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Faunal Resources in the Ritchie's Archipleago, Andaman and Nicobar Islands

C. SIVAPERUMAN

ZOOLOGICAL SURVEY OF INDIA

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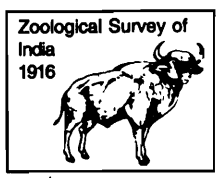

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CONTENTS

RITCHIE'S ARCHIPELAGO: AN OVERVIEW

INTRODUCTION

The Andaman and Nicobar archipelago consists of 572 islands and extends over 800 km (Fig. 1.1). These islands were once a part of the Asian mainland but got detached some 100 million years ago during the Upper Mesozoic Period due to geological upheaval. The existing groups of islands constitute the physiographic continuation of the mountainous ranges of Naga and Lushai Hills and Arakan Yoma of Burma through Cape Negrais to the Andaman and Nicobar Islands and southeast of Sumatra. The chains of these islands are in fact the camel backs of the submerged mountain ranges projecting above the sea level running north to south between 6° 452 and 13° 302 N latitudes and 90° 20' and 93° 562 E longitudes with an extent of 8,249 km^2.

The Andaman and Nicobar islands can be broadly divided into two groups, namely, the Andamans and the Nicobars. These two groups are separated by the Ten-degree Channel which is about 150 km wide and 400 fathoms deep. Average annual temperature varies from 24° to 28° C. The elevations range from 0 to 732 m at Saddle Peak in North Andaman and 642 m at Mount Thulier in Great Nicobar Island. The rainfall is slightly higher in Nicobar with an annual average of 3000 to 3500 mm.

FAUNA OF ANDAMAN AND NICOBAR ISLANDS

Andaman and Nicobar Islands are considered as Paradise of Biological Diversity. About 8425 species of fauna, of these, 846 species are endemic and more than sixty percent of biodiversity have been reported from marine habitat. The details of the fauna reported from Andaman and Nicobar Islands are presented in Table 1.1. The main terrestrial mammals are Long-tailed macaque, Wild Boar, Civets, and several species of Bats, Rats and Shrews. From the faunistic point of view, the most interesting feature is the absence of large mammals and the presence of a considerable number of endemics among the inland vertebrates (Ellis *et al.*, 2000).

Table 1.1. Faunal diversity of Andaman and Nicobar Islands

Sl. No.	Faunal group	World	India	A & N Islands	Endemic	% of Endemic
1.	Sponges	5100	519	112	5	7.14
2.	Helminthes (Flatworm - marine)	400	19	19	-	-
3.	Corals	700	600	600	-	-
4.	Earthworms	4000	585	21	7	33.33
5.	Leeches	500	59	10	-	-
6.	Polychaetes	8000	428	186	-	-
7.	Arachnids	120	21	14	-	-
8.	Gastrotricha	2500	88	32	6	18.75
9.	Chinorincha	100	10	4	2	50.00
10.	Crustaceans	24375	2970	607	56	9.22
11.	Spiders & Scorpions	35810	1352	113	28	45.16
12.	Centipede	3000	100	17		
13.	Millipedes	7500	162	5		
14.	Insects	867391	59353	2274	485	21.5
15.	Molluscs					
	Land	1500	950	110	75	68.18
	Freshwater	08765	284	51	12	23.52
	Marine	56235	32751	1422	2	0.2
	Opisthobranchia	6500	180	180		
16.	Siphonculates	202	38	25	-	-
17.	Echninoderms	6226	765	430	2	0.59
18.	Fishes	21723	2546	1484	2	0.14
19.	Amphibians	5150	240	23	3	16.66
20.	Reptiles	5817	460	104	23	25.55
21.	Aves	9026	1232	284	105	36.97
22.	Mammals	4629	397	62	33	55.00
	Total	**11,04,169**	**1,06,115**	**8,425**	**846**	

Ramakrisha *et al.*, 2010

LOCATION AND TOPOGRAPHY

Ritchie's Archipelago is a cluster of smaller islands which lie some 25-30 km east of Great Andaman, the main island group of the Andaman Islands (Fig. 1.2, Plate 1 & 2). The archipelago consists of 4 larger islands, 7 smaller islands and several islets, extending in a roughly north-south chain, parallel to the main Great Andaman group. Baratang Island and South Andaman Island lie to the west across Diligent Strait; the active volcano Barren Island is some 75 km further to the east.

HISTORY

The archipelago is named after an 18th century British marine surveyor, Mr. John Ritchie, who spent nearly two decades in the employ of the Council of Bengal charting and documenting the Andamans and surrounding regions. Ritchie was one who championed that the British administrations in India make further investigation and use of the Andamans.

GEOGRAPHY

The islands of Ritchie's Archipelago run in a closely spaced arc which extends about 60 km from the southern-most Hugh Rose Island to North Button Island with the strait between them and Great Andaman ranging from 30 km to less than 10 km. Most of the islands are clustered closely together separated by only narrow, almost river-like channels. The exceptions are Hugh Ross and Neil Islands to the south of Havelock, and the three small Button Islands which are smaller outliers to the northern group. The interior of most of the islands consists of undulating hills and plains, with a topography not exceeding 100 m above mean sea level. Occasionally the land rises reasonably abruptly from the sea to a domed plateau, and there are a few rocky coastal cliffs; however, in the main the coastlines are relatively flat, interspersed by both rocky and sand beaches and some low-lying lagoons and estuaries on the larger islands. Havelock, John Lawrence, Henry Lawrence and Outram Islands have a few tidal creeks winding into their interiors; in general freshwater streams are few.

GEOLOGY, ROCK AND SOIL

The rocks of the Ritchie's archipelago group cover a major portion of islands, but the partially compact, limestone beds are seen only along the coastal tracts of few islands and the mangrove swamps encircle all the islands and even penetrate deep along the creeks. The member and formations themselves overlie the ones below conformably without any sign of break in sedimentation (Pandian, 2006).

CLIMATE

The climate is wet tropical. It is warm and humid for the most of the year. The seasons can be divided into dry and rainy seasons. The extreme winter and summer are practically unknown, but there is a general nip in the air during the months of December, January and February. During the months of March, April, May and October can be uncomfortable due to high

humidity although the temperature is not high. The average annual temperature ranged from 26.85 - 33.5°C. The humidity varies from 65 to 91 per cent. The highest humidity is experienced from the month of May to November during the southwest monsoon. The rainfall ranges from 2020 to 3774mm per year. The southwest monsoon which brings most of the precipitation normally begins in the month of May and ends in October. The northeast monsoon starts during November and end in December.

FLORA

The Ritchie's archipelago is covered with luxuriant, almost impenetrable growth of tropical rain forest, characteristic of warm, humid and wet tropics. The dense forest consists of tangled mass of climbers, lianas, canes, bamboos etc. The trees grow in an intimate mixture of different species in all type of forests excluding mangroves. The mangrove forests make the border in low-lying banks of creeks and sheltered portions of coastal line subject of tidal action. The vegetation is composed of five major natural classes adapted according to the nature of the soil, elevation, topographical structure and edaphic factors. Andaman Evergreen forests are most luxuriant type of forest, with canopy formed by giant *Dipterocarpus* sp. Tropical semi evergreen forests include both evergreen and deciduous species (Fig. 1.3). The mangrove forest, which confines to sea washes soil is dominated by *Rhizophora* species while the littoral forest is dominated by *Manilkara littoralis* that forms a pure fringe on sandy beaches. Some of the important tree species are *Dipterocarpus gracilis, Dipterocarpus grandiflorus, Dipterocarpus costatus, Atrocarpus chaplasha, Hopea odorata, Pterospermum acerifolium, Calamus palustris, Cryptocarya ferrarsi, Pterocarpus dalbergioides, Dillenia pentagyna, Xanthophyllum andamanicum, Pongamia pinnata, Calophyllum inophyllum* and *Terminalia catappa.* The mangrove species are *Rhizophora mucronata, Bruguiera conjugata, Bruguiera cylindrica, Bruguiera parviflora, Avicennia officinalis* and *Kandelia candel.*

SALIENT FEATURES AND COORDINATES OF TRANSECTS IN DIFFERENT ISLANDS

The coordinates and salient characteristics of the study area are given in Table 1.2 and 1.3.

Tabel 1.2. Coordinates of transects in different islands

Location	Coordinates	
	Latitude	Longitude
Havelock Island		
Havelock	12° 01.960'	92°50.940'
Kalapathar	11° 58.769'	93°00.980'
Kalapathar	12° 00.235'	93°00.452'
Kalapathar	11° 58.511'	93°00.344'
Radha Nagar	11° 59.050'	92°57.253'
Radha Nagar	11° 59.059'	92°57.209'

Location	Coordinates	
	Latitude	Longitude
Radha Nagar	11° 59.837'	92°57.452'
Kalapathar	11° 58.511'	93°00.344'
Krishna Nagar	11° 59.305'	92°58.865'
Henry Lawrence Island	12° 05.137'	92°04.386'
	12° 05.000'	93°06.312'
John Lawrence Island	12° 04.276'	93°03.063'
	12° 03.116'	93°02.967'
	12° 02.830'	93°02.461'
	12° 03.221'	93°02.146'
Outram Island	12° 13.761'	93°06.055'
	12° 13.537'	93°04.415'
	12° 00.574'	92°56.808'
Middle Button Island	12° 16.473'	93°01.334'
South Button Island	12° 13.467'	93°01.244'
North Button Island	12° 18.974'	93°03.826'
Inglis Island	12° 08.586'	93°06.651'
	12° 08.683'	93°07.252'
	12° 08.454'	93°06.556'
Neil Island		
Neil	11° 59.305'	92°58.865'
Neil	11° 50.571'	93°00.868'
Neil	11° 50.527'	93°00.899'
Sitapur	11° 49.168'	93°03.382'
Sitapur	11° 48.897'	93°03.058'
Sitapur	11° 49.411'	93°03.688'
Sitapur	11° 49.347'	93°02.735'
Rampur	11° 49.229'	93°02.296'
Ramnagar	11° 49.202'	93°02.901'
Lakshmanpur	11° 50.057'	93°01.407'

Table 1.3. Salient characteristics of the study sites

Variables	Havelock	John Lawrence	Henry Lawrence	Inglis	South Button	North Button	Middle Button	Outram	Neil
Coordinates	11° 58.769' 93° 00.980'	12° 04.276' 93° 03.063	12° 05.137' 92° 04.386'	12° 08.586' 93° 06.651'	12° 13.467' 93° 01.244'	12° 18.974' 93° 03.826'	12° 16.473' 93° 01.334'	12° 13.761' 93° 06.055'	11° 49.168' 93° 03.382'
Description of islands	Tracts of land, smaller than a continent, surrounded by water at high water	Tracts of land, smaller than a continent, surrounded by water at high water	Tracts of land, smaller than a continent, surrounded by water at high water	Tracts of land, smaller than a continent, surrounded by water at high water	Tracts of land, smaller than a continent, surrounded by water at high water	Tracts of land, smaller than a continent, surrounded by water at high water	Tracts of land, smaller than a continent, surrounded by water at high water	Tracts of land, smaller than a continent, surrounded by water at high water	Tracts of land, smaller than a continent, surrounded by water at high water
Extent of area (km^2)	113.93	41.98	55	1.4	0.1	0.25	0.4	13	18.90
Annual average rainfall (mm)	3180.0	3180.0	3180.0	3180.0	3180.0	3180.0	3180.0	3180.0	3180.0
Average daily maximum air temperature (°C)	28	28	28	28	28	28	28	28	28
Average daily humidity (%)	73.9	73.9	73.9	73.9	73.9	73.9	73.9	73.9	73.9
Major vegetation types	Andaman Tropical Evergreen, Andaman Semi-evergreen, Andaman Moist deciduous, Mangrove, Littoral, Agriculture	Andaman Tropical Evergreen, Andaman Semi-evergreen, Andaman Moist deciduous, Mangrove, Littoral	Andaman Tropical Evergreen, Andaman Semi-evergreen, Andaman Moist deciduous, Mangrove, Littoral	Andaman Tropical Evergreen, Andaman Semi-evergreen, Andaman Moist deciduous, Mangrove, Littoral	Andaman Tropical Evergreen, Andaman Semi-evergreen, Andaman Moist deciduous, Mangrove, Littoral	Andaman Tropical Evergreen, Andaman Semi-evergreen, Andaman Moist deciduous, Mangrove, Littoral	Andaman Tropical Evergreen, Andaman Semi-evergreen, Andaman Moist deciduous, Mangrove, Littoral	Andaman Tropical Evergreen, Andaman Semi-evergreen, Andaman Moist deciduous, Mangrove, Littoral	Andaman Tropical Evergreen, Andaman Semi-evergreen, Andaman Moist deciduous, Mangrove, Littoral, Agriculture

STUDY PERIOD AND INTENSIVE STUDY AREA

The study was conducted from April 2008 - December 2011 and it was mainly based on direct observational methods (Altman, 1974). The following islands were surveyed on foot, boat and vehicle namely Havelock, John Lawerence, Henry Lawerence, South Button, North Button, Middle Button, Inglis, Outram and Neil islands.

OBJECTIVES

There is not sufficient data available on the fauna of Ritchie's archipelago. Therefore, an attempt has been made to fill the gap on the fauna of this archipelago. This study begins with selected faunal group with the following objectives. Howerver the other faunal groups will be made an attempt in feature.

- To assess the faunal diversity (Odonata, Lepidoptera, Amphibians, Reptiles, Birds and Mammals)
- To study the distribution and ecology of selected fauna groups in the Ritchie's archipelago

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ODONATA (DRAGONFLIES AND DAMSELFLIES)

INTRODUCTION

Dragonflies (Anisoptera) and Damselflies (Zygoptera) are one of the most easily recognizable insect taxa, due to their large size, bright colours and behavior. They include the largest insect that ever lived, the Griffenfly *Meganeuropsis permiana* Carpenter, with a wingspan of c. 70 cm (Kalkman *et al.*, 2008). Dragonflies are among the most ancient winged insects, dating back well into the Permian (Grimaldi and Engel, 2005). Odonates are widely distributed including in ponds, lakes, streams, rivers and canals. The larvae occupy a great diversity of aquatic habitat and form important component of aquatic food webs involving many invertebrates, fishes and other vertebrates. In general, the distribution and composition of aquatic insects and such as odonata community always change from time to time following the variation of environment (Lenat, 1993; Che Salmah *et al.*, 1999). Their assemblage is too dependent on the composition and structure of vegetation in and around their microhabitats (Hawking and New, 1996). Dragonflies are well studied group of invertebrates with their increasing recognition in conservation worldwide (Cordoda-Aguilar, 2008 and Samways, 2008). Dragonflies are key organisms of the food web as predators both as larvae and as imagoes (Benke, 1976). They usually have definite habitat preference and territorial behaviour (Corbet, 1999).

