

## Seahorses and pipefishes of the Tamil Nadu coast

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This study provides baseline information on the abundance and identification of seahorses and pipefishes of the Tamil Nadu coast. Monthly sampling for seahorses and pipefishes from the by-catch was made during 2000–01 at 15 landing centres along the Tamil Nadu coast. Five species of seahorses belonging to one genus and seven species of pipefishes belonging to four genera were recorded. *Hippocampus kelloggi* and *Trachyrhamphus bicoarctatus* were recorded for the first time in the Indian waters. *H. kelloggi* was abundant in the Coromandel coast, *H. kuda* in the Palk Bay and *H. trimaculatus* in the Gulf of Mannar. *H. fuscus* was absent in the Coromandel coast and *H. kelloggi* was not recorded in the Palk Bay and the Gulf of Mannar. Seagrasses, seaweeds and dead corals were the preferred habitat of seahorses. *H. kelloggi* was recorded at 10–20 m depth and the others were found at depths less than 10 m. Abundance of seahorses was more in the Palk Bay than in the Gulf of Mannar and the Coromandel coast. Area-wise and species-wise abundance of seahorses was maximum during northeast monsoon and minimum during summer. In all, 104,018 seahorses were collected from the by-catches, comprising 34% *H. trimaculatus*, 29% *H. kuda*, 19% *H. spinosissimus*, 9% *H. kelloggi* and 9% *H. fuscus*. This 2000–01 survey on the abundance of seahorses may serve as a yardstick to assess the impact of the excavation and subsequent navigation of the Sethu Canal. With preference to seagrasses and seaweeds, the pipefish, *Syngnathoides biaculeatus* was the most common species in the shallow coast. In the Palk Bay and the Gulf of Mannar, the percentage composition of *S. biaculeatus* was more than that of seahorses, while seahorses constituted more than 78% of the total syngnathid landings of the Coromandel coast. Other pipefish species were rare along the Tamil Nadu coast.

**Keywords:** Abundance, by-catch, identification, pipefishes, seahorses.

SEAHORSES, pipefishes and sea dragons are members of the family Syngnathidae, which includes 215 species under 52 genera<sup>1</sup>. Seahorses and pipefishes have been traded in dried form for medicinal and ornamental purposes. Seahorses are not used in Western medicine, but they are the major constituents in traditional Chinese medicine (TCM); their derived forms are 'Kanpo' in Japan, 'Hanyak' in Korea and 'Jamu' in Indonesia. In view of their peculiar

body form and fascinating habits, live fishes are considered valuable in marine aquaria. The syngnathids are invariably captured all over the world as by-catch during fishing operations. In the developing Asian countries, they are also targeted by the poorest fishers for their livelihood. These have led to an alarming 50% decline in the wild populations<sup>2</sup> over five-year periods in the 1990s. Destruction of habitats also facilitated their decline. Seahorses are characterized by sparse distribution, low mobility, narrow home range, low fecundity, lengthy parental care in smaller brood, site fidelity and faithful pair bonds – all these render them highly vulnerable to population decline. Presently, eight species of seahorses are listed as 'Vulnerable' or 'Endangered' and 25 species as 'Data Deficient' in the 2007 IUCN Red List of Threatened Animals<sup>3</sup>.

In India, there has been considerable exploitation of the syngnathids in terms of quantity and value, especially for the purpose of export. Target fishing for seahorse was initiated in 1992 in the Palk Bay<sup>4</sup> and expanded rapidly<sup>5</sup> during 1996–97. Skin divers, who collect molluscs and/or holothurians, also collected seahorses stealthily. The Ministry of Environment and Forests, Government of India banned the export permits for all syngnathids from the 11 July 2001 and kept them under Schedule I of the Indian Wildlife Protection Act, 1972. Following the implementation of the ban, there has been considerable decline in syngnathid fishing, but they are being exported through clandestine means. In 2001, 12,173 kg of pipefishes were exported to Hong Kong<sup>6</sup> and 5239 kg of dried seahorses were exported to Singapore and Hongkong<sup>7</sup>.

For want of proper documentation of the Indian syngnathids<sup>8</sup>, these fishes have failed to attract studies on their biology, behaviour and other medical uses. As conservation of these fishes in our waters has become a necessity, a preliminary survey was made using by-catches along the coastal waters of Tamil Nadu to ascertain the occurrence and abundance of these syngnathids.

Regular monthly sampling for the specimens from the by-catches was made from 15 selected landing centres (Figure 1) during October 2000–September 2001. Due to the ban on fishing enforced by the State Government, the sampling was restricted to specimens that landed as by-catches in various gears such as shore seines, country trawl nets and shrimp trawl nets, which are commonly used in the Palk Bay and the Gulf of Mannar. Shore seines are operated in the shallow coastal regions at 1.5–3 m depth. Country trawl nets are wind-driven and operated within 2–6 m depth. Shrimp trawl nets are commonly used at depths from 3 to 12 m. Along the Coromandel coast, trawlers fish up to a depth of 90 m. Ten types of fishing gears were randomly selected in the study area and the numbers of syngnathids present in the catches were multiplied to the total number of gears operated on that day<sup>9,10</sup>. The number of fishes per selected landing centre, counted during each sampling was pooled and expressed as percentage. All the measurements were taken to the nearest

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millimetre. Seahorses<sup>11</sup> and pipefishes<sup>1</sup> were identified using standard protocols. After measurements, the live animals were released back into the sea. In each centre sampling lasted for the day, usually from 6 am to 3 pm, when most landings occurred.

