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SUSTAINABLE MANAGEMENT OF COASTAL ECOSYSTEM

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Lake 2016: Conference on Conservation and Sustainable Management of Ecologically Sensitive Regions in Western Ghats [THE 10TH BIENNIAL LAKE CONFERENCE]
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Brachyuran Crabs of Aghanashini Estuary, South Indian West Coast, Karnataka

Ganesh N. Shet, M. D. Subash Chandran and T. V. Ramachandra
Energy and Wetland Research Group, Center for Ecological Science [CES],
Indian Institute of Science, Bangalore, 560012
Email:ganeshshet2@gmail.com,mds@ces.iisc.ernet.in, cestvr@ces.iisc.ernet.in

***Abstract*– Brachyuran crabs are one of the diverse group of crustaceans, infraorder Brachyura in the world ranges approximately from 5000 to 6000 species. A total of 30 species, 23 genera from 11 families of Brachyuran crabs recorded from six stations with respect to different micro habitats of Aghanashini estuary, Uttara Kannada district of South Indian West coast of Karnataka. Out of 30 species 10 species are commercially important, and others are play an important ecological role in estuary.**

Keywords*– *Crustaceans, Decapoda, Brachyuran crabs, Mud crab, Aghanashini estuary

INTRODUCTION

India is one of the few countries of the world with very diverse marine and coastal ecosystems. Among the Asian countries India with its coastline of 8,000 km is perhaps the only one that has a long record of inventories of coastal and marine biodiversity dating back to at least two centuries. The coastal ecosystems are of a wide range consisting of estuaries, lagoons, mangroves, salt marshes, rocky coasts, sandy stretches, coral reefs etc. The number of species recorded from India's marine-coastal realms exceeds 13,000 (Venkataraman, 2005). An estuary is a dynamic ecosystem towards the confluence of river with the Sea, where fresh water from the river mingle with the seawater, thereby creating fluctuating salinity conditions and water flows. Crabs belonging to the infra order Brachyura are considered to be highly successful group of Decapoda, adapted to diverse kinds of estuarine habitats. The brachyurans, forming conspicuous and bio-ecologically very important faunal constituents in estuarine ecosystem, consist of different families. Crabs have tremendous morphological diversity and colorations on their body. They occupy one or more habitats such as rocky shore, sandy shore, mud flats, mangroves etc. and display a variety of behavioral representations. Crabs are omnivores and scavengers feeding on plant and animal matter; their diet includes detritus, smaller bivalves, gastropods, insects and other smaller benthic organisms. Crabs make important food for scores of people along the coast and also, of late, figure prominently in marine products related exports from India. Indian, export of mud crabs (Genus *Scylla*) amounted to 1948 tons which earned revenue of Rs.46.2 Crore. Live crab exports from India increased from 3434 tons in 2008-09 to 5492 tons in 2009-10 (Shivakumar, 2010).

The brachyuran crabs in the world range approximately from 5000 to 6000 species. The largest proportion around 1500 to 2000 brachyuran crab species including marine and fresh water taxa are present in Western Central Pacific region (Kent *et.al,* 1998). There are variable estimates of crab recordings from India. According to Rao *et al*., (1973) 600 species of crabs as recorded from Indian waters (as cited in Sukumaran, 1995). A later study on carcinological fauna of the west coast of India by Venkataraman and Wafar (2005) mentions 254 species, from 120 genera under 24 families. Roy and Das (2000), recorded 55 species of brachyuran crabs under 31 genera from the mangrove habitats of India. Roy and Nandi's studies in 2008 (as cited in Bhatt and Kathiresan, 2011) in Goa, Maharashtra and Kerala, especially from mangroves revealed 35 species under 25 genera and 10 families. Kerala was leading with 27 spp. followed by Goa (17 spp.) and Maharashtra (12 spp.). Dineshbabu *et al.,* (2011) brought out a list of 112 species from Karnataka coast covering estuarine, inshore and offshore waters; to be precise, of these 35 species from 9 families were estuarine and 105 species from 18 families from marine (many crabs with overlapping habitats).

