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Occurrence of anemonefishes and host sea anemones in Andaman and Nicobar Islands

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Abstract

Among the anemonefishes, 13 species under the genus *Amphiprion viz*., *A. akallopisos, A. bicinctus, A. chrysogaster, A. clarkii, A. ephippium, A. frenatus, A. melanopus, A. ocellaris, A. percula, A. perideraion, A. polymnus, A. sandaracinos* and *A. sebae,* and one species under the genus *Premnas viz., P. biaculeatus* are reported from 14 selected study sites of the coral reef ecosystem of Andaman and Nicobar Islands during 2000-2005. Field observations reveal that the anemonefish are found in association with 10 host sea anemones *viz*., *Cryptodendrum adhaesivum, Entacmaea quadricolor, Heteractis aurora, H. crispa, H. magnifica, H. malu, Stichodactyla gigantea, S. haddoni, S. mertensii* and *Macrodactyla doreensis.* The fishes and their hosts were observed at a depth of 0.5 to 10 m during low tide in the coral reef areas and slopes. The sea anemones such as *C. adhaesivum, H. aurora, H. malu, S. haddoni, M. doreensis* are often found buried in the sediment or sand and retracted completely when disturbed whereas, *H. magnifica, H. crispa, S. gigantea, S. mertensii* and *E. quadricolor* were usually found attached to hard substrata. Among the fish species, melanistic variation was noticed only in *A. ocellaris*. The surveys show that the numerical abundance of *Amphiprion* populations from these groups of islands has diminished. Rapid developmental activities in the islands, turbidity, discharge of waste, increase in water temperature and deposition of sand due to tsunami and destruction of natural habitats due to ecological imbalance in the coastal belt are considered as the probable reasons for decrease in population.

Keywords: *Amphiprion* species, anemonefishes, sea anemones, Andaman and Nicobar Islands

Introduction

Amphiprion species belonging to the family Pomacentridae and subfamily Amphiprioninae represent the largest complex of anemonefish (clown fishes) with 28 species all over the world oceans. The coral reef ecosystem of Andaman and Nicobar islands harbours a variety of colourful marine ornamental fishes which have high demand in the international marine aquarium trade and is proved to be an ideal area for ichthyological biodiversity (Herre, 1941; Menon, 1976; Talwar, 1990). The members of the family Pomacentridae, commonly known as damselfishes and anemonefishes include 29 genera and 350 species under four subfamilies: Amphiprioninae, Chrominae, Lepidozyginae and Pomacentrinae (Allen, 1991). Eventhough the rich coral reef ecosystem with fringing reef on the eastern side and barrier reef on the western side of the islands (Mustafa *et al.,* 1987) are known for the diversity of marine ornamental resources, so far no scientific study has been conducted on the occurrence of anemonefish and their host sea anemones. As knowledge on species diversity, status of population and identification of potential areas are of prime importance in effective management and conservation of the resources, the present study was conducted to ascertain the availability of

anemonefish, their host sea anemones, social structure, habitat, distribution and abundance at various locations from these groups of islands.

Materials and Methods

Preliminary surveys were carried out in major coastal areas of Andaman and Nicobar Islands by snorkeling to find out the availability of anemonefish and their host sea anemones, and based on this, 14 sites *viz*., Ariel Bay, Mohanpur, Mayabunder (North Andaman); Bacon Bay, Rangat Bay (Middle Andaman); Havelock, Wandoor North, Wandoor South, North Bay, Marine Hill, Coriyaghat, Chidiyattappu (South Andaman); Car Nicobar and Campbell Bay (Nicobar group of Islands) were selected (Fig.1). Visual census was carried out in the waters of the selected sites