The family Syngnathidae is characterized by the presence of lobate gills, pore-like gills opening above the opercle and protection of the body by ring-like arrangement of dermal plates, and by the absence of pelvic fins and teeth<sup>1</sup>. The present study recorded the presence of five species of seahorses and seven species of pipefishes.

**Seahorses:** The head and neck of a seahorse resemble that of a horse, and the body that of a caterpillar. Besides, it has a tail like that of a monkey, a brood pouch like that of a kangaroo and independently moving eyes like those of a chameleon. It has a prehensile tail, by which it anchors itself onto a holdfast. The name *Hippocampus* is derived from the Greek word *Hippos* signifying a horse and *campus*, a caterpillar.

Seahorses are exclusively marine, distributed from 50°N to 50°S latitudes and occur in shallow coastal habitats amidst seagrasses, seaweeds, corals and mangroves<sup>12</sup>. They are masters of camouflage, which facilitates prey capture and avoidance from predators. Most seahorse species are monogamous during a breeding season<sup>13–15</sup>, but po-

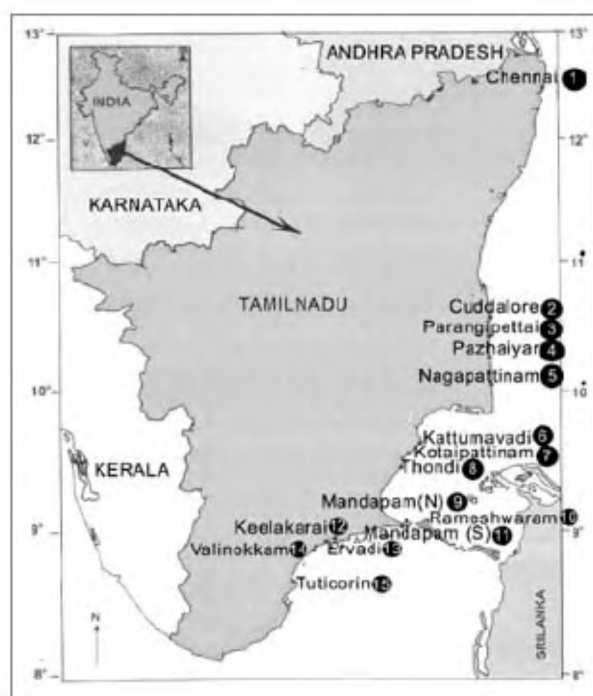
lygamy has also been reported in *H. abdominalis*<sup>16</sup>. Monogamous pair bonding is reinforced by daily greetings<sup>17</sup>. Male seahorses become pregnant and give birth to young ones. Embryos are protected, aerated and nourished within a brood pouch located beneath the trunk region<sup>18–20</sup>.

At present 33 species of seahorses are available<sup>21</sup>. Due to limited and poor descriptions, numerous synonyms, as well as due to the ability of seahorses to change their colour and to grow filaments to match the surroundings<sup>11</sup>, their identification has been confusing. Proper documentation of the Indian seahorses is wanting. Initially one species, namely *H. kuda*<sup>4</sup> and subsequently three species, namely *H. kuda*, *H. fuscus* and *H. trimaculatus*<sup>5</sup> were reported. In the present study five species of seahorses, viz. *H. kuda*, *H. fuscus*, *H. trimaculatus*, *H. spinosissimus* and *H. kelloggi* have been identified from the Tamil Nadu coast (Table 1). *H. kelloggi* has been reported for the first time in the Indian waters. Apart from these five seahorse species, *H. histrix*<sup>21</sup>, *H. mohnikei*<sup>22</sup> and *H. borboniensis*<sup>23</sup> were reported from the Indian waters in few numbers.

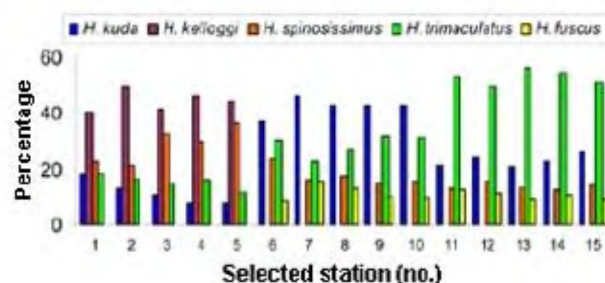
Resource assessment from the by-catches showed that the distribution of seahorses was not uniform along the Tamil Nadu coast (Figure 2). In the Coromandel coast, *H. kelloggi* was relatively more abundant and constituted  $44 \pm 3.3\%$  of the total seahorse landings. It was followed by *H. spinosissimus* ( $29 \pm 6.6\%$ ), *H. trimaculatus* ( $16 \pm 2.7\%$ ) and *H. kuda* ( $11 \pm 4.4\%$ ). However, *H. fuscus* was totally absent along this coast from Chennai to Nagapattinam.

In the Palk Bay, *H. kuda* was the dominant species constituting  $42 \pm 3.3\%$  of the total seahorses captured. *H. trimaculatus* was the second in abundance ( $29 \pm 4.0\%$ ). The contribution by *H. spinosissimus* decreased to  $18 \pm 3.4\%$  and *H. fuscus* began to appear, though in smaller quantities ( $11 \pm 2.7\%$ ).