India has a wide variety of suitable habitats that support large populations of Odonata and about 470 species belongs to 139 genera and 19 families occur in India (Subramanian, 2009). In, Andaman and Nicobar Islands, total of 72 species belongs to 11 families and 38 genera were reported by various workers. Studies on the Odonata of Andaman and Nicobar Island commenced with Selys (1853, 1863 and 1871), followed by Fraser (1924, 1933, 1934, 1936). Later, few researchers have been contributed on this group (Lahiri, 1975, 1998; Chhotani *et al.*, 1983; Mitra and Maiti, 1992; Lahiri and Mitra, 1993; Mitra, 1995; 2002b; Ram *et al.*, 2000; Yeh and Veenakumari, 2000; Nandy and Babu, 2009; Sivaperuman and Shah, 2012; Sivaperuman *et al.*, 2011 a,b; 2012). The Objectives of the study is to document the status, distribution, abundance and diversity of Odonata; study the community composition of Odonata in different islands of Ritchie's archipelago.

MATERIALS AND METHODS

The study was conducted from 2008 through 2011 in nine different islands at Ritchie's archipelago. All specimens were captured during the day with a sweep net. The samples were immediately stored in envelopes. Photographs were taken of almost all specimens in order to facilitate further identification. Odonates were identified based on standard systematic keys (Fraser, 1924, 1933, 1934, 1936; Subramanian, 2009 and Mitra, 2006 b).

RESULTS AND DISCUSSION

Occurrence of species

A total of 43 taxa of Odonata were recorded during the period, these belong to 9 families and 28 genera (Table 2.1, Plate 3). Of these, the family Libellulidae were the most common with 26 species, followed by Coenagrionidae (6 species) and Aeschnidae (4 species) (Table 2.2.). The Libellulidae was the dominant family accounting for 63.72 per cent of individuals was observed, followed by Coenagrionidae (16.31 per cent) and Aeschnidae (7.29 per cent). According to the IUCN status, the *Indothemis carnatica* listed under near threatened category, and *Lestes malabarica* as Data deficient and remaing species are listed under least concern.

Table 2.1. List of Odonata recorded in Ritchie's archipelago

Sl. No.	Family	Species name	IUCN status
1.	Aeschnidae	*Anax guttatus* (Burmeister)	LC
2.		*Gynacantha hyalina* Selys	-
3.		*Gynacantha bayadera* Selys	LC
4.		*Oligoaeschna andamani* Chhotani, Lahiri & Mitra	-
5.	Gomphidae	*Gomphidia ganeshi* Chotani, Lahiri & Mitra	-
6.	Libellulidae	*Acisoma panorpoides panorpoides* Rambur	LC
7.		*Brachydiplax chalybea chalybea* Brauer	LC
8.		*Crocothemis servilia servilia* (Drury)	LC
9.		*Cratilia lineata* Forester	-
10.		*Cratilia metallica* (Brauer)	-
11.		*Diplacodes trivialis* (Rambur)	LC
12.		*Diplacodes nebulosa* (Fabricius)	LC
13.		*Indothemis carnatica* (Fabricius)	NT
14.		*Lathrecista asiatica asiatica* (Fabricius)	LC
15.		*Neurothemis fluctuans* (Fabricius)	LC
16.		*Neurothemis intermedia intermedia* (Rambur)	LC
17.		*Neurothemis fulvia* (Drury)	LC
18.		*Neurothemis ramburii ramburri* (Brauers)	LC
19.		*Orthetrum chrysis* (Selys)	LC
20.		*Orthetrum pruinosum neglectum* (Rambur)	LC
21.		*Orthetrum pruinosum pruinosum* (Burmeister)	LC
22.		*Orthetrum sabina sabina* (Drury)	LC
23.		*Pantala flavescens* (Fabricius)	LC
24.		*Potamarcha congener* (Rambur)	LC
25.		*Tramea limbata similata* (Rambur)	LC
26.		*Tramea virginia* (Rambur)	LC

Sl. No.	Family	Species name	IUCN status
27.		*Trithemis aurora* (Brumeister)	LC
28.		*Trithemis festiva* (Rambur)	LC
29.		*Rhyothemis variegata variegata* (Linnaeus)	LC
30.		*Tholymis tillarga* (Fabricius)	LC
31.		*Zyxomma petiolatum* Rambur	LC
32.	Calopterygidae	*Vestalis gracilis gracilis* (Rambur)	-
33.	Coenagrionidae	*Aciagrion pallidum* Selys	LC
34.		*Agriocnemis femina oryzae* Lieftinck	LC
35.		*Agriocnemis rubescens* Selys	-
36.		*Pseudagrion andamanicum* Fraser	-
37.		*Pseudagrion microcephalum* (Rambur)	LC
38.		*Pseudagrion pruinosum* (Burmeister)	LC
39.	Lestidae	*Lestes praemorsus praemorsus* Selys	LC
40.		*Lestes malabarica* Fraser	DD
41.	Platycnemididae	*Copera marginipes* (Rambur)	LC
42.	Platystictidae	*Drepanosticta annandalei* Fraser	
43.	Protoneuridae	*Prodasineura verticalis andamanensis* (Fraser)	LC

Table 2.2. Overall family wise composition of number, percentage of species and individual observed

Family	Number of species	Percentage	Number of individuals	Perentage
Aeschnidae	4	9.30	38	7.29
Gomphidae	1	2.33	7	1.34
Libellulidae	26	60.47	332	63.72
Calopterygidae	1	2.33	8	1.54
Coenagrionidae	6	13.95	85	16.31
Lestidae	2	4.65	11	2.11
Platycnemididae	1	2.33	23	4.41
Platystictidae	1	2.33	7	1.34
Protoneuridae	1	2.33	10	1.92
	43		521	

Comparative occurrence of odonata species

A comparison of number of odonata species recorded from the Ritchie's archipelago with those from Andaman and Nicobar Islands, India, World is given in Table 2.3.

Table 2.3. Comparative occurrence of Odonata species in the Ritchie's archipelago

Sl. No.	Family	World[1]	India[2]	A & N Islands	Ritchie's archipelago[3]
1.	Aeschnidae	436	45	8	4
2.	Austropetaliidae	11	-	-	-
3.	Chlorogomphidae	45	10	-	-
4.	Cordulegastridae	51	9	-	-
5.	Corduliidae	249	16	-	-
6.	Gomphidae	958	85	2	1
7.	Libellulidae	972	85	38	26
8.	Macromiidae	123	17	1	-
9.	Neopetaliidae	1	-	-	-
10.	Pataluridae	11	-	-	-
11.	Synthemistidae	43	-	-	-
12.	Epiophlebiidae	2	1	-	-
13.	Amphipterygidae	10	-	-	-
14.	Calopterygidae	176	7	1	1
15.	Chlorocyphidae	149	21	4	-
16.	Coenagrionidae	1092	58	12	6
17.	Dicteriadidae	2	-	-	-
18.	Euphaeidae	69	18	-	-
19.	Hemiphlebiidae	1	-	-	-
20.	Isostictidae	45	-	-	-
21.	Lestidae	152	23	2	2
22.	Lestoideidae	4	-	-	-
23.	Megapodagrioniidae	303	1	-	-
24.	Perilestidae	19	-	-	-
25.	Philogangidae	9	1	-	-
26.	Platycnemididae	224	27	2	1
27.	Platystictidae	210	13	1	1
28.	Polythoridae	59	-	-	-
29.	Protoneuridae	258	22	1	1
30.	Pseudolestidae	1	-	-	-
31.	Pseudostigmatidae	19	-	-	-
32.	Synlestidae	35	4	-	-

1 - Kalkman *et al.* (2008), 2 - Subtramanian (2009), 3 - present study

Distribution of odonata in Ritchie's archipelago

Species of odonates recorded in different islands during the period of study is given in Table 2.4. Out of forty three species of odonates 39 species were recorded from Havelock, followed by Neil (29), Jonh Lawrence (28), Henry Lawerence (22), Outram (19), Inglis (17), Middle Button (12), North Button (11) and South Button (7). The species *Neurothemis intermedia intermedia* was recorded in only one location.

A total of 43 species of odonata under four families and 25 genera were recorded during the period of study. Out of these *Rhyothemis variegata variegata, Orthetrum sabina sabina, Neurothemis fluctuans, Crocothemis servilia servilia* and *Tremea limbata similiata* were most common and abundance species in all islands of Ritchie's archipelago. The family Calopterygidae, Lestidae, Protoneuridae, Platycnemididae and Platystictidae were represents only one species each namely *Vestalis gracilis, Lestes praemorsa praemorsa, Prodasineura verticalis andamanensia, Copera marginipes* and *Drepanosticta annandalei* respectively.

The occurrence of at least 43 species of Odonates on the Ritchie's archipelago suggests an excellent species richness, which likely reflects the wide variety of aquatic and terrestrial habitats on the forests. Many streams and ponds, often found to be with abundant shoreline vegetation, provide the classic lentic habitat for odonates. Several small water bodies, streams and small rivers also provide habitat diversity, ranging from sediment and large woody debris in flowing water to vegetation-choked reaches, pools and bank areas. The high habitat complexity at multiple spatial scales provides a wide variety of odonata habitat, which in turn results in high species richness of odonata in Ritchie's archipelago. The species richness of odonata in Ritchie's archipelago is comparable with other ecosystems and states in India (Table 2.5).

The Ritchie's archipelago supports a more diverse Odonata community in the Andaman and Nicobar Islands. All of the species observed in this study are associated with lentic habitats. Most of the dragonflies observed were oviposit in open water; most of the damselflies were associated with shallow water with emergent vegetation into which they oviposit endophytically. Natural communities have many species at similar trophic positions and each may respond quite differently to the same perturbation (Vanni, 1987 and Wootton, 1994). The comparison of assemblages in different communities indicates that major environmental changes can lead to the extirpation and replacement of some species but leave other species at the same trophic level largely unaffected (McPeek, 1998). The nine islands in Ritchie's archipelago supported different assemblages of odonata communities. The Havelock, Neil, John Lawrence and Inglis islands appeared to provide the most suitable habitats for many dragonfly species. The availability of microhabitats, and vegetation were strongly supported the diversity and distribution of Odonata communities in their respective vicinities (Davies and Nelson, 1994).

Of the recorded species, the *Zyxomma petiolatum, Tramea limbata similata, Diplacodes nebulosa,* and *Cratilla lineata* are new to Andaman and Nicobar islands. The ecology of the odonata of Ritchie's archipelago is very poorly known and therefore only a limited discussion of the habitat requirements of the recorded species can be given. At the very least, this work will serve as a foundation for the development of additional investigations and conservation

Table 2.4. Distribution of the Odonata in different islands

Species name	Islands of Ritchie's Archipelago								
	Havelock	John Lawrence	Henry Lawrence	Inglis	South Button	North Button	Middle Button	Outram	Neil
Anax guttatus	✓		✓	✓					✓
Gynacantha hyalina	✓							✓	✓
Gynacantha bayadera	✓	✓						✓	✓
Oligoaeschna andamni	✓	✓	✓	✓		✓		✓	✓
Gomphida ganeshi	✓		✓					✓	✓
Acisoma panorpoides panorpoides	✓	✓		✓				✓	✓
Brachydiplax chalybea chalybea	✓	✓	✓	✓			✓	✓	✓
Crocothemis servilia servilia	✓	✓		✓				✓	
Cratilia lineata	✓	✓	✓			✓		✓	✓
Cratilia metallica	✓	✓	✓	✓			✓		✓
Diplocodes trivialis	✓	✓	✓			✓			✓
Diplacodes nebulosa	✓	✓	✓						✓
Indothemis carnatica	✓	✓	✓					✓	✓
Lathrecista asiatica asiatica	✓	✓	✓		✓	✓			✓
Neurothemis fluctuans	✓	✓	✓						
Neurothemis intermedia intermedia			✓						
Neurothemis fulvia	✓		✓			✓		✓	✓
Neurothemis ramburii ramburri		✓		✓			✓		✓
Orthetrum chrysis	✓	✓	✓	✓	✓		✓	✓	✓
Orthetrum pruinosum neglectum	✓				✓				
Orthetrum pruinosum pruinosum	✓	✓		✓	✓		✓	✓	✓
Orthetrum sabina sabina	✓	✓	✓				✓	✓	
Pantala flavescens	✓								✓

Species name	Islands of Ritchie's Archipelago								
	Havelock	John Lawrence	Henry Lawrence	Inglis	South Button	North Button	Middle Button	Outram	Neil
Potamarcha congener	✓		✓						✓
Tremea limbata similata	✓			✓					
Tremea virginia	✓	✓		✓		✓		✓	✓
Trithemis aurora	✓		✓		✓		✓		✓
Trithemis festiva	✓	✓	✓						
Rhyothemis variegata variegate	✓	✓	✓			✓			
Tholymis tillarga	✓		✓						✓
Zyxomma petiolatum	✓	✓				✓			✓
Vestalis gracilis gracilis	✓	✓		✓		✓			
Aciagrion pallidum		✓			✓				✓
Agriocnemis femina oeyzae	✓	✓		✓	✓				
Agriocnemis rubescens	✓					✓			✓
Pseudagrion andamanicum	✓	✓		✓			✓	✓	
Pseudagrion microcephalum	✓		✓			✓		✓	✓
Pseudagrion pruinosum	✓	✓		✓			✓	✓	✓
Lestes praemorsa praemorsa	✓	✓	✓				✓		✓
Lestes malabarica									
Copera marginipes	✓	✓		✓			✓	✓	✓
Drepanosticta annandalei	✓	✓					✓		
Prodasineura verticalis andamanensis	✓			✓				✓	

Table 2.5. Comparison of species richness of Odonata with other ecosystems and States in India

Sl.No.	Name of the area/ecosystem	Number of species	Reference
1.	Rice field, Coimbatore	16	Gunathilagaraj *et al.*, 1999
2.	Courtallam, Tamil Nadu	14	Palot and Soniya, 2000
3.	Great Himalayan National Park	6	Uniyal *et al.*, 2000
4.	Parambikulam Wildlife Sanctuary	25	Emiliyamma and Radhakrishnan, 2000
5.	Annamalai University, Tamil Nadu	14	Asaithambi and Manickavasaram, 2002
6.	Irrigated rice field, Madurai, Tamil Nadu	12	Kandibane *et al.*, 2003
7.	Desert National Park	11	Prasad, 2004
8.	Rice field, Palakkad	21	Palot *et al.*, 2005
9.	Marayoor, Kerala	20	Sharma *et al.*, 2007
10.	Bengaluru, Karnataka	17	Sharma *et al.*, 2007
11.	Thangali, Karnataka	12	Sharma *et al.*, 2007
12.	Mandagadde, Karnataka	11	Sharma *et al.*, 2007
13.	Javadis, Tamil Nadu	16	Sharma *et al.*, 2007
14.	Chitteri, Tamil Nadu	08	Sharma *et al.*, 2007
15.	Jabalpur District	27	Prasad and Mishra, 2008
16.	Water bodies of Coimbatore and Salem Districts	21	Arulprakash and Gunathilagaraj, 2010
17.	Tropical Forest Research Institute campus, Jabalpur	48	Tiple *et al.*, 2012
18.	Pondicherry	15	Emiliyamma and Radhakrishnan, 2006
19.	Tripura	35	Srivastava and Sinha, 2000
20.	Tamil Nadu	135	Emiliyamma, 2009
21.	Arunachal Pradesh	92	Mitra, 2006c
22.	Nagaland	48	Mitra *et al.*, 2005
23.	Manipur	68	Srivastava and Sinha, 2004
24.	Goa	39	Kulkarni and Talmale. 2008
25.	Uttarakhand	102	Prasad and Mondal, 2010 Prasad and Sinha, 2010
26.	Kerala	137	Emiliamma *et al.*, 2005

strategies for Odonata in Ritchie's archipelago. In short, the results have contributed to a greater understanding of odonata distribution in Ritchie's archipelago. More intensive studies on the Odonata fauna of Ritchie's archipelago are needed to better understand the impact of the modification and destruc-tion of the habitat these islands in Andaman and Nicobar Islands.