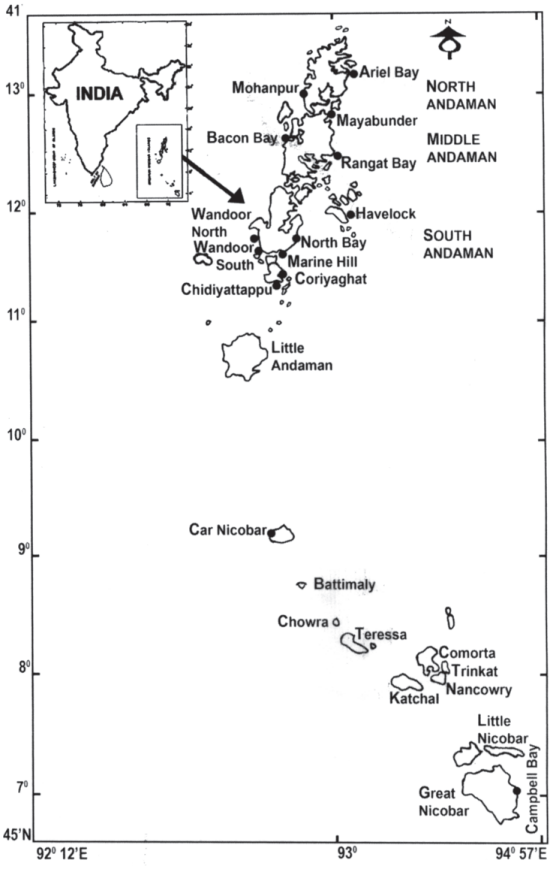

Fig. 1. Map showing study sites in Andaman and Nicobar Islands

(150x100 m area) by transect snorkeling during low tide and the fishes were photographed using underwater camera (Cannon Digital camera, PowerShot-G2, Pixel 5.0). After the survey, a map was prepared for each location and the parameters such as nature of substrate (coral cover, rubble, sandy bottom), depth at which fishes and anemones occupy, and size of the anemones were documented as per the methodology suggested by Hattori (1994). The fishes inhabited in the anemones were captured in a hand net, total length measured *in-situ,* and released back into the anemones from which they had been collected. Representative samples of fishes were preserved in formalin and identified as per the morphological characters suggested by Allen (1972) and Fautin and Allen (1997). For the identification of sea anemones, taxonomical criteria such as body form, presence or absence of verrucae, type of habitat, attachment of pedal or oral disc, number, size, shape and arrangement of tentacles were adopted as given by Dunn (1981), Fautin (1988) and Fautin and Allen (1997). The symbiotioc relationships between anemonefish to their respective host sea anemones in the wild were documented. Observations were made twice a month at each site throughout the period of study (2000-2005) and 80% occurrence was grouped as usual, 15% as occasional and 5% as rare. For determination of social structure in each study site, 10-15 colonies or host anemones were selected and their average number of adult fishes (female and male) and juveniles (sub adults) were recorded.

Results and Discussion

Anemonefishes: Thirteen species under the genus *Amphiprion* such as *A. akallopisos* (Skunk anemonefish), *A. bicinctus* (Two banded anemonefish), *A. chrysogaster* (Mauritian anemonefish), *A. clarkii* (Clark's anemonefish or yellow tailed anemonefish), *A. ephippium* (Red saddleback anemonefish), *A. frenatus* (Tomato anemonefish), *A. melanopus* (Red and black anemonefish), *A. ocellaris* (False clown anemonefish), *A. percula* (Clown anemonefish or true perc), *A. perideraion* (Pink anemonefish), *A. polymnus* (Saddle back anemonefish),