The Gulf of Mannar was most abundant with *H. trimaculatus* ( $53 \pm 2.8\%$ ), followed by *H. kuda* ( $23 \pm 0.9\%$ ), *H. spinosissimus* ( $14 \pm 1.3\%$ ) and *H. fuscus* ( $10 \pm 1.4\%$ ). *H. kelloggi*, which was most abundant along the Coromandel coast, was totally absent throughout the Gulf of Mannar stretching from Mandapam to Tuticorin.








**Figure 1.** Map showing the selected landing centres. Centres 1–5 (Chennai to Nagapattinam) are from the Coromandel coast, centres 6–10 (Kattumavadi to Rameshwaram) are from the Palk Bay and centres 11–15 (Mandapam South to Tuticorin) from the Gulf of Mannar. Encircled numbers after the name of the place correspond to the number of selected landing centres in Figures 2, 5 and 6.



**Figure 2.** Occurrence and relative abundance of seahorses along the Tamil Nadu coast during the period 2000–01. Names of landing centres can be traced from Figure 1.

Table 1. Identification characters of seahorses collected from the Tamil Nadu coast

Species	Characters	Picture
<i>Hippocampus fuscus</i> Rupell Sea pony	Large head – smooth body – spines low – coronet raised, rough crest – cheek and eye spines low – black to yellow in colour	
<i>Hippocampus kuda</i> Bleeker Yellow seahorse	Deep head – smooth, deep body – no spines – snout thick – coronet low to medium, overhangs at back – cup-like depression in the top – black to yellow or cream in colour with large dark spots	
<i>Hippocampus trimaculatus</i> Leach Three-spot seahorse	Narrow head – spines low and small – sharp, hook-like eye and cheek spines – coronet low, in line with arch of neck, five tiny points – brown to pale yellowish in colour, large dark spots on dorso-lateral surface of the 1st, 4th and 7th trunk rings	
<i>Hippocampus spinosissimus</i> Weber Hedgehog seahorse	Well-developed spines usually longer on 1st, 4th, 7th and 11th trunk rings and tail – blunt-tipped spines border pouch in males – single or double cheek spines – nose spine small or absent – coronet low or medium in height, four or five sharp spines – colour dark brown to white, dark saddles across dorso-lateral surface, darker cross-bands on tail	
<i>Hippocampus kelloggi</i> Jordan and Snyder Kellogg's seahorse	Deep head – narrow body – thick body rings – low, rounded spines – cheek spine low, rounded and backward pointing – coronet medium to high with five short spines – high plate in front of coronet – body pale with white spots running in vertical lines	

Repeated but random diving surveys indicated the depth and habitat preferred by these seahorses (Table 2). In general, seagrasses were the preferred habitat of seahorses. To seahorses with poor swimming ability, seagrasses provide excellent holdfast and offer better protection from predators. They also provide rich epifaunal assemblage, on which the seahorses prey<sup>24</sup>.

Dead corals and seagrasses were the preferred habitats of *H. fuscus*, whereas *H. kuda* was found among sponges also. *H. trimaculatus* and *H. spinosissimus* were common among seagrasses and seaweeds. In addition, the latter showed preference to sponges. The abundance of seahorses in the Palk Bay and the Gulf of Mannar corresponds to the availability of ideal habitats along these coasts.

*H. fuscus*, *H. trimaculatus* and *H. spinosissimus* were more often recorded at depths ranging from 2 to 5 m. However, *H. kuda* was recorded at greater depths (3–10 m) compared to other species along the Gulf of Mannar and the Palk Bay. *H. kelloggi* was common in the muddy bottoms and among gorgonids at 10–20 m depth. It preferred deeper than shallow waters<sup>11</sup>, which may explain its absence from the Palk Bay and the Gulf of Mannar.

Seahorses were more abundant in the Palk Bay than in the Gulf of Mannar and the Coromandel coast (Table 3). This may be due to shallowness of the coastal shelf area in the Palk Bay. The abundance also fluctuated seasonally; the maximum number of seahorses captured in the selected areas was recorded during the northeast monsoon and the minimum during summer (Figure 3). In the Palk Bay, about 35% of the seahorses were captured during the monsoon. The percentage of total number of seahorses landed in the Gulf of Mannar and Coromandel coast during this season was 33 and 38 respectively. After the northeast monsoon, there was a decline in the abundance of seahorses along the Tamil Nadu coast.

Species-wise abundance of seahorses during different seasons also showed similar trends, with maximum abundance from October to December coinciding with the northeast monsoon (Figure 4). For species-wise landing throughout the year, 34% *H. fuscus*, 36% *H. kuda*, 34% *H. trimaculatus*, 35% *H. spinosissimus* and 38% *H. kelloggi* were recorded during the monsoon months. This might be due to the peak breeding season for seahorses along, Tamil Nadu coast. Higher wave power, and wave heights of 1–3 and 1–1.5 m were reported from the east

coast during the southwest and northeast monsoon period respectively<sup>25</sup>. Strong wave action and winds prevailing in the coastal region may also detach the seahorses from the respective holdfasts, rendering them more vulnerable to different gears. The abundance of seahorses also increased after summer coinciding with the southwest monsoon period, when again the wave action is strong along the coast. Physical parameters like temperature did not show any influence on the distribution of seahorses. *H. trimaculatus* and *H. kuda* are euryhaline and tolerate up to 15‰ salinity under experimental conditions<sup>26</sup>. Temperature is reported to have profound influence on the gestation period of syngnathids<sup>27</sup>. A detailed study on this aspect is required.