The estuary of Aghanashini is one of the most well studied for its biodiversity and economic and livelihood importance. The mangroves have been mapped and finfishes, bivalves, human communities and their traditional knowledge etc. recorded (Boominathan et al., 2008; Chandran et al., 2012a; 2012b; Ramachandra et.al, 2012; 2013; Bhat et al., 2014a; 2014b; Mesta et al., 2014). In view of the rich biodiversity and livelihood dependence of thousands of families on the estuary, Chandran et al (2012b) submitted a proposal to the Karnataka Biodiversity Board for consideration of the estuary as a Biodiversity Heritage Site, under the provisions of the Biodiversity Act-2002. Estuary-wise studies on crabs are scanty in Karnataka despite several rivers flowing towards the Arabian Sea. Kakati's (1980) report on the 50 species of brachyuran crabs from 11 families from Karwar included both marine and estuarine habitats. Shivakumar et al. (2010) recorded 20 species from 14 genera and 6 families, as associated

with mangroves of Kali estuary. The data available on the crabs of Aghanashini estuary are sparse. The study therefore is mainly aimed at documenting diversity and habitat preferences of brachyuran crabs in the Aghanashini estuary.

MATERIALS AND METHODS

Study stations and habitat types: The crab diversity was studied at six estuarine stations (**Fig. 1**). Belekan and Kirubele are towards the funnel shaped river mouth, stations experiencing high salinity, except during the rainy season. Being closer to the seafront these stations are subjected to greater force of waves; their shores are rockier and interspersed with small sandy; mudflats are relatively larger and oyster beds also occur here. Bargi and Kagal are mid-estuary stations with medium salinity, and more of mangroves and marshes; small creeks and gazni rice fields are associated with this part of the estuary which is a spreadout zone. exist. Hegde and Divigi are upstream stations where the river is restricted in width, often flowing between low laterite hills and with lower salinity due to more mixing of fresh water. Within the zone of each station habitat diversity was documented (such as rocky and sandy shores, mangroves, marshy areas and sub- tidal areas). The marshy area closer to the low tide mark and with no plant cover is designated as *intertidal, open marshy area and mudflats*; marshy area with marsh grasses/sedges is *intertidal marshes with sedges-grasses*. Mangrove area near the low tide mark with oyster stones are *intertidal mangrove-oyster stones*, intertidal area with oyster beds and no mangrove is *intertidal oyster bed*, and *mangrove covered area.* Other estuarine habitats are *rocky shores*, *sandy shores* and *subtidal area*. Within each station limit habitats were recognized and studied for crabs. The geographic locations of the stations are given in **Table-1.**

Fig. 1: Aghanashini estuary with study stations

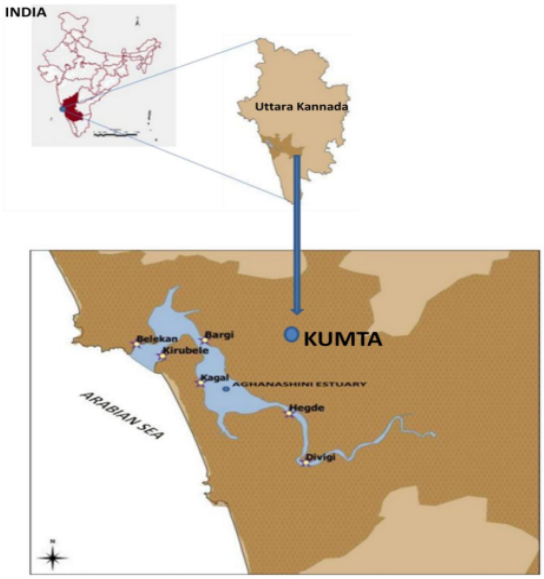

Table 1. Station-wise characterization of crab habitats studied

Station (Lat/Long)	Sampling Site	Habitats
DIVIGI (14º26.650'N 74º26.136'E)	1	Inter-tidal marsh with sedges-grasses
	2	Estuarine border and embankment
	3	Subtidal area

HEGDE (14º28.554'N 74º25.597'E)	4	Inter-tidal marsh with sedges-grasses
	5	Estuarine border and embankment
	6	Subtidal area
KAGAL (14º 29.735'N 74º 22.747'E)	7	Mangrove covered area
	8	Inter-tidal oyster beds
	9	Subtidal area
BARGI (14º31.386'N 74º 22.879'E)	10	Mangrove covered area
	11	Mangrove with oyster stones
	12	Subtidal area
BELEKAN (14º 31.241'N 74º 20.682'E)	13	Sandy shore
	14	Rocky shore
	15	Subtidal area
KIRUBELE (14º 30.779'N 74º 21.523'E)	16	Sandy shore
	17	Rocky shore
	18	Subtidal area

Crab sampling methods: The brachyuran crab habitat and distribution study in the Aghanashini estuary was carried out from August 2015 to December 2015. Monthly observations were made in every habitat type found within the 6 stations (2 stations each in estuarine mouth, mid estuary and upstream estuary). All out searches for crabs were made in each potential habitat within these stations, mainly during the low tide. As far as main body of the estuary constantly under submergence, we relied on the catches by local fisher folks using their various crab catching devices. Photographs were taken of the habitats and crabs. Collections of sample specimens for identification were made by hand picking wherever substratum was exposed. Moulted shells of crabs from respective sites were also collected as supporting evidence. The burrowing crabs in intertidal areas were collected by digging the burrows. Crabs climbing on mangrove trees were also observed. Questionnaire based interviews were conducted among the crab catchers for gaining more information related to crab species in relation to their habitats, times of occurrence, maturity, catching stage, uses in folk medicine etc.