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LEPIDOPTERA : (BUTTERFLIES)

INTRODUCTION

Invertebrates constitute about 99 per cent of the world's biodiversity and over half of these in terms of number of species, are represented by insects with nearly one million species being recorded from different habitats (Wilson, 1987 and 1988; Stork, 1991). Because of their highly diverse habits, insects have been very successful in diversifying and establishing in as many ecological niches as possible. They also play diverse roles and thus contribute to the sustainability of various ecosystems. The tropical forests, which cover less than 7 per cent of the earth's land surface, are one of the richest centers of biological diversity. It has been estimated that nearly 50 per cent of all known species belong to this ecosystem (Myers, 1988).

Butterflies have been suggested as potential ecological indicators of the impacts of habitat disturbance and their larva play an important roles in ecosystem functioning, including nutrient cycling and pollination (Kremen, 1992; Sparrow *et al.,* 1994; Hill *et al.*, 1995; Beccaloni and Gaston, 1995; Schulze and Fielder, 1998; Wood and Gillman, 1998). Butterflies can be used as indicators of habitat quality because they are widespread, conspicuous, day-flying; reasonably diverse for complete assessment and taxonomic identification; and relatively sensitive to environmental changes because of their precise ecological requirements and short life cycles (New, 1997; Kocher and Williams, 2000; Hardy and Dennis, 2005). This implies that tropical butterflies should be studied not just as potential biological indicators, but as targets of conservation in their own right (Bonebrake *et al.*, 2010 and Schulze *et al.*, 2010). Butterflies and moths offer good opportunities for studies on population dynamics and community ecology (Pollard, 1991). Many species are strictly seasonal, preferring only a particular set of habitats. In spite of this, butterflies have been generally neglected by community ecologists and there are very few studies are available on their community structures, population dynamics and the eco-climatic factors which affect them. Being good indicators of climatic conditions as well as season and ecological changes, they can serve in formulating strategies for conservation. Butterfly monitoring programs in the tropics must, by necessity, focus on changes in the relative abundance of species. The assumption behind this approach is that data on temporal fluctuations in locally common species will help assess environmental trends and evaluate the effectiveness of habitat conservation efforts.

Butterflies are taxonomically well studied group, which have received a rational amount of attention throughout the world (Ghazoul, 2002). Many of the butterfly species are strictly seasonal and prefer only a particular set of habitats and they are good indicators in terms of anthropogenic disturbance and habitat quality (Kunte, 1997; Kocher and Williams, 2000). These

modified habitats often negatively influence butterfly species and their dynamics (Gascon *et al.*, 1999; Rickets *et al.*, 2001). The seasonality in tropical butterflies has been investigated in West Africa, Central America, East Africa and Southeast Asia (Braby, 1995). Tropical butterflies, like many other tropical insects exhibit seasonal and annual variations in abundance particularly in those areas with marked wet and dry periods (Wolda, 1978; Braby, 1995; De Vries *et al.*, 1997 and Kunte, 1997).

Studies on butterflies of Andaman and Nicobar Island received attention after the publication of Wood Mason and de Nicebille (1880, 1881 a, b and 1882). Evans (1932) has worked on butterflies of these Islands. Later, only a few researchers have been contributed on the butterfly fauna of Andaman and Nicobar Islands (Talbot, 1939, 1947; Ferrar, 1948 and 1952; Vane-Wright, 1978, 1993; Arora and Nandhi, 1980, 1982; Chaturvedi, 1982; Khatri, 1989, 1991, 1992, 1993; Khatri and Singh, 1988; Khatri and Mitra, 1989 a,b; Ripley and Beehler, 1989; Veenakumari and Mohanraj, 1991, 1996; Chaturvedi and Hussain, 1991; Chandra and Khatri, 1995; Davidar *et al.*, 1995; Chandra and Rajan, 1996; Mohanraj and Veenakumari, 1996; Veenakumari *et al.*, 1997; Devy *et al.*, 1998; Sivaperuman *et al.*, 2010, 2011). The objectives of the study are to document the status, distribution, abundance and diversity of butterflies; study the community composition of butterflies in different islands in the Ritchie's archipelago.

MATERIALS AND METHODS

This study was conducted during November 2008 to December 2011. Butterfly species were estimated by 600 m transect, traversed in one hour (Pollard, 1977; Pollard and Yates, 1993). Transects were enumerated between 0600 to 1100 hours and data was not collected during heavy rain or strong winds. Butterflies were identified based on physical features with the help of field guides and reference books (Evans, 1932; Ferrar, 1948; Kunte, 2000 and Kehimkar, 2008). Butterflies observed in each islands were individually recorded. Unfamiliar species were collected for identification. Species observed outside the transects and forest edges were noted separately. Butterflies observed along the transects alone were considered for statistical analyses.

RESULTS

Occurrence of species

A total of 84 taxa of butterflies were recorded during the period, these belong to 5 families and 58 genera (Table 3.1, Plate 4 & 5). Of these, Nymphalidae were the most common with 29 species, followed by Lycaenidae (17 species), Pieridae (15 species), Papilionidae (13 species) and Hesperidae (10 species) (Table 3.2). The Nymphalidae was the dominant family accounting for 52.62 per cent of individuals followed by Pieridae (18.67 per cent) and Papilionidae (16.59 per cent).

Table 3.1. List of Butterflies recorded in Ritchie's archipelago

Sl.No.	Common Name	Species name
	Hesperidae (Skippers)	
1.	Pale Palm Dart	*Telicota colon* (Fabricius)
2.	Common Snow Flat	*Tagiades japetus* (Stoll)
3.	Common Awl	*Hasora badra* (Moore)
4.	White Banded Awl	*Hasora taminatus* Hubner
5.	Plain Banded Awl	*Hasora vita* (Butler)
6.	Brown Awl	*Badamia exclamationis* (Fabricius)
7.	Giant Redeye	*Gangara thyrsis* (Fabricius)
8.	Common Spotted Flat	*Celaenorrhinus leucocera* (Kollar)
9.	Paintbrush Swift	*Boaris farri* (Moore)
10.	Common Banded Demon	*Notocrypta paralysos* (Wood-Mason & de Niceville)
	Papilionidae (Swallotails)	
11.	Great Jay	*Graphium eurypylus* (Linnaeus)
12.	Fivebar Swordtail	*Graphium antiphates* (Cramer)
13.	Andaman Swordtail	*Graphium epanimondas* Obesthur
14.	Tailed Jay	*Graphium agamemnon* (Linnaeus)
15.	Andaman Helen	*Papilio prexaspes andamanicus* Rothscild
16.	Andaman Mormon	*Papilio mayo* Atkinson
17.	Great Mormon	*Papilio memnon* Linnaeus
18.	Common Mormon	*Papilio polytes* Linnaeus
19.	Lime Butterfly	*Papilio demoleus* Linnaeus
20.	Andaman Clubtail	*Atrophaneura rhodifier* (Butler)
21.	Andaman Birdwing	*Troides helena* (Linnaeus)
22.	Crimson Rose	*Atrophaneura hector* (Linnaeus)
23.	Common Rose	*Atrophaneura aristolochiae* (Fabricius)
	Pieridae (White and Yellows)	
24.	Three Spot Grass Yellow	*Eurema blanda* (Boisduval)
25.	Common Grass Yellow	*Eurema hecaba* (Linnaeus)
26.	Tree Yellow	*Gandaca harina* (Horsfield)
27.	Common Emigrant	*Catopsilia pomona* (Fabricius)

Sl.No.	Common Name	Species name
28.	Mottled Emigrant	*Catopsilia pyranthe* (Linnaeus)
29.	Yellow Orange Tip	*Ixias pyrene* (Linnaues)
30.	Great Orange Tip	*Hebomoia glaucippe* (Linnaeus)
31.	Andaman Wanderer	*Pareronia ceylanica* (C. & R. Felder)
32.	Striped Albatross	*Appias libythea* (Fabricius)
33.	Chocolate Albatross	*Appias lyncida* (Cramer)
34.	Orange Albatross	*Appias nero* (Fabricius)
35.	Common Albatross	*Appias albino* (Boisduval)
36.	Large Cabbage White	*Pieris brsssicae* (Linnaeus)
37.	Lesser Gull	*Cepora nadina* (Lucas)
38.	Pysche	*Leptosia nina* (Fabricius)
	Lycaenidae (Blues)	
39.	Indian Sunbeam	*Curetis thetis* (Drury)
40.	Common Cerulean	*Jamides celeno* (Cramer)
41.	Yamfly	*Loxura atymnus* (Stoll)
42.	Leaf Blue	*Amblypodia anita* Hewitson
43.	Club Silverline	*Spindasis syama* (Horsfield)
44.	Forget-Me-Not	*Catochrysops strabo* (Fabricius)
45.	Lesser Grass Blue	*Zizina otis* (Fabricius)
46.	Dark Blue Royal	*Pratapa icetas* (Hewitson)
47.	Plains Cupid	*Chilades pandava* (Horsfield)
48.	Leaf Blue	*Amblypodia anita* Hewitson
49.	Apefly	*Spalgis epius* (Westwood)
50.	Dark Grass Blue	*Zizeeria karsandra* (Moore)
51.	Dingy Blue	*Petrelaea dana* (de Niceville)
52.	Common Tit	*Hypolycaena erylus* (Godart)
53.	Silverstreak Blue	*Iraota timoleon* Stoll
54.	Common Onyx	*Horaga onyx* (Moore)
55.	Quaker	*Neopithecops zalmora* (Butler)
	Nymphalidae	
56.	Andaman Map	*Cyrestis thyodamas* Boisduval

Sl.No.	Common Name	Species name
57.	Striped Tiger	*Danaus genutia* Cramer
58.	Dark Glassy Tiger	*Prantica ageloides* (C & R. Felder)
59.	Plain Tiger	*Danaus chrysippus* (Linnaeus)
60.	Blue Tiger	*Tirumala limniace* Cramer
61.	Glassy Tiger	*Parantica aglea* (Stoll)
62.	Spotted Black Crow	*Euploea crameri* Lucas
63.	Andaman Crow	*Euploea andamanensis* (Atkinson)
64.	Tree Nymph	*Idea agamarschana* (C & R. Felder)
65.	Palmking	*Amathusia phidippus* (Linnaeus)
66.	Common Evening Brown	*Melanitis leda* (Linnaeus)
67.	Long-Brand Bush Brown	*Mycalesis visala* Moore
68.	Banded Bush Brown	*Mycalesis mineus* (Linnaeus)
69.	Andaman Chestnut Palmfly	*Elymanias cottonis* Hewitson
70.	Nigger	*Orsotrioena medus* Fabricus
71.	Leopard Lacewing	*Cethosia cyane* (Drury)
72.	Cruiser	*Vindula erota* Fabricius
73.	Common Sergeant	*Athyma perium* (Linnaeus)
74.	Common Sailer	*Neptis hylas* Linnaeus
75.	Clear Sailer	*Neptis clina* Moore
76.	Clipper	*Parthenos Sylvia* (Cramer)
77.	Hewitson Andaman Viscount	*Tanaecia cibaritis* Hewitson
78.	Peacock Pansy	*Junonia almana* (Linnaeus)
79.	Blue Pansy	*Junonia orithya* (Linnaeus)
80.	Peacock Pansy	*Junonia atlites* (Linnaeus)
81.	Yellow Pansy	*Junonia hierta* (Fabricius)
82.	Grey Pansy	*Precis atlites* (Linnaeus)
83.	Great Egg fly	*Hypolimnas bolina* (Linnaeus)
84.	Danaid Eggfly	*Hypolimnas misippus* (Linnaeus)

Table 3.2. Overall family wise composition of number, percentage of species and individual observed

Family	Number of species	Percentage	Number of individuals	Percentage
Hesperidae	10	11.90	32	2.47
Papilionidae	13	15.48	215	16.59
Pieridae	15	17.86	242	18.67
Lycaenidae	17	20.24	125	9.65
Nymphalidae	29	34.52	682	52.62
	84		1296	

Distribution of butterfly species

Species of butterflies recorded in different islands during the period of study is given in Table 3.3. Out of eighty four species of butterflies 79 species were recorded from Havelock, followed by Neil (56), Outram (41), Inglis (35), John Lawrence (39), Hendry Lawrence (37), Middle Button (27), North Button (25) and South Button (21). The species like, Great Mormon (*Papilio memnon*), Andaman Clubtail (*Atrophaneura rhodifer*), Common Rose (*Atrophaneura aristolochiae*) and Peacock Pansy (*Junonia atlites*) were recorded from only one location.

Species richness and abundance of butterflies

Species richness and abundance of butterflies varied in the different islands. Highest number of species richness and abundance was recorded from Havelock followed by Neil and Outram (Table 3.4). Highest number of individuals was recorded from the family Nymphalidae in Havelock and Neil Islands.