Although this survey was limited to 15 sample landing centres along the Tamil Nadu coast for a year, it has shown the huge loss suffered by seahorses inadvertently captured as by-catch by the fishing gears. The present survey has the following lessons for us.

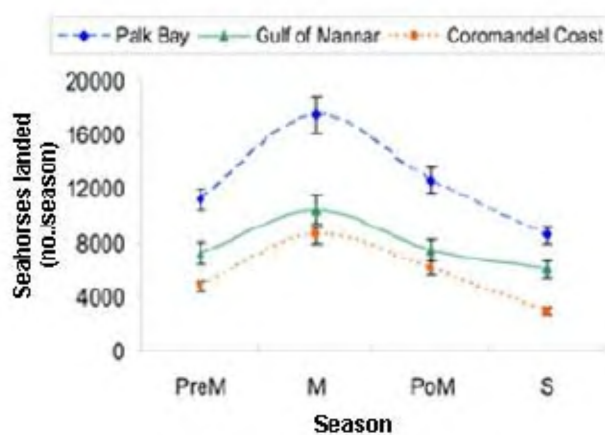


Figure 3. Area-wise landing of seahorses during different seasons in 2000–01 along the Tamil Nadu coast. PreM, Pre-monsoon; M, Monsoon; PoM, Post-monsoon; S, Summer (see also Table 3).

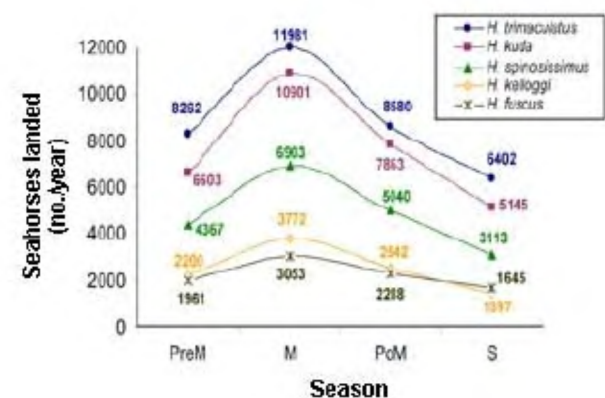


Figure 4. Species-wise landing of the seahorses during different seasons in 2000–01 along the Tamil Nadu coast.

Table 2. Depth and habitat preference of seahorses known from the survey along the Tamil Nadu coast during 2000–01

Species	Depth (m)	Habitat
<i>H. fuscus</i>	2–5	Seagrasses, dead corals
<i>H. kuda</i>	3–10	Dead corals, sponges, seagrasses
<i>H. trimaculatus</i>	2–5	Seaweeds, seagrasses
<i>H. spinosissimus</i>	2–5	Seagrasses, seaweeds, sponges
<i>H. kelloggi</i>	10–20	Muddy bottom, gorgonids

**Table 3.** Distribution and relative abundance of seahorses along the Tamil Nadu coast as a function of season during the period 2000–01. The number per selected area indicates abundance and the mean of 3-month samplings at five landing centres each ( $M \pm SE$ )

Parameter		Pre northeast monsoon (July–September)	Northeast monsoon (October–December)	Post northeast monsoon (January–March)	Summer (April–June)
Surface temperature (°C)		29.7 $\pm$ 0.61	26.4 $\pm$ 0.39	28.9 $\pm$ 0.59	32.6 $\pm$ 0.59
Temperature at 10 m depth (°C)		28.4 $\pm$ 0.61	25.2 $\pm$ 0.36	27.6 $\pm$ 0.61	31.3 $\pm$ 0.56
<i>H. fuscus</i>	Coromandel Coast	0	0	0	0
	Palk Bay	1126 $\pm$ 181.9	1973 $\pm$ 264.6	1438 $\pm$ 258.1	990 $\pm$ 242.1
	Gulf of Mannar	835 $\pm$ 268.1	1080 $\pm$ 299.1	850 $\pm$ 247.9	655 $\pm$ 269.5
<i>H. kuda</i>	Coromandel Coast	464 $\pm$ 44.2	939 $\pm$ 106.1	583 $\pm$ 82.3	302 $\pm$ 27.3
	Palk Bay	4558 $\pm$ 1083.8	7726 $\pm$ 1304.9	5553 $\pm$ 899.2	3419 $\pm$ 979.1
	Gulf of Mannar	1581 $\pm$ 389.3	2236 $\pm$ 506.5	1727 $\pm$ 432.5	1424 $\pm$ 371.3
<i>H. trimaculatus</i>	Coromandel Coast	781 $\pm$ 101.2	1202 $\pm$ 166.6	792 $\pm$ 115.1	428 $\pm$ 54.7
	Palk Bay	3437 $\pm$ 776.1	5044 $\pm$ 909.4	3684 $\pm$ 897.3	2530 $\pm$ 722.6
	Gulf of Mannar	4044 $\pm$ 880.5	5735 $\pm$ 1361.0	4104 $\pm$ 877.8	3444 $\pm$ 654.8
<i>H. spinosissimus</i>	Coromandel Coast	1409 $\pm$ 416.2	2684 $\pm$ 704.3	2264 $\pm$ 995.1	871 $\pm$ 284.9
	Palk Bay	2127 $\pm$ 341.6	2767 $\pm$ 231.4	1954 $\pm$ 344.9	1676 $\pm$ 409.4
	Gulf of Mannar	831 $\pm$ 246.0	1452 $\pm$ 492.6	822 $\pm$ 166.7	566 $\pm$ 114.9
<i>H. kelloggi</i>	Coromandel Coast	2200 $\pm$ 387.8	3772 $\pm$ 916.0	2542 $\pm$ 526.8	1397 $\pm$ 273.5
	Palk Bay	0	0	0	0
	Gulf of Mannar	0	0	0	0