Identification: The collected sample specimens were photographed and left back in the estuary in case of commoner crabs; the rest were brought to the field station, and preserved. Standard keys by Alcock, (1900), Marine Species Identification Portal website (http://species-identification.org), National Institute of Oceanography web site (http://www.niobioinformatics.in), Marine Biodiversity Database of India (http://www.biosearch.in) were mainly used for crab identification. The classification of brachyuran crabs is as per the standard protocol (http://www.marinespecies.org). Unidentified and doubtful specimens were identified with the help of experts from the Department of Marine Sciences of Goa University.

RESULTS

Species richness: The study recorded 30 brachyuran crab species from 23 genera and 11 families (**Table 2**). Sesarmidae, Portunidae and Ocypodidae were the leading families with 7, 6 and 4 species respectively.

Station-wise distribution: **Table 3** provides station-wise and habitat-wise crab distribution. Mid-estuary stations, Kagal and Bargi, with medium salinity conditions during most of post and pre-monsoon periods were richest, with 24 and 25 species respectively. The high salinity river-mouth stations Belekan and Kirubele recorded 22 and 21 species respectively. The low salinity Hegde towards upstream trailed marginally with 18 species, whereas further upstream Divigi had the least number. Almost everywhere mangrove associated habitats accounted for greater richness of crabs, followed by marshy area, sandy shore, sub tidal area and rocky shore

Table2. Family-wise genera and species of brachyuran crabs in Aghanashini estuary.

Sl. NO	Family	Number of genera	Number of species
1	Sesarmidae	6	7
2	Portunidae	4	6
3	Ocypodidae	2	4
4	Grapsidae	2	3
5	Dotillidae	2	3
6	Menippidae	2	2
7	Pilumnidae	1	1
8	Oziidae	1	1
9	Varunidae	1	1
10	Macrophthalmidae	1	1
11	Matutidae	1	1
Total		23	30

The mud crabs *Scylla serrata* and *S. olivacea* were the most widespread across all the stations, occurring in 13 of 18 sites. *Portunus pelagicus* followed with 8 sites and next were *Metopograpsus messor, P. sanguinolentus, Thalamita crenata* and *Uca annulepis,* each found in 6 sites. Crabs like *Ashtoret lunaris, Grapus albolineatus, Dotilla myctyroides, Scopimera proxima, Menippe rumphii, Ozyus tuberculosis, Charybdus lucifera* and *Ocypode cordimanus* were found only in river mouth sites. Interestingly *Dotilla malabarica* occurred only in an upstream site at Divgi and *Clistocoeloma tectum* at a similar site in Hegde. The maximum number of brachyuran crab species were recorded from Kagal and Bargi (18 species in each station) followed by Belekan (13 species); Kirubele and Hegde contributed same number of species (12 species) while minimum species diversity was recorded from Divigi (7 species). In sampling sites diversity, maximum diversity of brachyuran crabs was recorded from site number 7 and 10 while minimum diversity was recorded from site number 3 and 6 (**Table 3**)

Habitat-wise distribution:

Details of habitat-wise distribution of crab species are given in **Table 4**. Whereas some like *Grapsus albolineatus* were observed only on rocky shores *Scylla serrata* and *S. olivacea* occurred in several habitats.

a. ***Mangroves:*** Mangrove areas were richest in crab diversity, altogether accounting for 17 species. Marshes of intertidal zones with sedges, due to their muddy bottom and vegetation shared some species in common with mangroves such as *Metapograpus latifrons, Macropthalamus pacificus, Uca annulepis* etc. Economically very important mud crabs *Scylla serrata* and *S. olivacea* were most widespread in the estuary with mangrove areas accounting for bulk of their catch. *M. latifrons* which is typical of mangrove environment climbs on mangrove trees as well.

b. ***Marshy areas:*** Such areas are common in the estuary and exposed during low tides. The marshes may be with or without vegetation, mainly of sedges with occasional woody mangrove species, especially the shrubby *Acanthus ilicifolius* and the mangrove fern *Acrostichum aureum* (in low salinity marshes). The marshy habitats in general had 13 species of crabs.