Table 3.3. Distribution of butterflies in Ritchie's archipelago

Sl.No.	Common Nmae	Islands of Ritchie's Archipelago								
		Havelock Lawrence	John Lawrence	Henry	Inglis Button	South Button	North Button	Middle	Outram	Neil
1.	Pale Palm Dart	√								
2.	Common Snow Flat	√	√	√					√	√
3.	Common Awl									
4.	White Banded Awl		√							√
5.	Plain Banded Awl	√						√		
6.	Brown Awl		√	√	√		√		√	√
7.	Giant Red Eye	√	√	√		√			√	√
8.	Common Spotted Flat	√	√		√					
9.	Paint Brush Swift	√								
10.	Common Banded Demon		√	√	√				√	√
11.	Great Jay	√	√	√	√		√			√
12.	Fivebar Swordtail	√	√	√			√			√
13.	Andaman Swordtail	√	√		√		√	√	√	√
14.	Tailed Jay	√	√	√	√			√	√	
15.	Andaman Helen	√			√	√	√	√	√	√
16.	Andaman Mormon	√	√	√					√	√
17.	Great Mormon	√	√	√	√	√	√	√	√	√
18.	Common Mormon	√	√	√	√		√	√	√	√
19.	Lime Butterfly	√	√	√	√				√	√

Sl.No.	Common Nmae	Islands of Ritchie's Archipelago								
		Havelock Lawrence	John Lawrence	Henry	Inglis Button	South Button	North Button	Middle	Outram	Neil
20.	Andaman Clubtail	√	√	√	√	√	√	√	√	√
21.	Andaman Birdwing	√								√
22.	Crimson Rose	√							√	√
23.	Common Rose	√	√	√	√	√	√	√	√	√
24.	Three Spot Grass Yellow	√							√	√
25.	Common Grass Yellow	√								√
26.	Tree Yellow	√	√				√		√	√
27.	Common Emigrant	√	√	√	√	√	√	√	√	
28.	Mottled Emigrant	√		√	√	√	√	√	√	
29.	Yellow Orange Tip	√				√		√	√	√
30.	Great Orange Tip	√				√				√
31.	Andaman Wanderer	√	√	√	√	√	√			√
32.	Striped Albatross	√					√	√	√	
33.	Chocolate Albatross	√		√					√	
34.	Orange Albatross	√		√	√	√	√	√	√	√
35.	Common Albatross	√			√	√	√	√		√
36.	Large Cabbage White	√	√							√
37.	Lesser Gull	√	√		√	√	√	√		√
38.	Pysche	√							√	√
39.	Indian Sunbeam	√						√	√	√
40.	Common Cerulean	√								√

Sl.No.	Common Nmae	Islands of Ritchie's Archipelago								
		Havelock Lawrence	John Lawrence	Henry	Inglis Button	South Button	North Button	Middle	Outram	Neil
41.	Yamfly	√					√		√	
42.	Leaf Blue	√								
43.	Club Silverline	√								
44.	Forget-Me-Not	√								√
45.	Lesser Grass Blue	√		√			√	√	√	√
46.	Dark Blue Royal	√	√				√			
47.	Plains Cupid	√	√					√	√	√
48.	Purple Leaf Blue	√								
49.	Apefly	√			√			√	√	√
50.	Dark Grass Blue	√			√					√
51.	Dingy Blue									
52.	Common Tit	√		√		√				√
53.	Silverstreak Blue	√			√	√				√
54.	Common Onyx	√	√							√
55.	Quaker	√								√
56.	Andaman Map		√						√	
57.	Striped Tiger	√	√	√	√				√	√
58.	Dark Glassy Tiger	√	√	√						
59.	Plain Tiger	√	√		√					
60.	Blue Tiger	√	√	√			√	√	√	√
61.	Glassy Tiger	√		√	√	√				√
62.	Spotted Black Crow	√	√	√	√	√	√	√	√	

Sl.No.	Common Nmae	Islands of Ritchie's Archipelago								
		Havelock Lawrence	John Lawrence	Henry	Inglis Button	South Button	North Button	Middle	Outram	Neil
63.	Andaman Crow	√								√
64.	Tree Nymph	√								√
65.	Palmking	√		√					√	
66.	Common Evening Brown	√	√	√					√	√
67.	Long-Brand Bush Brown	√							√	√
68.	Banded Bush Brown	√							√	
69.	Andaman Chestnut Palmfly	√	√	√						
70.	Nigger	√							√	√
71.	Leopard Lacewing	√	√	√						
72.	Cruiser	√	√	√						
73.	Common Sergeant	√								
74.	Common Sailer	√			√			√	√	√
75.	Clear Sailer	√								
76.	Clipper	√			√		√		√	√
77.	Hewitson Andaman Viscount	√	√	√	√					√
78.	Peacock Pansy	√	√	√	√					√
79.	Blue Pansy	√	√	√	√					√
80.	Peacock Pansy	√	√	√	√	√	√	√	√	√
81.	Yellow Pansy	√			√	√		√		
82.	Grey Pansy	√			√	√	√	√	√	√
83.	Great Egg fly	√								√
84.	Danaid Eggfly	√		√				√		√

Table 3.4. Difference observed in line transect method in the study sites

Variables	Havelock	John Lawrence	Henry Lawrence	Inglis	South Button	North Button	Middle Button	Outram	Neil
Butterfly individuals observed	466	110	102	97	69	61	78	110	224
No. of species observed	79	39	37	35	21	25	27	41	56
Sampling effort (km walked)	32	12	12	18	10	10	10	15	30
Percentage of species identified	94.04	46.43	44.05	41.67	25	29.76	32.14	48.80	66.66

DISCUSSION

A total of 84 species of butterflies belongs to five families of the Order Lepidoptera were recorded. Of these, the family Nymphalidae were the most common with 29 species, followed by Lycaenidae (17 species), Pieridae (15 species), Papilionidae (13 species) and Hesperidae (10 species). The family Nymphalidae was the dominant family account for 52.62 per cent of individuals. A similar pattern of distribution was also reported in Western Ghats (Kunte, 1997; Kunte *et al.*, 1999; Eswaran and Pramod, 2005; Krishna Kumar *et al.*, 2008; Devy and Davidar, 2001; Padhye *et al.*, 2006). The distribution of butterfly species showed that the following species were recorded in all islands namely, Peacock Pansy, Great Mormon, Andaman Clubtail, and Common Rose. Differences in butterfly species richness observed at our study sites may result from variety of causes, which may be categorized as local or regional factors. The presence of all Lepidoptera families at each site is represented in a wide range. Butterfly families site selection could be determine by the availability of some factors such as food availability, access to light to regulate their body temperature, open space to flight away from predators or some others to use the breeze to flight to other places.

The structural complexity of habitat and diversity of vegetation forms have been shown to be correlated with animal and insect species diversity (Gardner *et al.*, 1995). Southwood (1975) suggested that the herbivores are more influenced by the food quality. Host plants are utilized only when sufficient adult resources are also available (Grossmueller and Lederhouse, 1987). Successful butterfly habitat must therefore include sufficient larval and adult food resources. In the present study, the maximum number of species and individuals were observed in Havelock and Neil islands, where availability of diverse vegetation and access to host plants. The changes in the diversity in different islands in the study area are also evident from the data, this because of the variation in the micro habitat, floristic structure and other habitat parameter. Habitat preference of butterflies can be directly related to the availability of food plants (Thomas, 1995). Each habitat has a specific set of micro environment suitable for a species. Most of the

species recorded during the present study were not habitat specific. Nymphalidae was the dominant family in the present study. Many members of this family are polyphagous which would help them to live in all habitats and in different elevation gradients. In some of the islands in Ritchie's archipelago is occupied by thick mangrove swamps and other are sandy beaches. In the latter the littoral or beach forest consists of some flowering bushes and this habitat support more number of species. It also observed that some of Nymphalids and Pierids were regularly visit the seashore and settle on damp patches for a few seconds, while others like Sailers, Lacewings and Blues confined themselves to the forested area. The Skippers remain within the forest area. From the conservation point of view, we recorded several endangered and endemic species of butterflies from the study area. Many butterfly species are specific in their habitat requirements and hence, are good indicator of habitat diversity of a locality (Kocher and Williams, 2000). Localities with greater diversity of habitats should generally support a greater number of butterfly species (Kocher and Williams, 2000; Hardy and Dennis, 2005). The Ritchie's archipelago in Andaman and Nicobar Islands support most local species, tailored management and maintenance of these habitats are equally important to maintain and enhance the habitat quality for butterflies.

Andaman and Nicobar islands is unique in endemism, the following species were recorded during the investigation Giant Red Eye (*Gangara thyrsis*), Tailed Jay (*Graphium agamemnon*), Andaman Mormon (*Papilio mayo*), Andaman Clubtail (*Atrophaneura rhodifier*), Andaman Crow (*Euploea andamanensis*), Hewitson Andaman Viscount (*Tanaecia cibaritis*), Andaman Birdwing (*Troides helena*), Andaman Swordtail (*Graphium epanimondas*), Andaman Map (*Cyrestis thyodamas*) and Andaman Chestnut Palmfly (*Elymanias cottonis*). The habitat loss or degradation has been the major threat to the survival of wildlife, including butterflies in worldwide (Thomas, 1984). The protected areas are important in preserving butterfly diversity, where populations of some species have contracted largely or entirely to protected areas (Thomas, 1984). The high representation of butterflies in Ritchie's archipelago has also demonstrated their importance in in-situ conservation. Long-term monitoring studies are needed with special reference to host plants and the factor influencing the distribution, diversity and abundance of butterflies.

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LEPIDOPTERA : (MOTHS)

INTRODUCTION

The moths are very familiar to mankind on account of their attractive coloration, size and plant relationships. They are cosmopolitan in distribution, occurring in every feasible habitat, from coastal areas and plains to deserts, forest and valleys of hills and mountains (Chandra, 2007). Though moths are much common than butterflies, people always refer to butterflies when speaking about Lepidoptera. In fact 87 per cent of all Lepidoptera are moths (van Niekirken *et al,* 2011). There are about 150,000 to 250,000 species of moth, with thousands of species yet to be described. Most species of moth are nocturnal, but there are crepuscular and diurnal species. It is estimated that approximately 10,000 species of moths are to be found in India belongs to 41 families. Moths and butterflies have been widely used in ecological and conservation research worldwide (Kitching *et al.*, 2000; Summerville and Crist, 2002; Kendrick, 2007; Barretto and Kendrick, 2007; Chandra, 2007). Literature reveals that, 529 species belong 30 families were reported from Andaman and Nicobar Islands. The major contribution on the Indian moth fauna, in general, belongs to Cotes and Swinhoe (1888), Hampson (1892, 1894, 1895 and 1896), Bell and Scott (1937), Rotchschild (1903) and Srivastava (2000). The studies on moth fauna of Andaman and Nicobar islands have been undertaken by Chandra (1993, 1994, 1996 and 1997), Chandra and Kumar (1992), Chandra and Rajan (1995 and 2004), Bhumnavar *et al.* (1991), Mandal and Bhattacharya (1980).

Islands play a prominent role in ecological and biogrogrpahic studies, since they are numerous in number and vary in size and degree of isolation. In addition, the characteristics of islands biodiversity are relatively easy to observe and quantify (MacArthur and Wilson 1967). The Andaman and Nicobar Islands are known for rich biodiversity resources (Mathur and Padalia, 2010). The archipelago consists 572 islands and extending over 800 km. The topography of the Andaman and Nicobar Islands are hilly and undulating, the elevation in Andamans is from 0 to 732 m and Saddle Peak is the highest in North Andaman Island. In the Nicobars the elevation rises from 0 to 568 m, Mt Thuillier being the highest peak on Great Nicobar Island. The habitats represented in the islands include bays, mangroves, moist deciduous forests and evergreen forests. These islands are tropical, that is, warm, moist and equable. The proximity of the sea and the abundant rainfall prevent extremes of heat. The mountainous parts of the southern group of islands get about 300 cm of rain annually whereas the islands of north get lesser rainfall. Flora and fauna in Andaman bear close biogeographical affinities with Myanmar and Thailand while Nicobar has affinities with Indo-Mayan regions (Ekman, 1953).

MATERIALS AND METHODS

Moths were collected by light trap using white screen (85 W / 4U energy saving CFL Lamp) during September 2009 to August 2010 and eighteen nights were operated covering all the three seasons. The Portable Honda Generator was used for power supply. The species were identified in the field itself, the doubtful species were collected and brought to the laboratory for identification. The collection date and location concerning each specimen were recorded in the field note book. Specimens were pinned using different size of insect pins and were mounted on the insect setting boards. The details of the light trapping location and other details is presented in Table 1. The species were identified using Hampson, (1892, 1894, 1895 and 1896); Barlow (1982) and Holloway (1983, 1985, 1987, 1988, 1989, 1993, 1994, 1996, 1997, 2005) and species classification has been followed by van Nieukirken *et al.* (2011). Detail of the light trappinglocation in Ritchie's archipelago is presented in Table 4.1.

Table 4.1. Details of light trapping location in Ritchie's archipelago

Location name	Habitat type	Mean under story density (%)	Mean canopy cover (%)	Mean light-trap radius (m)	Number of nights
Site 1 : Haveock	Evergreen	54.5	88.2	78.0	3
Site 2: Havelock	Moist deciduous	57.3	83.8	82.1	3
Site 3: John Lawerence	Evergreen	86.4	93.9	48.0	3
Site 4: Inglis	Evergreen	90.7	69.7	48.0	3
Site 4: Neil	Plantation	70.5	59.0	60.0	3
Site 4: Neil	Plantation	75.0	50.0	65.0	3

RESULTS AND DISCUSSION

During the study period, a total of 394 individuals and 76 species belongs to 10 families were recorded (Table 4.2, Plate 6 & 7). The family names were arranged according to classification of van Nieukirken *et al.* (2011).

Table 4.2. List of moth species recorded in Ritchie's archipelago

Sl.No.	Family	Sub-family	Species name
1.	Thyrididae	Striglininae	*Striglina scitaria* (Walker, 1862)
2.	Pyralidae	Pyralinae	*Vitessa suradeva* Moore,1860
3.			*Maruca testulalis* Geyer
4.			*Xanthomelaena schematias* (Meyrick)
5.			*Telanga sexpunctalis* Moore
6.		Phycitinae	*Crocidophora ptyophora* Hampson,1896

Sl.No.	Family	Sub-family	Species name
7.	Crambidae	Pyraustinae	*Ostrinia furnacalis* Guenee,1854
8.		Spilomelinae	*Aetholix flavibasalis* (Guenee,1854)
9.			*Cnaphalocrocis medinalis* (Guenee,1854)
10.			*Diaphania actorionalis* Walker, 1859
11.			*Glyphodes caesalis* Walker,1859
12.			*Palpita nigropunctalis* (Bremer,1864)
13.			*Sisyrophora pfeifferae* Lederar,1863
14.			*Glyphodes picticostalis* Hampson,1896
15.			*Hymenia perspectalis* Hubner,1796
16.			*Spoladea recurvalis* (Fabricius,1775)
17.			*Lamprosema charesalis* Walker,1859
18.			*Psara licarsisalis* Walker, 1859
19.			*Rhimphalea ochalis* (Walker,1859)
20.			*Rhimphalea trogusalis* (Walke,1859)
21.			*Samea castoralis* (Walke,1859)
22.			*Sylepta derogata* (Fabricius,1775)
23.			*Sylepta lunalis* (Guenee,1854)
24.			*Talanga sexpunctalis* (Moore,1887)
25.			*Tetridia caletoralis* (Walker,1859)
26.			*Tyspanodes linealis* Moore,1867
27.			*Phostria maculicostalis* Hampson
28.	Drepanidae	Drepaninae	*Tridrepana fulvata* Snellen,1876
29.	Sphingidae	Smerithinae	*Marumba dyras dyras* Walker,1856
30.		Sphinginae	*Acherontia styx styx* Westwood,1847
31.			*Psilogramma menephron menephron* Cramer,1780
32.		Macroglossinae	*Angonyx testacea* Walker,1856
33.	Uraniidae	Uraniinae	*Lyssa patroclus* (Linnaeus,1758)
34.		Microniinae	*Acropteris obliquaria* Moore,1877
35.			*Micronia aculeata* (Guenee,1857)
36.	Geometridae	Ennominae	*Cleora alienaria* (Walker,1860)
37.			*Cleora injectaria* Walker, 1860
38.			*Hyposidra talaca* (Walker,1860)
39.			*Probithia exclusa* (Walker,1860)
40.			*Zeheba lucidata* (Walker,1862)
41.			*Heterostegane* sp.