**Table 4.** Total by-catch of seahorses along the Tamil Nadu coast

Species	Coromandel coast (no./yr)	Palk Bay (no./yr)	Gulf of Mannar (no./yr)	Total (no./yr)
<i>H. fuscus</i>	—	5527	3420	8947
<i>H. kuda</i>	2288	21,256	6968	30,512
<i>H. trimaculatus</i>	3203	14,695	17,327	35,225
<i>H. spinosissimus</i>	7228	8524	3671	19,423
<i>H. kelloggi</i>	9911	—	—	9911
Total by-catch	22,630	50,002	31,386	104,018

(i) The approximate weight of the 104,018 seahorses (Table 4) thus captured is about 1456 kg. During the same period, MPEDA, Kochi<sup>7</sup> reported that the weight of seahorses exported from India was 5239 kg, which is about 72% more than the value estimated by us and suggests the need for inclusion of more landing centres and extended surveys by an agency like the Central Marine Fisheries Research Institute, Kochi.

(ii) The species-specific loss of *H. trimaculatus* (34%), *H. kuda* (29%), *H. spinosissimus* (19%), *H. kelloggi* (9%) and *H. fuscus* (9%) may indicate their relative abundance and/or the need for species-specific conservation measures to be adopted by the Forest Department, especially for *H. fuscus* and *H. kelloggi*, which are less abundant and are not distributed throughout the length of the Tamil Nadu coast. To enable the Forest Department to ranch young ones, mass culturing techniques to rear all these seahorses and pipefishes have been developed in our laboratory.








(iii) This survey which was undertaken during 2000–01, without having any idea about the forthcoming Sethu Canal Project, may serve as a yardstick to measure the impact

of the excavation and subsequent navigation on the abundance of seahorses in the Palk Bay and the Gulf of Mannar, when future surveys of this kind are made.

Pipefishes: These derive their name from the peculiarly long and slender angular body. They are almost cosmopolitan in distribution between 21°N and 56°S latitudes<sup>1</sup>. Most species inhabit estuarine and coastal waters and a few are found in freshwaters. They show relatively low mobility. Their fins are variable, some have a moderately sized caudal fin, but in its absence, the fish has a prehensile tail. Pelvic fins are absent and the anal fin is small or degenerated. Pipefishes are cryptic predators on slow-moving prey. Like seahorses, the male pipefish cares for the developing embryos in a brood pouch. The brood pouch, situated either on the trunk or the tail, varies from simple ventral gluing to a fully enclosed pouch<sup>28</sup>. Young ones resemble the adults in body form and yolk sac is fully absorbed before birth<sup>29</sup>. Pipefishes provide a classical example of sex role reversal; females compete more intensively than males for access to a mate<sup>30,31</sup>. However, monogamous mating pattern is also recorded in few species<sup>32–34</sup>.

## RESEARCH COMMUNICATIONS

**Table 5.** Identification characters of pipefishes collected from the Tamil Nadu Coast

Species	Character	Picture
<i>Halicampus grayi</i> Kaup Gray's pipefish	Elongate body – stout, heptagonal trunk, tail tetragonal – superior trunk ridge arched dorsal on sub-dorsal rings – inferior trunk ridge ends at anal ring – lateral trunk ridge continuous with inferior tail ridge – superior trunk and tail ridges discontinuous – brood pouch located below the tail, pouch plates and folds present	
<i>Hippichthys cyanospilos</i> (Bleeker) Blue speckled pipefish	Elongate body – discontinuous superior trunk and tail ridges – lateral trunk ridge straight or deflected ventrally near anal ring – inferior trunk and tail rings continuous – dorsal fin present – brood pouch below the tail, pouch plates and folds	
<i>Hippichthys spicifer</i> (Ruppell) Belly barred pipefish	Slender body – pattern of body ridges as in <i>H. cyanospilos</i> – dorsal fin originates on tail rings – brood pouch below the tail	
<i>Syngnathoides biaculeatus</i> (Bloch) Alligator pipefish	Depressed, tetragonal body – superior and inferior trunk ridges continuous with respective tail ridges – lateral trunk ridge deflected dorsally, ending below superior tail ridge near dorsal fin base – dorsal fin originates on trunk – caudal fin absent – brood below the trunk – plates and folds absent	
<i>Trachyrhamphus bicoarctatus</i> (Bleeker) Double-ended pipefish	Superior trunk and tail ridges discontinuous – lateral trunk ridge confluent with inferior tail ridge – Trunk rings 21–24, tail rings 55–63. Snout arcuate in sub adults and adults – brood pouch below the tail, plates and folds present	
<i>Trachyrhamphus longirostris</i> Kaup Long-nosed pipefish	Body ridges as in <i>T. bicoarctatus</i> – trunk rings 21–23, tail rings 42–53 – brood pouch below the tail, plates enlarged, folds present	
<i>Trachyrhamphus serratus</i> (Temminck and Schlegel) Crested pipefish	Body ridges as in <i>T. bicoarctatus</i> – median snout ridge entire with prominent irregular denticulations – trunk rings 21–23, tail rings 41–48 – brood pouch below the tail – plates and folds present	