A. sandaracinos (Orange anemonefish), *A. sebae* (Sebae anemonefish) and one species of *Premnas, P. biaculeatus* (Spine cheek anemonefish or maroon clown) were observed from 14 locations (Fig. 2: a-n) with their respective symbiotic hosts (Table 1). Earlier Talwar (1990) reported the occurrence of six species such as *A. akallopisos, A. ephippium, A. frenatus, A. ocellaris, A. polymnus* and *A. sebae* from A & N Islands. The occurrence of these fish communities in other parts of the world oceans are New Guinea, Madang on the north coast of Papua New Guinea and central Indo-West Pacific locality such as Guam, Lizard Island on the Great Barrier Reef (Kailola, 1987; Randall *et al.,* 1990; Fautin and Allen, 1997), Indonesia (Schuster and Djajadiredja, 1952; Kuiter, 1992), Philippines (Herre and Umali, 1948; Herre, 1953), North Queensland and Melanesia (Allen, 1972, 1991), United States and Canada (Robins *et al.,* 1991), Hong Kong (Ni and Kwok,1999), Indo-Pacific, Caribbean and Red sea (Lieske and Myers,1994). It has also been reported that the same species of anemonefish may vary morphologically due to variation in geographic location, melanism, behavioural pattern, sex change, hybridisation, genetic and ontogenetic (Fautin and Allen,1997) characteristics as well as in response to host anemones. However, in the present study melanistic variation among species from different locations was noticed only in *A. ocellaris.* The yellow variety dominated in stations excluding Chidiyattapu, where the fishes were entirely brown-

Table 1. *Anemonefishes and their host sea anemones from Andaman and Nicobar Islands*

Anemonefishes	Association of anemonefishes to host sea anemones		
	Usually	Occasionally	Rarely
A.akallopisos	*H.magnifica*	*S.gigantea*	*S.mertensii*
A.bicinctus	*S.merensii* *E.quadricolor* *S.gigantea*	*H.magnifica* *H.crispa*	*H.aurora*
A.chrysogaster	*S.haddoni* *H.magnifica*	*M.doreensis* *S.mertensii*	*H.aurora*
A.clarkii	*C.adhaesivum* *S.mertensii* *E.quadricolor* *S.gigantea* *S.mertensii*	*M.doreensis* *S.haddoni*	*H.magnifica* *H.malu*
A.ephippium	*E.quadricolor*	*H.crispa*	*H.magnifica*
A.frenatus	*E.quadricolor* *H.aurora*	*H.magnifica* *M.doreensis*	*S.haddoni*
A.melanopus	*H.crispa* *E.quadricolor*	*H.magnifica*	-
A.ocellaris	*H.magnifica*	*S.gigantea*	*S.mertensii*
A.percula	*H.magnifica*	*S.gigantea*	*H.crispa*
A.perideraion	*S.gigantea* *H.magnifica*	*M.doreensis*	*H.crispa*
A.polymnus	*S.mertensii* *S.haddoni*	*H.crispa*	*M.doreensis*
A.sandaracinos	*H.magnifica*	*H.crispa*	*S.mertensii*
A.sebae	*S.haddoni*	-	*C.adhaesivum*
P.biaculeatus	*E.quadricolor*	*H. magnifica*	*S.haddoni*