Sl.No.	Family	Sub-family	Species name
42.		Geometrinae	*Aporandria specularia* (Guenee,1857)
43.			*Dysphania militaris* (Linnaeus,1758)
44.		Sterrhinae	*Perixera orbinaria* (Guenee,1858)
45.			*Antitrygodes divisaria* (Walker,1861)
46.	Notodontidae	Dudusinae	*Gangarides rosea* (Walker,1865)
47.	Erebidae	Lymantriinae	*Olene mendosa* Hubner,1823
48.			*Euproctis bimaculata* Walker,1855
49.			*Euproctis scintillans* (Walker,1856)
50.		Arctiinae	*Amata (Amata) cingulata* Weber,1801
51.			*Amata (Syntomis) wimberleyi* Swinhoe,1889
52.			*Eressa affinis* Moore,1877
53.			*Creatonotus gangis* (Linnaeus,1763)
54.			*Cyana amabilis* (Moore,1877)
55.			*Padenia duplicana* (Walker,1863)
56.			*Amerila astreaus* (Drury,1773)
57.			*Utethesia pulchelloides* Hampson,1907
58.		Aganainae	*Euplocia membliaria* Cramer-Stoll,1780
59.			*Asota caricae* (Fabricius,1775)
60.			*Peridroma orbicularis* (Walker,1854)
61.		Erebinae	*Amphigonia hepatizans* Guenee,1852
62.			*Erebus ephesperis* (Hubner,1827)
63.			*Ericeia eriophora* (Guenee,1852)
64.			*Lacera alope* (Cramer,1780)
65.			*Thyas coronata* (Fabricius,1775)
66.			*Eudocima fullonia* (Clerck,1764)
67.			*Parallelia arcuata* Moore,1877
68.			*Thermesia bolinoides* (Guene,1852)
69.			*Ischyja manlia* (Cramer,1766)
70.			*Sympis rufibasis* (Guenee,1852)
71.	Noctuidae	Plusiinae	*Chysodeixis eriosoma* (Doubleday, 1843)
72.		Amphipyrinae	*Chasmina candida* (Walker,1865)
73.			*Spodoptera litura* (Fabricius,1775)
74.			*Ercheia cyllaria* Cramer, 1780
75.		Agaristinae	*Sarbanissa albifascia* Walker,1865
76.		Hadeninae	*Callyna jugaria* Walker,1858

The highest number of species belongs to Erebidae (24, 31.57 per cent), followed by Crambidae (21, 27.63 per cent) and Geometridae (10, 13.15 per cent) and Noctuidae (6, 7.89). The number of species in each family and their percentage to the families were given in Fig. 4.1.

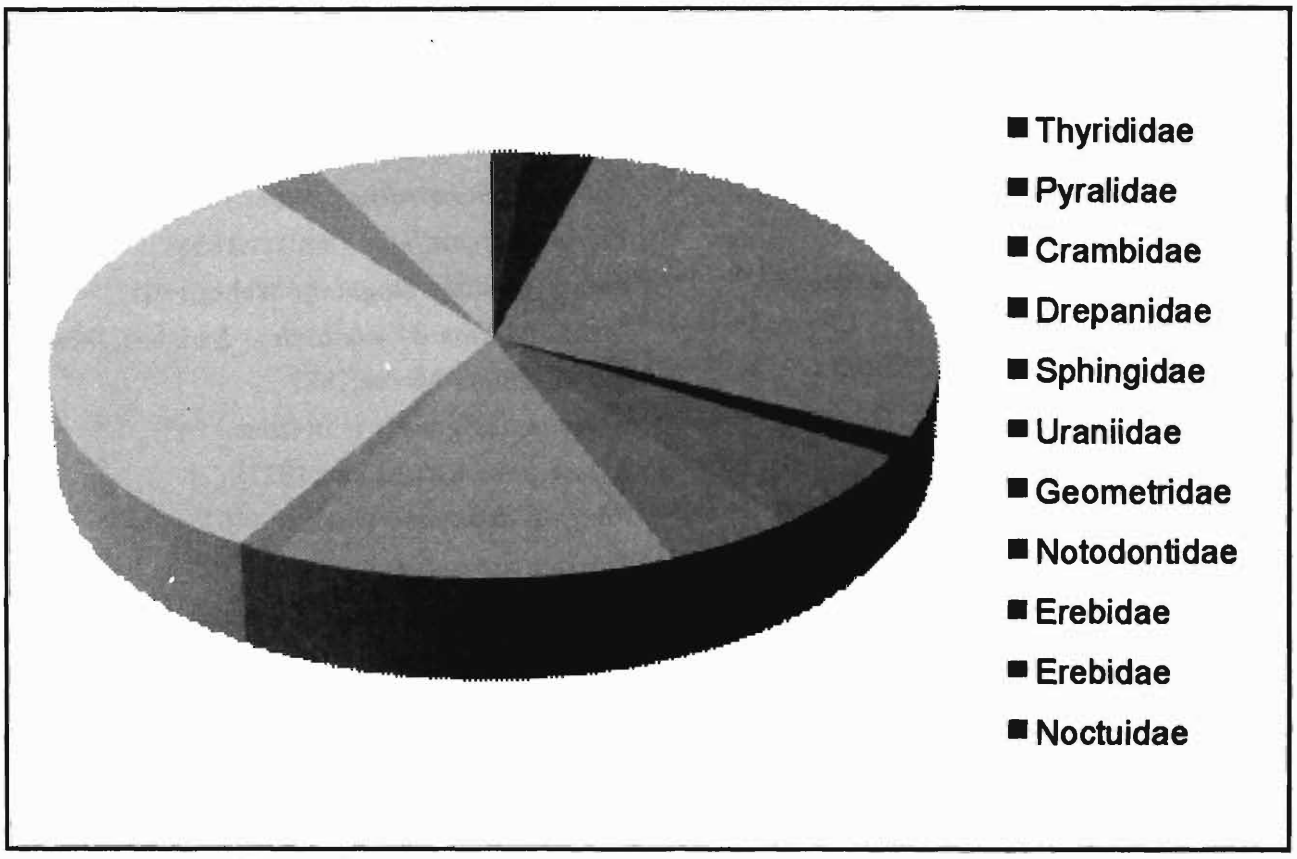

Fig. 4.1. Percentage of species recorded in Ritchie's archipelago

Among the collected species of moths, 11 species were considered as pests of forest trees, namely *Chysodeixis eriosoma, Aporandria specularia, Cleora alienaria, Hyposidra talaca, Trygodes divisaria, Utethesia pulchelloides, Dasychira mendosa, Sylepta derogata, Striglina scitaria, Acherontia styx styx* and *Hypsa ficus.* Of the recorded species, three species, namely *Amata (Syntomis) whimberleyi, Eressa affinis,* and *Cyana amabilis* are endemic to Andaman and Nicobar islands. Most of the species obtained were collected during post monsoon season. This was because post monsoon season is the most suitable season for the mating and regeneration activities of Lepidopteran adults. Comparisons of moth species of Baratang Islands with other places in India and other countries have been provided in Table 4.3. The number of species obtained through the light trapping shows that, this island is one of the diverse habitat in Andaman group of Islands. The relatively high diversity of moths at distributed in Ritchie's archipelago is probably due to the availability of secondary forests. This research analyzed the distribution and diversity of moths and this is the preliminary assessment of the moth fauna in Ritchie's archipelago. The samples were collected from only few locations more habitats remain unexplored, especially in the Outram and Henry Lawrence Islands, consequently it is expected that more species may be found in Ritchie's archipelago. Our results provide first hand information on the diversity and distribution of moth fauna of Ritchie's archipelago,

further studies should investigate the response of moths to different levels of disturbances, such as logging and plantations.

Table 4.3. Comparison of moths with area of India and other countries

Sl. No.	Name of the Island	Country	Number of species	Reference
1.	Great Nicobar	India	118	Chandra, 1996
4.	Madhya Pradesh	India	142	Chandra, 2007
5.	Chhattisgarh	India	58	Chandra, 2007
6.	Hong Kong	China	2200	Kendrick, 2007
7.	Bogildo Island	Korea	272	Park *et al.*, 2009
8.	Ritchie's archipelago	India	76	Present study

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AMPHIBIANS AND REPTILES

INTRODUCTION

Recent thrust on biodiversity conservation necessitates a comprehensive knowledge of the fauna, their distribution and abundance that are important prerequisites for the management of an area, especially the Wildlife Sanctuaries and National Parks. South Asia has a rich diversity of amphibian and reptilian fauna including several unique and endemic species (Shah and Tiwari, 2004). It appears that only about 50 per cent of the biodiversity of amphibians in South Asia has been discovered. However, there is increasing habitat loss and fragmentation, which are rapidly depleting amphibian populations. Very few species have been described from disturbed habitats, indicating a diminished species composition when compared with the original habitat (Molur, 2008).

The Andaman and Nicobar Islands in India has received considerable attention due to its faunistic and floristic diversity and high degree of endemism. In Andamans, so for 40 species of reptiles and 8 species of amphibians and in Nicobars, 47 species of reptiles and 10 species of amphibians were reported (Harikrishnan *et al.*, 2010). The herpetofauna is one of the least studied groups in these Islands. The primary colonization source for the herpetofauna of these islands is thought to be Myanmar for the Andamans and Thailand for the Nicobars (Biswas and Sanyal, 1980). The current state of knowledge on snake fauna of Nicobar Islands was obtained from the early works which includes collections, descriptions and reviews on the museum collections (Vijayakumar and David, 2006).

Studies on Indian herpetofauna are comparatively few. Edward Blyth published his "Notes on the Fauna of Nicobar Islands", in the erstwhile *Journal of Asiatic Society of Bengal* (Blyth, 1846). Most of the studies on the amphibians and reptiles are limited to surveys and new descriptions. Later, several studies have been conducted to listing the species. Tytler (1864) described a new species of Giant gecko *Gecko verreauxi* from Andaman. Stoliczka (1873) made the detailed collection and study of reptiles of Andaman and Nicobar Islands and reported 13 species of lizards, 10 species of snakes and three species of frogs. Smith (1940) listed 60 species of squamate reptiles from Andaman and Nicobar Islands. Biswas and Sanyal (1965) described a new species of wolf snake *Lycodon tiwarii*, from Andaman and Nicobar islands. Tiwari and Biswas (1973) described a new species of Agamid lizard *Calotes danieli* and a new species of snake, *Dendrelaphis humayuni* from Great Nicobar. Whitaker (1975) reported 35 species of snakes, 28 species of lizards and nine species of amphibians from Andaman and Nicobars. Pillai (1977) reported two species of Microhylid frogs from Andamans, including a new species *Microhyla chakrapanii.* Biswas and Sanyal (1977) described a new species of

tree skink *Dasia nicobarensis* from the island of Car Nicobar. Biswas and Sanyal (1978) described a new species of krait *Bungarus andamanensis* from Andaman. Biswas and Sanyal (1980) reported a collection of 29 reptiles from Andaman and Nicobar islands. Mansukhani and Sarkar (1980) described *"Bufo" camortensis* from Camorta in Nicobars. Murthy and Mehta and Rao (1987) reported *Microhyla heymonsi* Vogt, 1911 from Great Nicobar. Sarkar (1990) in his review listed nine species of Amphibians from Nicobars. Tiwari (1992) reported the sunbeam snake *Xenopeltis unicolor* Reinwardt, 1827 from Great Nicobar. Das (1994) listed 17 species of amphibians, 31 species of lizards and 39 species of snakes from Andaman and Nicobar Islands. Das and Chandra (1994) added two more species of snakes to the fauna; *Boiga cyaneum* (Dumeril and Bibron, 1864) from Great Nicobar and *Microcephalophis cantoris* Gunther, 1864 from Andaman. Das (1995) described a new tree frog, *Polypedates insularis* from Great Nicobar. Das (1996a) described a new species of Ranid frog, *Limnonectes shompenorum* and reported the presence of another frog *Hylarana chalconota* (Schlegel, 1837) from Great Nicobar (Das, 1996b). Das (1996d) revived *Dibamus nicobaricus* (Fitzinger in Steindachner, 1867) from the synonymy of *Dibamus leucrurus* (Bleeker, 1860) and considered the former as endemic to Nicobars. Daniels and David (1996) reported eight species of frogs, six species of lizards and six species of snakes from Great Nicobar. Das (1999) listed 40 species of squamate reptiles and 12 species of amphibians from Andamans and, 37 species of reptiles and 11 species of amphibians from Nicobars. Recently, Vijayakumar (2005) recorded 24 species of lizards, 14 species of snakes and 10 species of amphibians, including several suspected new species. Based on this survey and previous collections for which voucher specimens are available, Vijayakumar and David (2006) listed 22 species of snakes from Nicobar Islands.

MATERIALS AND METHODS

Random surveys were conducted in almost all parts of the study area to document the amphibian and reptile species. The streams and marshy areas were specially surveyed for amphibians. The calls during the night time helped to locate and collect amphibian species. Diurnal data were collected between dawn and mid day. Usually hand picking was employed for the collection of specimens. Night observations were made wherever possible. Collected specimens were preserved in 10% formaldehyde solution. The specimens were identified based on field guide and systematic reference (Boulenger, 1890; Smith, 1933, 1935 and 1943; Daniel, 1963a and b, 1975; Daniel and Sekar, 1989; Tikader and Sharma, 1992).

Quadrat sampling method was used for estimating abundance and diversity indices. Plots of 8 x 8m size were laid at random, ensuring adequate representations of all habitat types and altitudes. These plots were thoroughly searched by a team of three persons (Heyer *et al.*, 1984). Adequate time was spent in each plot to search the area completely. Amphibians and reptiles in the plot were identified in the field itself as far as possible.

RESULTS AND DISCUSSION

Occurrence of species

A total of 26 species of reptiles and amphibians belonging to 21 genera and 12 families were recorded during the period of study (Table 5.1 and 5.2, Plate 8). Highest number of reptiles were recorded from Havelock (15 species), followed by John Lawrence (14), Neil (13), Inglis (11), Outram and Henry Lawrence (10), North Button (8). Of the recorded species of amphibians, Havelock and Henry Lawrence Islands showed high species richness.