Pipefishes are sold live as ornamentals and dry as curios; they are an essential ingredient in TCM. Large-scale exploitation has indeed led to their drastic decline in the natural waters. Six species of pipefishes are listed in the

IUCN Red List and collections of all pipefishes are banned from the Indian waters by the Government of India.

There is no comprehensive report on their occurrence and abundance in the Indian waters. Our survey showed



the occurrence of seven species of pipefishes belonging to four genera, viz. *Halicampus grayi*, *Hippichthys cyanospilos*, *Hi. spicifer*, *Syngnathoides biaculeatus*, *Trachyrhamphus bicoarctatus*, *T. longirostris* and *T. serratus* (Table 5). The survey also recorded the occurrence of *T. bicoarctatus* for the first time in the Indian waters.

Seagrasses and seaweeds abundant in the Palk Bay and the Gulf of Mannar provide ideal habitats for the pipefishes. The pipefishes mimic the seagrass blades and coil around them with their prehensile tail. *Hi. cyanospilos* and *Hi. spicifer* occur few in number amidst the seaweeds, seagrasses and mangroves. However, *Ha. grayi* and *Trachyrhamphus* spp. were captured by trawlers operating at depths above 20 m. *T. serratus* and *T. longirostris* were common along the Coromandel coast, but *T. bicoarctatus* was rarely recorded. *S. biaculeatus* was the most common pipefish in the shallow coast at 2–5 m depth. Due to rarity, the occurrence of other pipefishes and their resource assessment was restricted to *S. biaculeatus* (Figure 5). This occurs in larger numbers in the Palk Bay (987,478 numbers/yr) than in the Gulf of Mannar (545,295). Along the Coromandel coast, it occurs only between Pazhaiyar and Nagapattinam centres.

All the seahorses except *H. kelloggi* and pipefishes except *Trachyrhamphus* spp. and *Ha. grayi* inhabit the shallow coast on seaweeds, seagrasses and dead corals. The percentage composition of seahorses and the pipefish, *S. biaculeatus* in different stations (Figure 6) showed that

pipefishes were more abundant than seahorses in the Palk Bay and the Gulf of Mannar. The percentage composition of *S. biaculeatus* ranged from 71.7 (station 10) to 88.8 (station 6) in the Palk Bay, and 70.6 (station 11) to 83.9 (station 13) in the Gulf of Mannar. Seahorses were relatively less abundant than pipefishes in the Palk Bay and the Gulf of Mannar. The abundance ranged from 11 (station 7) to 29% (station 10) in the Palk Bay and 16 (station 13) to 30% (station 11) in the Gulf of Mannar. However, along the Coromandel coast, pipefishes formed less than 22% and seahorses constituted more than 78% of the total syngnathid landings in all the landing centres. The ratio of seahorses to pipefishes was 5 : 1 and 4 : 1 in Pazhaiyar and Nagapattinam centres of the Coromandel coast. However, in the Palk Bay the ratio was 1 : 8 in Kotaipattinam and 1 : 2.5 in Rameshwaram. Along the Gulf of Mannar, five and two pipefishes for every seahorse landed in Ervadi and South Mandapam respectively. In seasonal syngnathid sampling, this skewed ratio between pipefishes and seahorses was observed; the relative abundance of the pipefishes *Stigmatopora nigra* (68%) and *S. argus* (27%) was 99% against 1% of all the seahorses<sup>35</sup>. In the Suwannee River estuary too, pipefishes and seahorses constituted 2.1 and 0.06% of the fish assemblages respectively<sup>36</sup>. Seahorses are patchily distributed and occur at low densities throughout the world<sup>12</sup>. However, interaction, if any, between the seahorses and pipefishes inhabiting the same habitat is not yet known. There seems to be no competition for space, because of their narrow home range, sluggishness and low mobility. The reason for the relatively more abundance of pipefishes than seahorses is not clear, but is likely related to species composition and density of the seaweeds. A study in this area is needed.

The syngnathids are usually associated with vegetated or other structurally complex habitats<sup>11,37</sup>. However, specific habitat associations have been documented for *H. bargibanti* and *S. nigrolineatus*<sup>11,38</sup>. Different species of syngnathids often co-exist in the seagrass beds<sup>35,39–41</sup>, which provides a high degree of structural complexity, spatial variability and offers the opportunity of sympatric species to partition their habitats<sup>41</sup>. Sympatric pipefish species partition the habitat within and among the seagrass beds, to suit their morphology, mobility, forage pattern and habitat use<sup>35,42</sup>. Within a seagrass community, sympatric seahorses also differ in appearance, holdfast preferences, habitat use and foraging strategies<sup>41</sup>. Future studies aimed at conservation of Indian syngnathids should focus on assessment of population density, habitat use and partitioning, interactions among sympatric species, ecological impacts of habitat destruction and fishing gears.