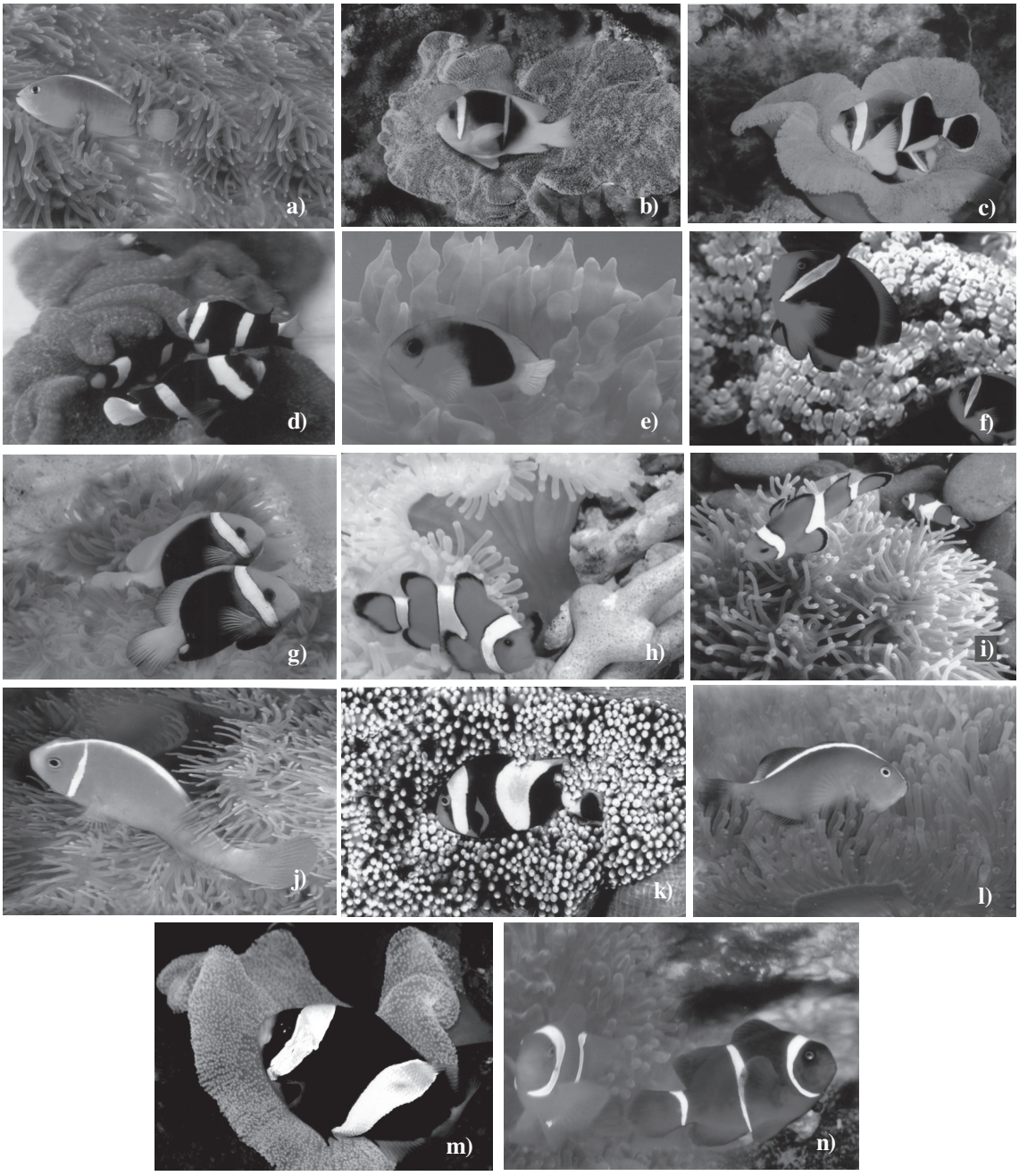

Fig. 2. Anemonefishes with their host sea anemones recorded from A&N islands : (a): *A. akallopisos* with host sea anemone *S. gigantea*; (b): *A. bicinctus* with *S. mertensii*; (c): *A. chrysogaster* with *S. haddoni*; (d): *A. clarkii* with *C. adhaesivum* ; (e): *A. ephippium* with *E. quadricolor*; (f): *A. frenatus* with *H. aurora*; (g): *A. melanopus* with *H. crispa*; (h): *A. ocellaris* with *H. magnifica*; (i): *A. percula* with *H. magnifica*; (j): *A. perideraion* with *S. gigantea*; (k): *A. polymnus* with *S. mertensii*; (l): *A. sandaracinos* with *H. magnifica*; (m): *A. sebae* with *S. haddoni* ; (n): *P. biaculeatus* with *E. quadricolor.*

ish except for the white bars. Six colour phases were discriminated on the caudal fin colouration which corresponded to gonadal phases in *A. clarkii* (Hattori and Yanagisawa, 1991). However, in the Andaman waters, morphological difference was observed only in the juvenile stage of *A. clarkii* with the entire body yellow in colour with three white bands and fins often boarded with a thin black line.