Table. 5.1. List of reptiles recorded in different in Ritchie's archipelago

Sl.No.	Species name	1	2	3	4	5	6	7
	Crocodilidae							
1.	*Crocodylus porosus* Schneider 1801	✓	✓		✓	✓	✓	
	Gekkonidae							
2.	*Cnemaspis kandianus* (Kelaart, 1852)	✓				✓	✓	
3.	*Cosymbotus platyurus* (Schneider, 1792)				✓		✓	
4.	*Gecko gecko* (Linnaeus, 1758)	✓	✓		✓		✓	✓
5.	*Gecko verreauxi* (Tytler, 1865)	✓			✓		✓	
6.	*Hemidactylus frenatus* (Dumeril & Bibron, 1836)	✓	✓	✓	✓	✓	✓	✓
7.	*Phelsuma andamanense* (Blyth, 1860)	✓	✓	✓		✓	✓	
	Agamidae							
8.	*Calotes andamanensis* (Boulenger, 1891)	✓	✓	✓				
9.	*Calotes emma alticristatus* (Schmidt, 1845)		✓			✓		
10.	*Calotes mystaceus* (Dumeril & Bibron, 1837)		✓	✓		✓		
11.	*Coryphophylax* subcristatus (Blyth, 1860)	✓	✓	✓	✓	✓		✓
12.	*Calotes versicolor* (Daudin, 1802)	✓	✓	✓	✓	✓	✓	✓
	Scincidae							
13.	*Dasia olivacea* (Gray, 1838)		✓					✓
14.	*Eutropis andamanensis* (Smith, 1935)	✓	✓	✓	✓	✓	✓	✓
15.	*Eutropis tytleri* (Theobald, 1868)	✓		✓		✓		
	Varanidae							
16.	*Varanus salvator* (Laurenti, 1768)					✓		
	Typhlopidae							
17.	*Ramphotyphlops braminus* (Daudin, 1803)		✓	✓				
18.	*Typhlops andamanensis* (Laurenti, 1768)		✓		✓	✓		✓
	Colubridae							
19.	*Dendrelaphis pictus andamanensis* (Anderson, 1871)		✓			✓		
	Elapidae							
20.	*Bungarus andamanensis* (Biswas & Sanyal, 1978)		✓			✓		
21.	*Ophiophagus hannah* (Cantor, 1836)	✓				✓		
22.	*Naja sagittifera* (Wall, 1913)	✓		✓	✓		✓	
	Viperidae							
23.	*Trimeresurus purpureomaculatus andersoni* (Theobald, 1868)	✓	✓	✓	✓		✓	✓

(1 - Neil; 2 - Havelock; 3 - Inglis; 4 - Outram; 5 - John Lawrence; 6 - Henry Lawrence; 7 - North Button)

Table. 5.2. List of amphibians recorded in different in Ritchie's archipelago

Sl.No.	Species name	1	2	3	4	5	6	7
	Dicroglossidae							
1.	*Fejervarya andamanensis* (Stolicka, 1870)	✓	✓	-	✓	-	✓	✓
	Ranidae							
2.	*Limnonectus limnocharis* (Boie, 1994)	-	✓	✓	-	✓	✓	✓
	Bufonidae							
3.	*Duttaphrynus melanostictus* (Schneider, 1799)	✓	✓	✓	✓	✓	✓	✓

(1 - Neil; 2 - Havelock; 3 - Inglis; 4 - Outram; 5 - John Lawrence; 6 - Henry Lawrence; 7 - North Button)

Our results show that the diversity and distribution of reptiles and amphibians in particular, and the herpetofauna in general, followed similar trends at different Islands. Of the recorded species, only four were observed from all locations namely *Hemidactylus frenatus*, *Calotes versicolur, Eutropis andamanensis* and *Duttaphrynus melanostictus*. The species like *Copsymbotus platyurus, Calotes emma alticristatus, Dasia olivacea, Varanus salvator, Ramphotyphlops braminus, Dendrelaphis pictus andamanensis, Bungarus andamanensis,* and *Ophiophagus hannah* were recorded only in one or two more sites. The reason for significantly greater species diversity and higher species richness of reptiles in the Havelock and John Lawrence is that the both areas are covered with evergreen forest and presence of different microhabitats. Among the islands studied, the Havelock Island and Neil Island are facing more problems. The road networks were major disturbance factors in these areas. Accidental killings of reptiles and amphibians along the road were observed and annual clearings of road edges were also noticed.

Most of the animals were found on the low vegetation, below 1 m and under debris of the forest floor. Few animals were found on high vegetation, which is comparable with the study of Minh (2005). The Ritchie's archipelago reptiles and amphibian fauna suggest that the Andaman and Nicobar Islands fauna has closer biogeographic affinities with the south-east Asian one than to the Indian fauna. The herpetofauna of the Ritchie's archipelago is subject to the anthropogenic pressures similar to other parts of the world (Tompson, 2001; Wilson and McCranie, 2004a, b). The herpetofauna still faces considerable pressures due to increasing population pressure and other developmental activities.

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AVIFAUNA

INTRODUCTION

The community studies have been largely expressed in terms of species richness, abundance, density and diversity. All these components have been used as indicators of habitat quality, because an increase in the value of the components is generally thought to reflect larger amounts of the necessary resources to sustain larger population within a given area. The quantitative information on abundance of bird species in different habitats is necessary for solving many fascinating ecological issues. Through monitoring, it might be possible to identify long-term population trends by determining the magnitude of annual population fluctuations (USFWS, 1988).

Birds possess great intrinsic interest, they are certainly among the most population of all wildlife groups. Moreover, it is widely recognised that birds can act as valuable indicators of the quantity and quality for wildlife. The studies on avian communities attracted great attention over the past several years all over the world. Much of the early efforts emphasized on the patterns and processes in the avian communities and the listing of species. Previous workers mainly concentrated on the narrow perspectives and focused on single variables, but the recent studies have emphasised the necessity of multi-scale, multi-factor approaches and the inclusion of both short-term and long-term temporal variables. The difficulties of assessing numerous variables and several scales, both temporal and spatial, seem to have discouraged the contemporary ecologists from embarking on studies on avian communities.

Monitoring in the conventional sense of detecting change in population parameters over both short term and long term periods, can help to identify bird communities or species undergoing important population change, can contribute to the setting of habitat objectives, and serves as a tool for evaluating conservation and management actions. The structure and composition of bird communities are known to vary in different vegetations types (Wiens, 1989). The pioneering attempt has been made by MacArthur and MacArthur (1961) to assess the relationship between bird diversity and vegetation structure. Information on abundance, distribution, ecology, and management for bird species in Ritchie's archipelago is scanty. Such information is important to gain reliable knowledge of species status and distribution and has important management implications (Sutherland, 1996). The aim of this study is to address the topic of site-focused monitoring in detail, to meet the needs of a variety of users, from amateur to professional.

STUDIES IN ANDAMAN AND NICOBAR ISLANDS

The study on birds in the Andaman & Nicobar Islands has been initiated by Beavan (1867) listing the avifauna of Andaman Islands followed by Hume (1873, 1874 a, b, 1876). Many researchers have listed the birds of Andaman & Nicobar Islands and few studies on individual species *e.g.* Nicobar Magapode (Sankaran, 1995a), Andaman Teal (Vijayan, 1996), Edible-Nest Swiftlets (Sankaran, 2001), Narcondam Hornbill (Yahya and Zarri, 2003). Only, a few of studies have been conducted on the community ecology. Although considerable amount of general information is available on the avifauna of Andaman and Nicobar Islands, quantitative studies on avian communities of Ritchie's archipelago are entirely lacking. Therefore, the following objectives were formulated to address the lack of information about this resource in order to document the status, distribution, abundance and relative density of avifauna.

MATERIALS AND METHODS

The study was conducted from 2008 through 2011 and it was mainly based on direct observational methods (Altman, 1974). The whole area was surveyed on foot, vehicle and boot and all the important areas were visited. Line transect and point count methods were used to census the birds (Burnham *et al.*, 1980) The census was conducted from 07.00 to 10.00 hour. Birds were identified based on physical features with the help of field guides and reference books (Ali and Ripley, 1983; Grimmett *et al.*, 1999). Birds were classified as migratory and resident species based on the occurrence data and published literature. Globally threatened species of birds were identified based on BirdLife International (2001). Feeding and guild composition were collected from the available literature (Ali and Ripley, 1983). Bird species have been categorised as aquatic feeders, insectivores, granivores, nectar-frugivores, carnivores, frugivores and omnivores.

RESULTS

Occurrence of species

During the present study, a total of 136 species of birds belong to 15 orders and 40 families were recorded in Ritchie's archipelago. Out of these 85 (62.5 per cent) were residents, 27 (19.8 per cent) resident migrants and 24 (17.6 per cent) migrant (Table 6.1, Plate 9, 10 & 11).

Table 6.1. Species of birds recorded from Ritchie's archipelago

Sl.No.	Common Name	Scientific Name	Status
	Ciconiiformes **Ardeidae**		
1.	Little Egret	*Egretta garzetta* (Linnaeus)	R
2.	Pacific Reef-Egret	*Egretta sacra* (Gmelin)	R
3.	Great-billed Heron	*Areda sumatrana* Raffles	V
4.	Purple Heron	*Ardea purpurea* Linnaeus	R
5.	Grey Heron	*Ardea cinerea* Linnaeus	R

Sl.No.	Common Name	Scientific Name	Status
6.	Large Egret	*Casmerodius albus* (Linnaeus)	R
7.	Median Egret	*Mesophoyx intermedia* (Wagler)	R
8.	Cattle Egret	*Bubulcus ibis* (Linnaeus)	R
9.	Indian Pond-Heron	*Ardeola grayii* (Sykes)	R
10.	Yellow Bittern	*Ixobrychus sinensis* (Gmelin)	R
	Anseriformes		
	Anatidae		
11.	Cotton Teal	*Nettapus coromandelianus* (Gmelin)	R
12.	Andaman Teal	*Anas gibberifrons* (Muller)	R
	Falconiformes		
	Accipitridae		
13.	Andaman Blackcrested Baza	*Aviceda leuphotes andamanica* Abdulali	R
14.	Black Kite	*Milvus migrans* (Boddaert)	R
15.	Brahminy Kite	*Haliastur indus* (Boddaert)	R
16.	White-bellied Sea-Eagle	*Haliaeetus leucogaster* (Gmelin)	R
17.	Greater Grey-headed Fish Eagle	*Ichthyophaga ichthyaetus* (Horsfield)	R
18.	Crested Serpent-Eagle	*Spilornis cheela davisoni* Hume	R
19.	Western Marsh-Harrier	*Circus aeruginosus* (Linnaeus)	M
20.	Shikra	*Accipiter badius* (Richmond)	R
21.	Eurasian Sparrowhawk	*Accipiter nisus* (Linnaeus)	M
22.	Changeable Hawk-Eagle	*Spizaetus cirrhatus andamensis* (Gmelin)	R
	Galliformes		
	Phasianidae		
23.	Grey Francolin	*Francolinus pondicerianus* (Gmelin)	R
	Gruiformes		
	Rallidae		
24.	Blue-breasted Rail	*Gallirallus striatus* Linnaeus	R
25.	Andaman White-breasted Waterhen	*Amaurornis phoenicurus* (Pennant)	R
26.	Water Cock	*Gallicrex cinerea* (Gmelin)	R
27.	Purple Moorhen	*Porphyrio porphyrio* (Linnaeus)	R

Sl.No.	Common Name	Scientific Name	Status
28.	Common Moorhen	*Gallinula chloropus* (Linnaeus)	RM
	Charadriiformes		
	Charadriidae		
29.	Pacific Golden-Plover	*Pluvialis fulva* (Gmelin)	M
30.	Little Ringed Plover	*Charadrius dubius* Scopoli	RM
31.	Lesser Sand Plover	*Charadrius mongolus* Pallas	RM
32.	Kentish Plover	*Charadrius alexandrinus* Linnaeus	M
	Scolopacidae		
33.	Pintail Snipe	*Gallinago stenura* (Bonaparte)	M
34.	Jack Snipe	*Lymnocryptes minimus* (Brunnich)	M
35.	Bar-tailed Godwit	*Limosa lapponica* (Linnaeus)	M
36.	Whimbrel	*Numenius phaeopus phaeopus* (Linnaeus)	M
37.	Eurasian Curlew	*Numenius arauata* (Linnaeus)	M
38.	Common Redshank	*Tringa totanus* (Linnaeus)	M
39.	Common Greenshank	*Tringa nebularia* (Gunner)	M
40.	Green Sandpiper	*Tringa ochropus* Linnaeus	M
41.	Wood Sandpiper	*Tringa glareola* Linnaeus	M
42.	Common Sandpiper	*Actitis hypoleucos* Linnaeus	M
43.	Ruddy Turnstone	*Arenaria interpres* (Linnaeus)	M
44.	Great Knot	*Calidris tenuirostris* (Horsfield)	M
45.	Little Stint	*Calidris minuta* (Leisler)	M
	Burhinidae		
46.	Beach Stone-Plover	*Esacus neglectus* (Vieillot)	R
	Laridae		
47.	Gull-billed Tern	*Gelochelidon nilotica* (Gmelin)	M
48.	Black-naped Tern	*Sterna sumatrana* Raffles	R
49.	Lesser Crested Tern	*Sterna bengalensis* Lesson	R
50.	White-winged Black Tern	*Chlidonias leucopterus* (Temminck)	M
	Colimbiformes		
	Columbidae		
51.	Blue Rock Pigeon	*Columba livia* Gmelin	R
52.	Andaman Wood-Pigeon	*Columba palumboides* (Hume)	R
53.	Red Collared-Dove	*Streptopelia tranquebarica* (Hermann)	R

Sl.No.	Common Name	Scientific Name	Status
54.	Spotted Dove	*Streptopelia chinensis* (Scopoli)	R
55.	Little Brown Dove	*Streptopelia senegalensis* (Linnaeus)	R
56.	Andaman Cuckoo-Dove	*Macropygia rufipennis andamanica* Abdulali	R
57.	Emerald Dove	*Chalcophaps indica* (Linnaeus)	R
58.	Nicobar Pigeon	*Caloenas nicobarica* (Linnaeus)	R
59.	Pompadour Green-Pigeon	*Treron pompadora chlorptera* Blyth	R
60.	Andaman Green Imperial-Pigeon	*Ducula aenea andamanica* Abdulali	R
	Psittaciformes		
	Psittacidae		
61.	Vernal Hanging-Parrot	*Loriculus vernalis* (Sparrman)	R
62.	Alexandrina Parakeet	*Psittacula eupatria* (Linnaeus)	R
63.	Red-breasted Parakeet	*Psittacula alexandri* (Linnaeus)	R
64.	Red-cheeked Parakeet	*Psittacula longicauda* (Boddaert)	R
	Cuculiformes		
	Cuculidae		
65.	Brainfever Bird	*Hierococcyx varius* (Vahl)	R
66.	Common Cuckoo	*Cuculus canorus* Linnaeus	RM
67.	Oriental Cuckoo	*Cuculus saturatus* Blyth	RM
68.	Asian Koel	*Eudynamys scolopacea* (Linnaeus)	R
69.	Andaman Coucal	*Centropus andamanensis* Beavan	R
70.	Drongo Cuckoo	*Surniculus lugubris* (Horsfield)	R
	Strigiformes		
	Tytonidae		
71.	Andaman Barn Owl	*Tyto alba* (Scopoli)	R
	Caprimulgiformes		
	Caprimulgidae		
72.	Indian Jungle Nightjar	*Caprimulgus indicus* Latham	R
73.	Large-tailed Nightjar	*Caprimulgus macrurus* Horsfield	R
	Apodiformes		
	Apodidae		
74.	White-bellied Swiftlet	*Collocalia esculenta* (Linnaeus)	R
75.	Common Edible-nest		