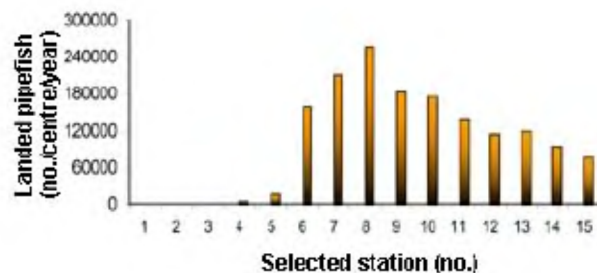


Figure 5. Abundance of pipefish *S. biaculeatus* along the Tamil Nadu coast during 2000–01.

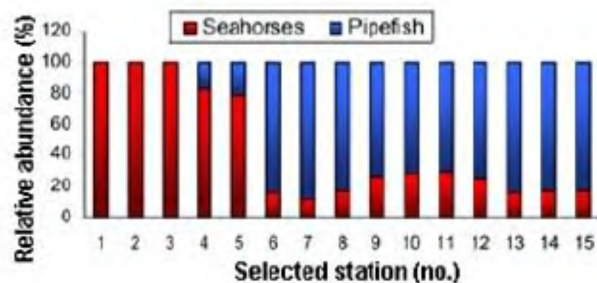


Figure 6. Relative abundance of seahorses and the alligator pipefish (*S. biaculeatus*) along Tamil Nadu coast during 2000–01.

1. Dawson, C. E., *Indo-Pacific Pipefishes (Red Sea to the Americas)*, Gulf Coast Research Laboratory, Ocean Spring, Mississippi, USA, 1980, p. 230.
2. Vincent, A. C. J., *The International Trade in Seahorses*, TRAFFIC International, Cambridge, UK, 1996, p. 163.