c. ***Sandy shores:*** Notable sandy beaches occurred only in Belekan and Kirubele towards the river mouth, subjected to relatively forceful action of waves and tides. This habitat accounted for 9 species of crabs, of which *Dotilla myctiroides, Ocypode cordimana* and *Scopimera proxima* were found exclusive to such areas.

d. ***Rocky shores:*** Natural rocky shores characterized river-mouth stations Belekan and Kirubele. Six species of crabs were found associated with habitat, subjected to higher wave action compared to the interior of the estuary. Characteristic crabs, exclusive to this habitat type, were *Grapsus albolineatus* and *Menippe rumphii.*

e. ***Subtidal areas:*** These are submerged parts of the estuary. It is probable that most crabs pass through such water covered areas while shifting their locations or for feeding purpose or en course their journey to the sea for egg laying and back. Of the 7 species recorded associated with such habitat none was exclusive to it. Family Portunidae was dominant with all the 6 species noted spend

more time submerged in the estuary; most of them migrate to the sea as well. Species *Charybdis lucifera* and *Ashtoret lunaris*were recorded only from station Belekan and Kirubele towards river mouth.

Fig. 2: Noncommercial crabs of Aghanashini estuary

Fig. 3: Commercially important crabs of Aghanashini estuary

DISCUSSION

Aghanashini estuary appears to be one of the richest in brachyuran crabs along the Indian west coast. Many of the crabs recorded from the estuarine areas are also found along the sea coast. Even a recent detailed study by researchers of the Zoological Survey of India, in the Marine National Park, Gulf of Kachchh, yielded only 22 species of crabs, despite the park having a combination of habitats like the coral reef, seagrass bed, seaweed cover, sandy and muddy bottoms etc. Moreover, the Gulf of Kachchh is considered one of the world's richest marine biospheres, occupies an area of 7350 sq km and 42 islands (Beleem et al., 2014). In contrast, the Aghanashini estuary is barely 50 sq km in area including the brackish water rice fields and shrimp/prawn culturing areas, which make about half of the estuary. Considering the fact that study by Dineshbabu et al (2011) from 8 estuaries of Karnataka (Aghanashini not included) reported only 35 species of brachyuran crabs, 30 species so far found in Aghanashini from our study speaks much about the relative naturalness this estuary compared to most others under high anthropogenic pressures.

Recent years witnessed greater appreciation of the role of brachyuran crabs in mangrove ecosystem, especially for the commercially valuable species found there and others which affect the overall mangrove ecology (Tan and Ng, 1994). The Aghanashini estuary, which witnessed an intensive drive towards mangrove afforestation by the Karnataka forest Department in the recent years, is turning out to be big producer of edible mud crabs, associated mainly with mangroves. The most important of these are *Scylla serrata* and *S. olivacea* the capture of which provides employment for few hundred persons every day. Whereas the smaller crabs are more consumed as food in the local households and sold in local markets, the larger ones fetch high value in big cities and are also exported to foreign markets as well. *Portunus* spp. are other important food species from the estuary and the sea coast.

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Table 3. Station-wise and habitat-wise diversity of brachyuran crabs in Aghanashini estuary (TS* = total sites)

Species and Family	Station and sampling sites																		TS*
	Divigi			Hegde			Kagal			Bargi			Belekan			Kirubele			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Matutidae																			
Ashtoret lunaris	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	+	-	+	**4**
Sesarmidae																			
Neosarmatium malabaricum	-	-	-	+	+	-	+	-	-	+	-	-	-	-	-	-	-	-	**4**
Perisesarma bidens	-	-	-	+	-	-	+	-	-	+	-	-	-	-	-	-	-	-	**3**
Parasesarma plicatum	-	-	-	+	-	-	+	-	-	+	-	-	-	-	-	-	-	-	**3**
Sesarmops intermedius	-	-	-	+	-	-	+	-	-	+	-	-	-	-	-	-	-	-	**3**
Pseudosesarma edwardsii	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**2**
Clistocoeloma lanatum	-	-	-	+	-	-	+	-	-	+	-	-	-	-	-	-	-	-	**3**
Clistocoeloma tectum	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**1**
Grapsidae																			
Grapsus albolineatus	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	+	-	**2**
Metopograpsus messor	-	+	-	-	+	-	+	+	-	+	+	-	-	-	-	-	-	-	**6**
Metopograpsus latifrons	-	-	-	-	-	-	+	-	-	+	-	-	-	-	-	-	-	-	**2**
Macrophthalmidae																			
Macrophthalmus pacificus	+	-	-	+	-	-	+	-	-	+	-	-	-	-	-	-	-	-	**4**
Dotillidae																			
Dotilla malabarica	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**1**
Dotilla myctiroides	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	**1**
Scopimera proxima	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	+	-	-	**1**
Menippidae																			
Menippe rumphii	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	+	-	**2**
Myomenippe hardwickii	-	-	-	-	-	-	-	-	-	+	-	-	-	+	-	-	+	-	**3**
Pilumnidae																			
Heteropanope glabra	-	-	-	-	-	-	+	+	-	+	+	-	-	-	-	-	-	-	**4**
Oziidae																			
Ozius tuberculosus	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	+	-	**2**