Sl.No.	Common Name	Scientific Name	Status
	Swiftlet	*Collocalia fuciphaga* Thunberg	R
76.	Brown-back Needletail-Swift	*Hirundapus giganteus* (Temminck)	R
77.	Common Swift	*Apus apus* (Linnaeus)	M
	Coraciformes		
	Alcedinidae		
78.	Small Blue Kingfisher	*Alcedo atthis* (Linnaeus)	R
79.	Blue-eared Kingfisher	*Alcedo meninting* Horsfield	R
80.	Stork-billed Kingfisher	*Halcyon capensis* (Linnaeus)	R
81.	White-breasted Kingfisher	*Halcyon smyrnensis* (Linnaeus)	R
82.	Black-capped Kingfisher	*Halcyon pileata* (Boddaert)	R
83.	Andaman Collared Kingfisher	*Halcyon chloris davisoni* Sharpe	R
	Meropidae		
84.	Blue-tailed Bee-eater	*Merops philippinus* Linnaeus	RM
85.	Chestnut-headed Bee-eater	*Merops leschenaultia* Vieillot	R
86.	Small Bee-eater	*Merops orientalis* Latham	R
	Coraciidae		
87.	Oriental Broad-billed Roller	*Eurystomus orientalis* (Linnaeus)	R
	Piciformes		
	Picidae		
88.	Fulvus-breasted Pied Woodpecker	*Dendrocopos macei* (Vieillot)	R
89.	Andaman Black Woodpecker	*Dryocopus hodgei* (Blyth)	R
	Passeriformes		
	Hirundinidae		
90.	House Swallow	*Hirundo tahitica* Gmelin	R
91.	Red-rumped Swallow	*Hirundo daurica* Linnaeus	R
	Motacillidae		
92.	Forest Wagtail	*Dendronanthus indicus* (Gmelin)	RM
93.	Large Pied Wagtail	*Motacilla maderaspatensis* Gmelin	R

Sl.No.	Common Name	Scientific Name	Status
94.	Yellow Wagtail	*Motacilla flava* Linnaeus	R
95.	Grey Wagtail	*Motacilla cinerea* Tunstall	M
	Campephagidae		
96.	Large Cuckoo-Shrike	*Coracina macei* (Lesson)	R
97.	Bar-bellied Cuckoo-Shrike	*Coracina striata* (Boddaert)	R
98.	Pied Triller	*Lalage nigra* (Forster)	R
99.	Small Minivet	*Pericrocotus cinnamomeus* (Linnaeus)	R
100.	Scarlet Minivet	*Pericrocotus flammeus* (Forster)	R
	Pycnonotidae		
101.	Red-whiskered Bulbul	*Pycnonotus jocosus* (Linnaeus)	R
102.	Andaman Bulbul	*Pycnonotus atriceps fuscoflavescens* Temminck	R
	Irenidae		
103.	Asian Fairy-Bluebird	*Irena puella* (Latham)	R
	Lanidae		
104.	Brown Shrike	*Lanius cristatus* Linnaeus	M
105.	Philippine Shrike	*Lanius cristatus lucionensis* Linnaeus	M
	Turdinae		
106.	Orange-headed Thrush	*Zoothera citrina* (Latham)	R
107.	Andaman Ground Thrush	*Zoothera citrina andamanensis* (Walden)	R
108.	Oriental Magpie-Robin	*Copsychus saularis* (Linnaeus)	R
109.	Andaman Shama	*Copyschus albiventris* Blyth	R
	Sylviinae		
110.	Streaked Fantail-Warbler	*Cisticola juncidis* (Rafinesque)	R
111.	Thick-billed Warbler	*Acrocephalus aedon* (Pallas)	M
112.	Grenish Leaf-Warbler	*Phylloscopus trochiloides* (Sundevall)	M
	Muscicapinae		
113.	Asian Brown Flycatcher	*Muscicapa dauurica* Pallas	RM
	Monarchinae		
114.	Asian Paradise-Flycatcher	*Terpsiphone paradisi* (Linnaeus)	RM
115.	Blacknaped Monarch-Flycatcher	*Hypothymis azurea* (Boddaert)	R
	Dicaeidae		
116.	Plain Flowerpecker	*Dicaeum concolor* Jerdon	R

Sl.No.	Common Name	Scientific Name	Status
117.	Andaman Flowerpecker	*Dicaeum concolor virescens* (Jerdon)	R
	Nectariniidae		
118.	Olive-backed Sunbird	*Nectarinia jugularis andamanica* Linnaeus	R
119.	Crimson Sunbird	*Aethopyga siparaja* (Raffles)	R
	Zosteropidae		
120.	Oriental White-eye	*Zosterops palpebrosus* (Temminck)	R
	Estrildidae		
121.	White-rumped Munia	*Loncghura striata* (Linnaeus)	R
122.	Black-headed Munia	*Lonchura malacca* (Linnaeus)	R
	Passerinae		
123.	House Sparrow	*Passer domesticus* (Linnaeus)	R
	Sturnidae		
124.	Asian Glossy Starling	*Aplonis panayensis* (Scopoli)	R
125.	White-headed Starling	*Sturnus erythropygius* (Blyth)	R
126.	Common Myna	*Acridotheres tristis* (Linnaeus)	R
127.	Common Hill-Myna	*Gracula religiosa* Linnaeus	R
	Oriolidae		
128.	Eurasian Golden Oriole	*Oriolus oriolus* (Linnaeus)	RM
129.	Andaman Black-naped Oriole	*Oriolus chinensis andamansis* Tytler	R
	Dicruridae		
130.	Crow-billed Drongo	*Dicrurus annectans* (Hodgson)	R
131.	Ashy Drongo	*Dicrurus leucophaeus* Vieillot	RM
132.	Large Andaman Drongo	*Dicrurus andamanensis dicruriformes* (Hume)	R
133.	Greater Racket-tailed Drongo	*Dicrurus paradiseus* (Linnaeus)	R
	Artamidae		
134.	White-breasted Woodswallow	*Artamus leucorynchus* (Linnaeus)	R
	Corvidae		
135.	Andaman Treepie	*Dendrocitta bayleyi* Tytler	R
136.	Jungle Crow	*Corvus macrothynchos* Wagler	R

R = Residents, RM = Local migrants, M = Trans-continental migrants

Migratory species

Total of twenty four species of migratory were species recorded during the study period (Table 6.2). Of these, Common Redshank, Wood Sandpiper, Common Sandpiper, Pacific Golden-Plover and Eurasian Curlew were most common species observed in these islands.

Table 6.2. List of migratory species recorded in the study area

Sl.No.	Common Name	Scientific Name
1.	Western Marsh-Harrier	*Circus aeruginosus* (Linnaeus)
2.	Eurasian Sparrowhawk	*Accipiter nisus* (Linnaeus)
3.	Pacific Golden-Plover	*Pluvialis fulva* (Gmelin)
4.	Pintail Snipe	*Gallinago stenura* (Bonaparte)
5.	Jack Snipe	*Lymnocryptes minimus* (Brunnich)
6.	Bar-tailed Godwit	*Limosa lapponica* (Linnaeus)
7.	Whimbrel	*Numenius phaeopus phaeopus* (Linnaeus)
8.	Eurasian Curlew	*Numenius arauata* (Linnaeus)
9.	Common Redshank	*Tringa totanus* (Linnaeus)
10.	Common Greenshank	*Tringa nebularia* (Gunner)
11.	Green Sandpiper	*Tringa ochropus* Linnaeus
12.	Wood Sandpiper	*Tringa glareola* Linnaeus
13.	Common Sandpiper	*Actitis hypoleucos* Linnaeus
14.	Ruddy Turnstone	*Arenaria interpres* (Linnaeus)
15.	Great Knot	*Calidris tenuirostris* (Horsfield)
16.	Little Stint	*Calidris minuta* (Leisler)
17.	White-winged Black Tern	*Chlidonias leucopterus* (Temminck)
18.	Common Swift	*Apus apus* (Linnaeus)
19.	Grey Wagtail	*Motacilla cinerea* Tunstall
20.	Brown Shrike	*Lanius cristatus* Linnaeus
21.	Philippine Shrike	*Lanius cristatus lucionensis* Linnaeus
22.	Orange-headed Thrush	*Zoothera citrina* (Latham)
23.	Thick-billed Warbler	*Acrocephalus aedon* (Pallas)
24.	Grenish Leaf-Warbler	*Phylloscopus trochiloides* (Sundevall)

Wader

Waders constitute an important group of wetland species. These birds depend heavily on shallow waters and mud flats, usually recorded from September onwards in the Ritchie's archipelago. Details on the occurrence of waders in the Ritchie's archipelago are presented in Table 6.3. The Little Ringed Plover (*Charadrius dubius*), Lesser Sand Plover (*Charadrius*

mongolus), Whimbrel (*Numenius phaeopus phaeopus*), Common Redshank (*Tringa tetanus*), Wood Sandpiper (*Tringa glareola*), Common Sandpiper (*Actitis hypoleucos*) Beach Stone-Plover (*Esacus magnirostris*), Black-naped Tern (*Sterna sumatrana*), Lesser Crested Tern (*Sterna bengalensis*) and White-winged Black Tern (*Chlidonias leucopterus*) were the most common waders in Ritchie's archipelago

Table 6.3. List of waders recorded in the study area

Sl.No.	Common Name	Scientific Name
	Charadriiformes	
	Charadriidae	
1.	Pacific Golden-Plover	*Pluvialis fulva* (Gmelin)
2.	Little Ringed Plover	*Charadrius dubius* Scopoli
3.	Lesser Sand Plover	*Charadrius mongolus* Pallas
4.	Kentish Plover	*Charadrius alexandrinus* Linnaeus
	Scolopacidae	
5.	Pintail Snipe	*Gallinago stenura* (Bonaparte)
6.	Jack Snipe	*Lymnocryptes minimus* (Brunnich)
7.	Bar-tailed Godwit	*Limosa lapponica* (Linnaeus)
8.	Whimbrel	*Numenius phaeopus phaeopus* (Linnaeus)
9.	Eurasian Curlew	*Numenius arauata* (Linnaeus)
10.	Common Redshank	*Tringa totanus* (Linnaeus)
11.	Common Greenshank	*Tringa nebularia* (Gunner)
12.	Green Sandpiper	*Tringa ochropus* Linnaeus
13.	Wood Sandpiper	*Tringa glareola* Linnaeus
14.	Common Sandpiper	*Actitis hypoleucos* Linnaeus
15.	Ruddy Turnstone	*Arenaria interpres* (Linnaeus)
16.	Great Knot	*Calidris tenuirostris* (Horsfield)
17.	Little Stint	*Calidris minuta* (Leisler)
	Burhinidae	
18.	Beach Stone-Plover	*Esacus magnirostris* (Vieillot)
	Laridae	
19.	Gull-billed Tern	*Gelochelidon nilotica* (Gmelin)
20.	Black-naped Tern	*Sterna sumatrana* Raffles
21.	Lesser Crested Tern	*Sterna bengalensis* Lesson
22.	White-winged Black Tern	*Chlidonias leucopterus* (Temminck)

Order wise classification and feeding guild composition of bird species

The order wise classification of avian species observed in Ritchie's archipelago is given in Table 6.4. The Order Passeriformes had the highest percentage (34.5 per cent) of species followed by Charadriiformes (16.2 per cent) and Ciconiiformes (14.7 per cent). Feeding guild analysis showed that majority of species were aquatic feeders (31.6 per cent) followed by Insectivores (27.9 per cent) and Omnivores (16.9 per cent) (Table 6.4).

Table 6.4. Order wise classification and feeding guild composition of bird species recorded from the Ritchie's archipelago

Sl.No.	Order	Status			Feeding guilds						
		R	M	Total	A	I	G	N/F	C	F	O
1.	Ciconiiformes	10	-	20	10	-	-	-	-	-	-
2.	Anseriformes	02	-	02	2	-	-	-	-	-	-
3.	Falconiformes	08	02	10	-	-	-	-	10	-	-
4.	Galliformes	01	-	01	-	-	-	-	-	-	1
5.	Gruiformes	05	-	05	3	-	-	-	-	-	2
6.	Charadriiformes	05	17	22	22	-	-	-	-	-	-
7.	Columbiformes	10	-	10	-	-	4	-	-	3	3
8.	Psittaciformes	04	-	04	-	-	-	-	-	4	-
9.	Cuculiformes	06	-	06	-	-	-	-	-	-	6
10.	Strigiformes	01	-	01	-	-	-	-	1	-	-
11.	Caprimulgiformes	02	-	02	-	2	-	-	-	-	-
12.	Apodiformes	03	01	04	-	4	-	-	-	-	-
13.	Coraciiformes	10	-	10	6	4	-	-	-	-	-
14.	Piciformes	02	-	02	-	2	-	-	-	-	-
15.	Passeriformes	42	05	47	-	26	3	5	-	2	11
	Total	**111**	**25**	**136**	**43**	**38**	**7**	**5**	**11**	**9**	**23**

Comparative occurrence of bird species

A comparison of number of bird species recorded from the Ritchie's archipelago with those from Andaman and Nicobar Islands, India, Asia and World is given in Table 6.5.

