key difference between these two species. The second species, *H. hippocampus,* has more tail rings, more dorsal fin rays, and fewer pectoral fins than *H.fuscus.* However, *H. hippocampus* has some similar characteristics with *H. fuscus,* as its distribution is restricted to the European waters (Lourie et al., 2004). However, the third species *H. kuda* has a larger body, deeper head, more tail rings, and a well-developed coronet with rounded shape as compared to the *H.fuscus*. Furthermore, the snout depth of *H.fucus* was higher than *H. kuda.*

Discussion

The present specimen *Hippocampus fuscus* was previously known as *Hippocampus brachyrhynchus* Duncker, 1914, reported from Chilika Lake by Choudhury (1916). Choudhury (1916) collected 7 sea horse species belonging to *Hippocampus brachyrhynchus* from the Rambha bay (southern sector) of Chilika Lake. Out of seven specimens, 3 were young, 3 were female and 1 was the male representative. Choudhury further confirmed that *Hippocampus fuscus* was a regular breeder inside the lake mostly in the sea grass bed region of the Lake's southern sector, also reported by Jones and Sujansingani (1954), ZSI, (1995) and Mahapatro (2016). However, comparatively limited information of its history is found in the publication. Pictorial information is entirely lacking, as well as the morphometric characters.

Thus, the study on spatial distribution of this vulnerable species in Chilika Lake and the adjoining coastal waters has been missing for last 99 years. Presently, Mahapatro et al., (2015a) found a pale yellow coloured sea horse from the sea grass bed of the Rambharatia region of Chilika Lake. Hence, the migration of sea horse from the BoB to Lake could be due to the potential feeding activities or through the tidal current. Interestingly, the specimen of *H. fuscus* was also observed in the coastal waters of Gopalpur, Bay Bengal, from the depth of 4 m as seen earlier (Mohapatro et al., 2015a). This suggests that the species *H. fuscus* was present in the

BoB and gradually shifted/drifted into the southern sector of Chilika Lake during the EICC through Palur channel. In addition, the proliferation of the sea grass bed in southern sector of Chilika Lake could support a preferable habitat for *H. fuscus*.

Consideration of the literature showed that *H. fuscus* is commonly observed in the coastal waters of Kerala and Tamilnadu (Thangaraj & Lipton, 2011; Lipton & Thangaraj, 2013). This might be a reason for the migration of *H. fuscus* from south to the northeast coast under the influence of EICC (Durand et al., 2009). A similar incident has been observed by Harasti (2015) in the Australian coastal waters, as the sea horse *Hippocampus histrix* migrated southward around 1800 km in the Great Barrier Reef due to the influence of East Australian Current (EAC). Large scale changes in the geographical distributional pattern of marine organisms which are not uncommon, as current circulation plays the key role. As seen here, EICC in the Indian east coast might have a significant role for the migration of *H. fuscus,* covering approximately 1100 km from the south to the northeast coast of India to appear within Lake Chilika.

Conclusion

The occurrence of *H. fuscus* in coastal waters of the BoB, and its extended range to the southern sector of Chilika Lake may reflect the migration from the south to the northeast coast of India under the influence of East India Coastal Current (EICC). Over the last 99 years, there has not been any information on the diversity, food, feeding habits or breeding biology of *H. fuscus* in the Chilika Lake and adjoining BoB. However, it is acknowledged that further and recurrent study of *H. fuscus* would confirm migration trends along the north eastern coast of BoB, if any, due to physical forces and/or oceanic currents in the region. In addition to the collection of in-situ datasets, satellite measured environmental parameters such as temperature, ocean colour, wind and current patterns is essential to study the effects of biophysical processes on population, community, and ecosystem dynamics (Jena et al., 2010; Mishra et al., 2003; Naik et al., 2014; Mahapatro et al., 2015b). This would help to delineate the ecological sensitive areas (ESA) for the appropriate management and conservation of *H. fuscus*.

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Availability of data and materials

The datasets generated and/or analysed during the current study and interpreted in the manuscript.

Authors contributions

The author DM collected the sample and followed the procedure to analyze the method and identified the species. RKM is analyzed and interpreted the result towards the discussion. SP was a major contributor for comments the manuscript. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

Consent for publication

The research on the species is undertaken with no conflict of interest of the authors and the manuscript is prepared by the authors which have equal contribution to this publication.

Ethics approval and consent to participate

The Authors in the study of "Range extension of a vulnerable Sea horse Hippocampus fuscus (Actinopterygii: Syngnathidae) on the north-eastern Bay of Bengal coast", which has recently been accepted at Cambridge University Press for the journal Marine Biodiversity Records declared that the species is The IUCN Red List of Threatened Species™ is produced and managed by the IUCN Global Species Programme, the IUCN. Therefore the authors studied the species for research purposes for scientific awareness to the fishery folks and societal under the regional research sustainable program "Integrated Coastal Zone Management (ICZM), India by the world bank sponsored project. Hence the species is undertaken for the research purpose only not used for any commercial or other. And authors acknowledged properly to the host institute for the research.

Author details

[1]Department of Marine Sciences, Berhampur University, Berhampur, Odisha, India. [2]National Centre for Antarctic and Ocean Research, Ministry of Earth Sciences, Government of India, Goa, India. [3]Regional CCF, Angul, Odisha, India.

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