Varunidae																			
Paraypyxidognathus deianira	-	-	-	-	-	-	+	+	-	+	+	-	-	-	-	-	-	-	**4**
Portunidae																			
Charybdis lucifera	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	**6**
Portunus pelagicus	-	-	-	-	-	-	+	-	+	+	-	+	+	-	+	+	-	+	**8**
Portunus sanguinolentus	-	-	-	-	-	-	-	-	+	-	-	+	+	-	+	+	-	+	**6**
Scylla olivacea	+	-	+	+	+	+	+	-	+	+	-	+	+	-	+	+	-	+	**13**
Scylla serrate	+	-	+	+	+	+	+	-	+	+	-	+	+	-	+	+	-	+	**13**
Thalamita crenata	-	-	-	-	-	-	-	-	+	-	-	+	-	+	+	-	+	+	**6**
Ocypodidae																			
Ocypode cordimana	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	+	-	-	**2**
Uca annulepis	+	+	-	+	+	-	+	-	-	+	-	-	-	-	-	-	-	-	**6**
Ucad ussumieri	-	-	-	-	-	-	+	-	-	+	-	-	-	-	-	-	-	-	**2**
Uca vocans	-	-	-	-	-	-	+	-	-	+	-	-	-	-	-	-	-	-	**2**
Total species in sample site	**5**	**3**	**2**	**11**	**5**	**2**	**16**	**3**	**5**	**17**	**3**	**5**	**9**	**6**	**7**	**8**	**6**	**7**	
Total species station-wise	**10**			**18**			**24**			**25**			**22**			**21**			

Table 4. Habitat preferences of brachyuran crabs in Aghanashini estuary

Species	Habitat type																	
	Marshy area				Mangrove				Sandy shore		Rocky shore		Sub tidal area					
	1	2	4	5	7	8	10	11	13	16	14	17	3	6	9	12	15	18
Ashtoret lunaris	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	+	+
Grapsus albolineatus	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-
Metopograpsus messor	-	+	-	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-
Metopograpsus latifrons	-	-	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-
Paraypyxidognathus	-	-	-	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
Neosarmatium malabaricum	-	-	+	+	+	-	+	-	-	-	-	-	-	-	-	-	-	-
Perisesarma bidens	-	-	+	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-
Parasesarma plicatum	-	-	+	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-
Sesarmops intermedius	-	-	+	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-
Pseudosesarma edwardsii	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clistocoeloma lanatum	-	-	+	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-
Clistocoeloma tectum	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Dotillamalabarica	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dotilla myctiroides	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
Macrophthalmus pacificus	+	-	+	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-
Ocypode cordimana	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-
Scopimera proxima	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-
Uca annulepis	+	+	+	+	+	-	+	-	-	-	-	-	-	-	-	-	-	-
Uca dussumieri	-	-	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-
Uca vocans	-	-	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-
Charybdis lucifera	-	-	-	-	-	-	-	-	+	+	+	+	-	-	-	-	+	+
Portunus pelagicus	-	-	-	-	+	-	+	-	+	+	-	-	-	-	+	+	+	+
Portunus sanguinolentus	-	-	-	-	-	-	-	-	+	+	-	-	-	-	+	+	+	+
Scylla olivacea	+	-	+	+	+	-	+	-	+	+	-	-	+	+	+	+	+	+
Scylla serrata	+	-	+	+	+	-	+	-	+	+	-	-	+	+	+	+	+	+
Thalamita crenata	-	-	-	-	-	-	-	-	-	-	+	+	-	-	+	+	+	+
Heteropanope glabra	-	-	-	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
Menippe rumphii	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-
Myomenippe hardwickii	-	-	-	-	-	-	+	-	-	-	+	+	-	-	-	-	-	-
Ozius tuberculosus	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-
Total species in sample site	**5**	**3**	**1**	**5**	**1**	**3**	**1**	**3**	**9**	**8**	**6**	**6**	**2**	**2**	**5**	**5**	**6**	**6**
Total species in habitat	**13**				**17**				**9**		**6**		**7**					