Symbiotic sea anemones/actinians: The present study recorded 10 species of sea anemones *viz., C. adhaesivum* (Adhesive sea anemone), *E. quadricolor* (Bulb-tentacle sea anemone), *H. aurora* (Beaded sea anemone), *H. crispa* (Leathery sea anemone), *H. magnifica* (Magnificent sea anemone/ Finger anemone), *H. malu* (Delicate sea anemone), *M. doreensis* (Corkscrew tentacle sea anemone), *S. gigantea* (Gigantic sea anemone), *S. haddoni* (Haddon's sea anemone) and *S. mertensii* (Mertens sea anemone) belonging to the phylum Coelentrata, class Anthozoa and order Actiniaria from various locations of A & N Islands and the fishes showed species specific symbiotism to sea anemones (Table 1). Though nearly 1000 species of sea anemones are recorded from the world oceans (Fautin and Allen, 1997), only 10 species belonging to the families Actiniidae (genera: *Entacmaea* and *Macrodactyla);* Stichodactylidae (*Heteractis* and *Stichodactyla)* and Thalassianthidae (genus *Cryptodendrum)* are reported as host (Dunn,1981; Fautin, 1988). The precise nature of the symbiotic relationship between anemonefish and certain tropical sea anemones has been debated since its discovery more than a century ago (Collingwood, 1868). However, in the present study, not a single anemonefish was observed without a host anemone in the the surveyed areas indicating that the availability of hosts is also an influencing factor for the distribution of anemonefishes, and the host actinians provide territory and protection from predators for the anemonefish as observed by others (Allen, 1972; Fricke, 1979; Allen, 1980; Fautin and Allen, 1997). Specificity to a host anemone is controlled by three factors; an innate preference, competitive superiority and chance (Fautin and Allen, 1997). Anemonefishes of one species shared with an individual actinian or a colony in all the study locations. Among the host sea anemones, *H. magnifica* was found as the usual host for *A. ocellaris, A. percula, A. sandaracinos* and *A. akallopisos* whereas, *E. quadricolor* as host for *P. biaculeatus, A. ephippium* and *A. frenatus.* Out of the 13 species of clownfishes recorded, *A. clarkii* showed maximum association with different sea anemones but usually occurred in association with *C. adhaesivum*. *A. chrysogaster* and *A. sebae* were often associated with *S. haddoni* whereas, *A. polymnus* and *A. bicintus* appeared usually among the tentacles of *S. mertensii. A. melanopus* often showed tendency to be with *H. crispa* and *A. perideraion* with *S. gigantean.*

Social structure: The anemonefish usually appeared around the host anemone as a social group that included one adult pair and one to three juveniles and there were consistent size variations among the adults (Table 2) as reported from other oceans (Allen 1972; Hattori, 1991). In Bacon Bay, Rangat Bay, Ariel Bay, Coriyaghat and Marine Hill, the fishes exhibited competition for shelter due to scarcity of anemones in all social groups. Similar observations were recorded earlier (Allen, 1972; Moyer and Bell, 1976; Fautin, 1991). Although the anemonefishes exhibited sex reversal (protandrous hermaphroditism), the largest and socially dominant individual acted as female and the second largest as male in a colony. They constituted a monogamous pair as observed in the study area and a hierarchy was also visible like in *A. ocellaris* (Nelson *et al.,* 2000). A similar but less obvious female/male size ratio was also reported for *A. clarkii* (Moyer and Sawyers, 1973; Moyer and Bell, 1976).

***Habitat*:** The sea anemones and the fishes are found to exist only in shallow clear water because the cells of the anemones' tentacles and oral disc harbour live microscopic single celled brown dianoflagellate algae called zooxanthellae which require sunlight for photosynthesis. Most of the anemonefishes and anemones were observed at a depth of 0.5 to 10 m during low tide in the Andaman waters. The species such as *A. melanopus, A. ephippium* and *P. biaculeatus* occurred mainly in the crevices of coral rubbles and rocks where

Table 2. *Size of sea anemones and anemonefishes from different social groups (colonies) from A & N Islands*