3. IUCN, 2007 IUCN Red List of threatened species, 2007; <http://www.iucnredlist.org/> (accessed on 19 November 2007).
4. Marichamy, R., Lipton, A. P., Ganapathy, A. and Ramalingam, J. R., Large-scale exploitation of seahorse (*Hippocampus kuda*) along the Palk Bay coast of Tamil Nadu. *Mar. Fish. Inf. Ser., T&E Ser.*, 1993, **119**, 17–20.
5. Lipton, A. P. and Thangaraj, M., Present status of seahorse fishing along the Palk Bay coast of Tamil Nadu. *Mar. Fish. Inf. Ser., T&E Ser.*, 2002, **174**, 5–8.
6. Martin-Smith, K. M., Lam, T. F. and Lee, S. K., Trade in pipe-horses *Solegnathus* spp for traditional medicine in Hong Kong. *TRAFFIC Bull.*, 2003, **19**, 139–148.
7. Anon., Statistics of marine products exports, MPEDA, Kochi, 2003, p. 83.
8. Sreepada, R. A., Desai, U. M. and Naik, S., The plight of Indian seahorses: Need for conservation and management. *Curr. Sci.*, 2002, **82**, 377–378.
9. Hilborn, R. and Walters, C. J., *Quantitative Fisheries Stock Assessment: Choice, Dynamics and Uncertainty*, Chapman and Hall, London, 1992, p. 570.
10. King, M., *Fisheries Biology, Assessment and Management*, Blackwell Science Ltd, Oxford, 1995, p. 341.
11. Lourie, S. A., Vincent, A. C. J. and Hall, H. H., *Seahorse: An Identification Guide to the World's Species and their Conservation*, Project Seahorse, London, 1999, p. 214.
12. Foster, S. J. and Vincent, A. C. J., Life history and ecology of seahorse: Implications for conservation and management. *J. Fish. Biol.*, 2004, **65**, 1–61.
13. Vincent, A. C. J., Seahorses exhibit conventional sex roles in mating competition, despite male pregnancy. *Behaviour*, 1994, **128**, 131–151.
14. Vincent, A. C. J. and Sadler, L. M., Faithful pair bonds in wild seahorses, *Hippocampus whitei*. *Anim. Behav.*, 1995, **50**, 1557–1569.
15. Masonjones, H. D. and Lewis, S. M., Courtship behaviour in the dwarf seahorse, *Hippocampus zosterae*. *Copeia*, 1996, **1996**, 634–640.
16. Woods, C. M. C., Preliminary observations on breeding and rearing the seahorse *Hippocampus abdominalis* (Teleostei: Syngnathidae) in captivity. *N. Z. J. Mar. Freshwater Res.*, 2000, **34**, 475–485.
17. Vincent, A. C. J., A role of daily greetings in maintaining seahorse pair bonds. *Anim. Behav.*, 1995, **49**, 258–260.
18. Hara, M. and Okiyama, M., An ultrastructural review on the spermatozoa of Japanese fishes. *Bull. Ocean Res. Inst. Univ. Tokyo*, 1998, **3**, 1–138.
19. Linton, J. R. and Soloff, B. L., The physiology of the brood pouch of the male seahorse *Hippocampus erectus*. *Bull. Mar. Sci. Gulf Caribb.*, 1964, **14**, 45–61.
20. Haresign, T. W. and Shumway, S. E., Permeability of the marsupium of the pipefish *Syngnathus fuscus* to <sup>14</sup>[C]-alpha amino isobutyric acid. *Comp. Biochem. Physiol.*, 1981, **3**, 603–604.
21. Lourie, S. A., Foster, S. J., Cooper, E. W. T. and Vincent, A. C. J., *A Guide to the Identification of Seahorses*, Project Seahorse and TRAFFIC North America, Washington DC, University of British Columbia and Wildlife Fund, 2004, p. 114.
22. Thangaraj, M. and Lipton, A. P., Occurrence of the Japanese seahorse *Hippocampus mohnikei* Bleeker 1854 from the Palk Bay coast of south-eastern India. *J. Fish Biol.*, 2007, **70**, 310–312.
23. Salin, K. R., Yohannan, T. M. and Nair, C. M., Fisheries and trade of seahorses, *Hippocampus* spp., in southern India. *Fish. Manage. Ecol.*, 2005, **12**, 269–273.
24. Tipton, K. and Musick, J. A., Foraging patterns of two syngnathid fishes: Importance of harpacticoid copepods. *Mar. Ecol. Prog. Ser.*, 1988, **47**, 31–43.
25. Chandramohan, P., Sanil Kumar, V. and Nayak, B. U., Wave statistics around the Indian coast based on ship observed data. *Indian J. Mar. Sci.*, 1991, **20**, 87–92.
26. Hilomen-Garcia, G. V., Reyes, R. D. and Garcia, C. M. H., Tolerance of seahorse *H. kuda* (Bleeker) juveniles to various salinities. *J. Appl. Ichthyol.*, 2003, **19**, 94–98.
27. Ahnesjo, I., Temperature affects male and female potential reproductive rates differently in the sex role reversed pipefish, *Syngnathus typhle*. *Behav. Ecol.*, 1995, **6**, 229–233.
28. Herald, E. S., From pipefishes to seahorse – A study of phylogenetic relationships. *Proc. Calif. Acad. Sci.*, 1959, **29**, 465–473.
29. Dhanya, S., Rajagopal, S., Ajmal Khan, S. and Balasubramanian, T., Embryonic development in alligator pipefish *Syngnathoides biaculeatus* (Bloch, 1785). *Curr. Sci.*, 2005, **88**, 178–181.
30. Trivers, R. L., Parental investment and sexual selection. In *Sexual Selection and Decent of Man* (ed. Campbell, B.), Aldine, Chicago, 1972, pp. 136–179.
31. Vincent, A., Ahnesjo, I., Berglund, A. and Rosenquist, G., Pipefishes and seahorses: Are they all sex role reversed? *Trends Ecol. Evol.*, 1992, **7**, 237–241.
32. Gronell, A. M., Courtship, spawning and social organization of the pipefish, *Corythoichthys intestinalis* (Pisces: Syngnathidae) with notes on two congeneric species. *Z. Tierpsychol.*, 1984, **65**, 1–24.
33. Watanabe, S., Watanabe, Y. and Okiyama, M., Monogamous mating and conventional sex roles in *Hippichthys penicillus* (Syngnathidae) under laboratory conditions. *Ichthyol. Res.*, 1997, **295**, 141–149.
34. Matsumoto, K. and Yanagisawa, Y., Monogamy and sex role reversal in the pipefish *Corythoichthys haematopterus*. *Anim. Behav.*, 2001, **61**, 163–170.
35. Kendrick, A. J. and Hyndes, G. A., Patterns in the abundance and size-distribution of syngnathids fishes among habitats in a seagrass-dominated marine environment. *Estuarine Coastal Shelf Sci.*, 2003, **57**, 631–640.
36. Tuckey, T. D. and Dehaven, M., Fish assemblages found in tidal-creek and seagrass habitats in the Suwannee River estuary. *Fish. Bull.*, 2006, **104**, 102–117.
37. Pollard, D. A., A review of ecological studies on seagrass-fish communities, with particular reference to recent studies in Australia. *Aquat. Bot.*, 1984, **18**, 3–42.
38. Phillips, D. H. J. and Pullin, R. S. V., *Siokunichthys nigrolineatus* (Syngnathidae) found on *Fungia* sp. *Copeia*, 1987, **1987**, 509–511.
39. Howard, R. K. and Koehn, J. D., Population dynamics and feeding ecology of pipefish (Syngnathidae) associated with eelgrass beds of western Port, Victoria. *Aust. J. Mar. Freshwater. Res.*, 1985, **36**, 361–370.
40. Vincent, A. C. J., Berglund, A. and Ahnesjo, I., Reproductive ecology of five pipefish species in one eelgrass meadow. *Environ. Biol. Fish.*, 1995, **44**, 347–361.
41. Curtis, J. M. R. and Vincent, A. C. J., Distribution of sympatric species along a gradient of habitat complexity in a seagrass-dominated community. *Mar. Ecol. Prog. Ser.*, 2005, **291**, 81–91.
42. Malavasi, S., Franco, A., Riccato, F., Valerio, C., Torricelli, P. and Franzoi, P., Habitat selection and spatial segregation in three pipefish species. *Estuarine Coastal Shelf Sci.*, 2007, **75**, 143–150.

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