No. of colonies	Anemones (diameter in mm)	Fishes	No. of fishes and average length (mm)		
			Male	Female	Juveniles
14	*H. magnifica* (300-500)	*A. akallopisos*	14 (75.8)	14 (109.5)	40 (50.2)
10	*S. mertensii* (500-1000)	*A. bicinctus*	12 (100.8)	12 (139.5)	28 (52.3)
12	*S. haddoni* (400-500)	*A. chrysogaster*	13 (130.2)	13 (135.6)	35 (58.2)
12	*C. adhaesivum* (250-300)	*A. clarkii*	12 (133.2)	12 (135.8)	36 (40.4)
15	*E. quadricolor* (300-400)	*A. ephippium*	17 (100.3)	17 (115.9)	42 (38.3)
10	*H. aurora* (200-250)	*A. frenatus*	12 (100.8)	12 (113.7)	29 (35.6)
12	*H. crispa* (180-250)	*A. melanopus*	12 (111.8)	12 (115.1)	38 (40.8)
15	*H magnifica* (300-500)	*A. ocellaris*	15 (79.3)	17 (109.2)	42 (32.8)
15	*H. magnifica* (300-500)	*A. percula*	16 (69.2)	16 (98.2)	43 (34.6)
12	*S. gigantea* (400-500)	*A. perideraion*	14 (79.2)	14 (95.1)	31 (41.2)
14	*S.mertensii* (500- 1000)	*A. polymnus*	15 (82.9)	15 (115.4)	40 (31.6)
15	*H. magnifica* (300-500)	*A. sandaracinos*	16 (89.6)	16 (125.4)	44 (48.3)
14	*S. haddoni* (400-500)	*A. sebae*	14 (112.2)	14 (118.2)	41 (50.2)
15	*E. quadricolor* (300-400)	*P. biaculeatus*	15 (79.5)	15 (150.2)	25 (40.2)

the depth is less than 0.5 m. In most of the cases *A. clarkii* and A. *sandaracinos* were present in the deeper areas (8 to 10 m) and the host sea anemones were usually found buried in the muddy substratum. The anemones *C. adhaesivum, H. aurora, H. malu, S. haddoni, M. doreensis* were observed buried in the sediment or sand, and retracted completely into the sediment when disturbed whereas, *H. magnifica, H. crispa, S. gigantea, S. mertensii* and *E. quadricolor* appeared often attached to hard substrata of the shallow areas and reef slopes.

Distribution: *A. ocellaris* was the most widely distributed species observed in the study sites except in Car Nicobar and Campbell Bay whereas, occurrence of *A. percula* was restricted to South Andaman and Nicobar group of islands (Table 3). *A. ocellaris* shares an allopatric distribution with *A. percula*, and both are very much similar except for the dorsal spine count and the middle bar length indicating the possibilities of dichopatric or vicariant speciation. *A. clarkii* was observed from Nicobar group, north and middle Andaman groups of islands. *P. biaculeatus* occurred from Nicobar to South Andaman whereas, *A. sebae* from North Andaman as well as Nicobar group of islands. The population existing in Nicobar group of islands might be an extension from Indonesian and Taiwan waters and that of Andaman group from mainland of India and Myanmar waters or *vice versa* due to larval dispersal by currents and the possibility of peripatric speciation. The wide range of distribution of these species over geographically distant locations can be attributed to the long duration of pelagic larval period and the high survival rate of larvae while drifting by current. The planktonic larval duration (Allen, 1972, 1980; Sale and Douglas, 1984) and ocean currents (Barber *et al.*, 2000) play major roles in determining distribution and abundance of reef fish populations. Distribution of *A. ephippium, A. frenatus* and *A. sandaracinos* was restricted to Andaman group of islands whereas, A. *chrysogaster, A. polymnus, A. akallopisos, A. perideraion, A. melanopus* and *A. bicintus* were observed in the vicinity of Nicobar group of islands. Apart from these, the occurrence of anemonefish around Andaman and Nicobar Islands can be attributed to

Table 3. *Distribution of anemonefishes* (Amphiprion *spp. and* Premnas *sp.) at various locations off Andaman and Nicobar Islands*

Anemonefishes	North Andaman			Middle Andaman		South Andaman group of Islands							Nicobar group of Islands	
	Ariel Bay	Moha-npur	Maya-bunder	Bacon Bay	Rangat Bay	Havel-ock	Wand-oor North	Wand-oor South	North Bay	Marine Hill	Coriy-aghat	Chidiya-ttappu	Car Nicobar	Campbell Bay
A. akallopisos	-	-	-	-	-	-	-	-	-	-	-	-	+	+
A. bicintus	-	-	-	-	-	-	-	-	-	-	-	-	+	+
A. chrysogaster	-	-	-	-	-	-	-	-	-	-	-	-	+	+
A. clarkii	+	+	+	+	+	-	-	-	+	-	-	+	-	-
A. ephippium	+	-	+	-	+	-	-	-	+	+	+	+	-	-
A. frenatus	+	-	+	-	+	-	-	-	-	-	-	-	-	-
A. melanopus	-	-	-	-	-	-	-	-	-	-	-	-	+	+
A. ocellaris	+	+	+	+	+	+	+	+	+	+	+	+	-	-
A. percula	-	-	-	-	-	+	+	+	+	-	-	-	+	+
A. perideraion	-	-	-	-	-	-	-	-	-	-	-	-	+	+
A. polymnus	-	-	-	-	-	-	-	-	-	-	-	-	+	+
A. sandaracinos	-	+	+	-	-	+	-	-	+	+	+	+	-	-
A. sebae	+	+	+	-	-	-	-	-	-	-	-	-	+	+
P. biaculeatus	-	-	-	-	-	-	-	-	+	-	-	+	+	+

+ = Present, - = Not found

the topographical characterization in which the fragmented numbers of islands offer suitable shallow water conditions in the coral reef ecosystem for sea anemones and anemonefishes as reported from Indo-Malayan region (Woodlands, 1983).

The numerical abundance of anemonefishes indicated a declining trend during 2000-2005 (Table 4) except in North Bay, Chidiyattappu, Rangath Bay, Bacon Bay and Mayabunder due to the deposition of sand in coral reef ecosystem by the effect of tsunami on 26th December, 2004 and associated environmental calamities. The destruction of natural habitat due to turbidity, increase in water temperature, rapid developmental activities in the islands and discharge of waste, exploitation of adult pairs of anemonefish for exhibition and entertainment purposes adversely affected the anemonefish population besides depleting the coral resources and the associated fauna of the reef ecosystem. Considering the commercial importance of anemonefish, we suggest that it is necessary to take up measures to conserve and sustain these fish communities through captive breeding and sea ranching programmes.

Acknowlegements

The authors are highly

Table 4. *Number of anemonefishes from different locations of A & N Islands; the figures in parenthesis refer to number of sea anemones*

Locations	Years of study				
	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005
Ariel Bay	745(352)	555(145)	234(100)	254(98)	121(32)
Mohanpur	846(423)	765(234)	321(103)	311(99)	55(12)
Mayabunder	1100(567)	980(456)	543(234)	633(154)	456(123)
Bacon Bay	965(321)	745(234)	432(124)	455(198)	345(154)
Rangat Bay	897(412)	564(302)	321(150)	421(110)	320(98)
Havelock	767(301)	654(230)	345(123)	245(145)	88(31)
Wandoor North	678(333)	531(234)	321(101)	221(99)	15(14)
Wandoor South	650(456)	540(231)	234(141)	145 (88)	25 (12)
North Bay	1345(654)	981(453)	456(124)	556(112)	502(110)
Marine Hill	987(123)	762(104)	321(100)	234(88)	23(15)
Coriyaghat	678(345)	564(234)	342(188)	321(150)	123(31)
Chidiyattappu	999(342)	723(231)	345(154)	312(156)	298(123)
Car Nicobar	1234(876)	1203(776)	1100(553)	897(432)	34(14)
Campbell Bay	1132(987)	987(546)	765(436)	543(321)	45(18)

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