Table 6.5. Comparative occurrence of bird species in the Ritchie's archipelago

Sl.No.	Order and Family	World[1]	Asia[1]	India[2]	A & N Islands[3]	Ritchie's Archipelago*
1.	**Ciconiiformes**					
	Ardeidae	65	33	20	15	10
2.	**Anseriformes**					
	Anatidae	158	81	41	7	2
3.	**Falconiformes**					
	Accipitridae	235	103	56	22	10
4.	**Galliformes**					
	Phasianidae	181	124	44	3	1
5.	**Gruiformes**					
	Rallidae	130	45	17	9	5
6.	**Charadriiformes**					
	Charadriidae	66	32	19	8	4
	Scolopacidae	89	72	42	24	13
	Burhinidae	9	5	3	1	1
	Laridae	99	65	32	10	4
7.	**Columbiformes**					
	Columbidae	311	142	29	16	10
8.	**Psittaciformes**					
	Psittacidae	329	105	12	6	4
9.	**Cuculiformes**					
	Cuculidae	140	74	22	11	6
10.	**Strigiformes**					
	Tytonidae	18	9	3	1	1
11.	**Caprimulgiformes**					
	Caprimulgidae	86	21	8	2	2
12.	**Apoidiformes**					
	Apodidae	93	34	5	6	4
13.	**Coraciformes**					
	Alcedinidae	92	59	12	10	6

Sl.No.	Order and Family	World[1]	Asia[1]	India[2]	A & N Islands[3]	Ritchie's Archipelago*
	Meropidae	26	11	6	2	2
	Coraciidae	12	9	3	1	1
14.	**Piciformes**					
	Picidae	216	63	33	3	2
15.	**Passeriformes**					
	Hirundinidae	100	24	15	3	2
	Motacillidae	62	27	19	11	4
	Capephagidae	92	58	14	6	5
	Pycnonotidae	134	62	18	3	2
	Irenidae	2	2	1	1	1
	Lanidae	30	16	9	3	2
	Turdinae	173	73	34	12	4
	Sylviinae	271	154	80	13	3
	Muscicapinae	276	171	90	4	1
	Monarchinae	89	38	2	2	2
	Dicaeidae	48	40	8	1	2
	Nectariniidae	123	44	14	4	2
	Zosteropidae	125	45	1	1	1
	Estrildidae	143	41	8	2	2
	Passerinae	42	22	11	1	1
	Sturnidae	68	49	18	10	4
	Oriolidae	32	21	5	4	2
	Dicrurudae	26	13	9	7	4
	Artamidae	46	11	2	2	1
	Corvidae	115	53	21	3	2

1 - Gill and Donsker (2012); 2 - Ali and Ripley (1983); 3 - Tikader, 1984; 4 – Present study

Endemic and globally threatened species

Out of the 20 species of birds, which are endemic to Andaman Islands (Jathar and Rahmani, 2006), 13 species were recorded in Ritchie's archipelago. According to BirdLife International (2001), one hundred and twenty nine threatened bird species occur in India, of these 5 species were recorded from the Ritchie's archipelago (Table 6.6).

Table 6.6. Comparison of bird species with different country/region in Southeast Asia

Country / region	Number of species	Number of Endemic	Number of Globally Threatened species	Number of Introduced species
Myanmar	1079	5	51	2
Loas	706	1	27	2
Vietnam	856	19	43	3
Cambodia	554	2	26	1
Thailand	1011	1	53	1
Malaysian Borneo	555	6	24	2
Malay Peninsula	685	2	34	4
Brunei	456	-	25	1
Singapore	390	-	16	17
Philippines	638	206	69	5
Mindanao	286	35	24	-
Indonesia	1663	421	123	6
Greater Sundas	1020	153	73	3
Sumatra	718	29	39	4
Kalimantan	540	1	27	1
Java and Bali	539	32	23	2
Sulawesi	477	102	25	2
Lesser Sunda	563	82	25	2
Maluku Islands	642	89	30	7
Irian Jaya	697	18	23	2
Andaman & Nicobar Islands	284	28	15	4
Ritchie's archipelago	136	13	05	02

Comparison of bird species with different archipelago

Number of species recorded from different archipelago is presented in Table 6.7.

Table 6.7. Comparison of bird species with different archipelago

Name of the Archipelago	Number of species	Number of Endemic	Number of Globally Threatened species	Number of Introduced species
Mentawai	227	1	6	-
Sumatra	718	28	39	4
Nias	216	-	4	-
Java and Bali	539	32	23	2
Sulawesi	477	102	25	2
Sula	76	6	1	-
Raja Ampat	259	1	6	1
Sariga	202	-	2	-
Ritchie's	136	13	05	02

Species richness and abundance birds

Species richness of birds varied in different islands in the study area. Highest number of species richness and abundance was recorded at Havelock Islands followed by Neil Island (Fig. 6.1).

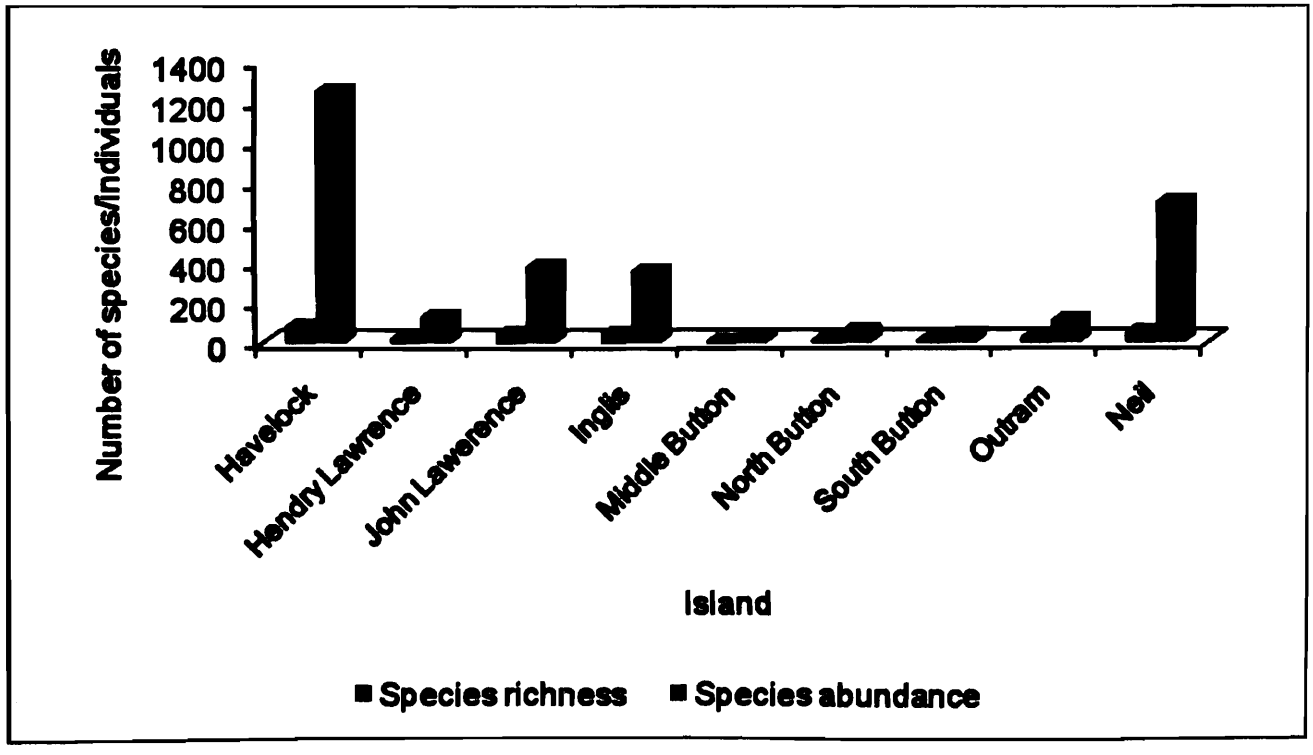

Fig. 6.1. Species richness and abundance birds in different islands in Ritchie's archipelago

DISCUSSION

The abundance and distribution of bird species in Ritchie's archipelago have been examined and the results of this study support that this area represents a unique and important habitat type. During the period of study 4063 individuals were sighted. Out of these 25 were transcontinental migrants. Species like Common Hill Myna (*Gracula religiosa*), White-bellied Sea-Eagle (*Haliaeetus leucogaster*), Andaman Wood-Pigeon (*Columba palumboides*), Andaman Green Imperial-Pigeon (*Ducula aenea andamanica*), Red-breasted Parakeet (*Psittacula alexandri*), Red-cheeked Parakeet (*Psittacula longicauda*), Black-capped Kingfisher (*Halcyon pileata*), White-headed Starling (*Sturnus erythropygius*), Andaman Black-naped Oriole (*Oriolus chinensis andamansis*) and Greater Racket-tailed Drongo (*Dicrurus paradiseus*) were most common in this area. Out of 28 endemic species to Andaman and Nicobar Islands, 13 were recorded and they are Andaman Teal (*Anas gibberifrons*), Andaman Serpent-Eagle (*Spilornis cheela*), Andaman Wood-Pigeon (*Columba palumboides*), Andaman Cuckoo-Dove (*Macropygia rufipennis*), Andaman Coucal *Centropus andamanensis*), Large-tailed Nightjar (*Caprimulgus macrurus*), Andaman Black Woodpecker (*Dryocopus hodgei*), Andaman Bulbul (*Pycnonotus fuscoflavescens*), Andaman Shama (*Copyschus albiventris*), Andaman Flowerpecker (*Dicaeum virescens*), White-headed Starling (*Sturnus erythropygius*), Andaman Drongo (*Dicrurus andamanensis*) and Andaman Treepie (*Dendrocitta bayleyi*).

The bird species richness and diversity may be influenced by factors such as the composition of plant communities, forest type and other environmental factors (Wiens and Rottenberry, 1981). The availability of micro habitats in the study area may influence the species diversity of Ritchie's archipelago. In this study, the agricultural landscape features, rather than macro habitat or microhabitat, were the most important and frequent predictors of bird occurrence (Saab, 1999). For example, the insectivores species are more abundant in Havelock and Neil Islands, this landscapes support more agricultural fields and grasslands that presumably provide good foraging areas (Freemark *et al.*, 1995 and Saab, 1999).

The cover-types and vegetation associations appear to be particularly important for bird species in this region. The forest and adjacent areas provide good habitats for rich avifaunal diversity in this Ritchie's archipelago. Many bird species were generalists and that were found throughout the study area. Other species appeared to prefer certain tree and shrub species and were more limited in distribution. The local ecological factors are important in determining diversity and abundance of birds. The different features may influence the species distribution in this archipelago *viz.*, the vegetation structure or the floristic richness may explain specific habitat preference, this was not observed in the temperate archipelago (Martin and Lepart, 1989 and Martin *et al.*, 1995), the number of habitat types on an islands or habitat diversity, is often considered a determinant of species richness (Murphy and Wilconx, 1986).

This study was limited in duration and geographic area, our observations of Ritchie's archipelago specific bird species suggest that the increase the regional avifaunal diversity by providing abundant resources, unique microhabitats and landscape level habitat heterogeneity that attract a diversity of bird species. Future studies comprising larger samples and censuses throughout the year are important and unique feature of the Ritchie's archipelago. The results shows that Ritchie's archipelago support unique avian assemblages, comprising of many rare

and endemic species and therefore it could be considered as an important "hotspot of avian diversity" in the Andaman and Nicobar Islands. In conclusion, the community composition appeared to be determined primarily by forest type and patchiness of Islands area.

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Chapter 7

MAMMALS

INTRODUCTION

Many aspects of wildlife management have raised growing attention of scientists in the last decades, with respect to growing and expending population, conflicts and interactions with human activity, sustainable harvest and conservation (Bobek *et al.*, 1991 and 1992). Wildlife populations are exposed to variable intra-population and environmental parameters, which often result in subtle mechanisms that require rigorous monitoring to be detected and understood (Milner *et al.*, 2007). Demographic of any population is important to be assessed, as variations in population density and environmental conditions were shown to affect a population as a function of this structure, even at a small scale (Coulson *et al.*, 1999, 2001).

The term census is used in the field of wildlife management to denote the operations leading to estimation of abundance of wildlife population. Wildlife management requires information on the population especially its distribution and abundance in various parts of the forests, in order to monitor the population status or assess the response of animals to management practices followed in the area. The requirements of the wildlife manager thus could often be satisfied with the knowledge of the trend of the population over a period of time. The information required about the distribution and abundance, can be gathered through the application of various techniques. The assessment could be based on qualitative criteria on the occurrence such as present, absent, rare, common, and abundant. However, it is often necessary to have information on abundance of population in terms of more quantitative measures like density.

The mammals of Andaman and Nicobar Islands consists rich assemblages of Bats and Rodents (Hill, 1967; Miller, 1902; Saha, 1980). The literature review reveals that, Alenxander (1827) published an account of the landing of a party at Little Andaman in sear of water and in his report mentioned that the skulls of Andaman Pig and also drawing of the same. Later, Blyth (1846) reported a brief note on the fauna of the Nicobar. He also reported mammals of south Andaman (Blyth, 1858, 1959, 1860). Blyth (1863) and Miller (1902) gave detailed descript of Mammals of Andaman and Nicobar Islands. Thereafter, very scanty and scattered works are available on the mammalian fauna of this archipelago. During, 60s' Zoological Survey of India has taken up extensive surveys on mammals of this islands (Chaturvedi, 1966 a,b, 1969; Soota and Chaturvedi, 1971; Nath and Chaturvedi, 1975; Bhattacharya, 1976; Chakraborty, 1978; Chaturvedi, 1980; Saha, 1980)

Spotted deer (*Axis axis*) and Wild pig (*Sus scrofa*)

The spotted deer (*Axis axis*) is indigenous to Asia (Walker, 1975). Prater (1971) describes 2 sub-species, *A. a. axis* on the Indian sub-continent and *A. a. ceylonensis* found in Sri Lanka. The spotted deer *Axis axis* introduced sometime between 1915 and 1930 in Andaman and Nicobar islands. These animals have spread all over North, Middle and South Andaman Islands, including the islands close to the coast. They are found in Ritchie's archipelago as well. They have also been established on islands with no known freshwater sources, though rainfall is high enough for this not to be a problem.

The highly adaptable and geographically variable Eurasian or Common Wild Pig *Sus scrofa* Linnaeus, is the most widespread member of the Pig family (Suidae), with possibly more than 16 subspecies distributed across much of Europe, North Africa, mainland Asia, Taiwan, and Japan (Nowak, 1999; Groves, 2007; Francis, 2008). Throughout Southeast Asia, it is often the sole pig species occurring in a wide variety of habitats ranging from mature forests to plantations (Francis, 2008).

The wild pig has adapted to a wide variety of habitats, from semi-arid environment to tropical forests (Gabor *et al.*, 1999; Ickes, 2001). Nevertheless, landscape structure and diversity were shown to affect their distribution, as the accessibility to water, food resources and shelters are determinant factors of habitat selection (Étienne, 2003 and Acevedo *et al.*, 2006). Resting sites are preferably located in areas with dense cover and undergrowth to maximise the security (Cargnelutti *et al.*, 1995). Although security remains important, habitat selection is also affected by food resources (Spitz and Janeau, 1995). Wild boar are mainly nocturnal (Boitani *et al.*, 1994 and Cahill *et al.*, 2003) but the diurnal activity can become gradually important in conditions of food shortage or little human disturbance (Russo *et al.*, 1997).

Wild Pig is opportunistic omnivores, as their diet is determined by the availability of various type of food, including agricultural crops (Schley and Roper, 2003). While adult males are solitary, females live in social family groups with overlapping generations (Kaminski *et al.*, 2005). The breeding ecology is characterized by multiple litters (Servanty *et al.*, 2007) and early onset of puberty (Mauget and Pépin, 1991). The mean litter size and the participation of Christian Hebeisen Introduction November 2007 females to reproduction vary along with environmental conditions (Fernandez-Llario and Mateos-Quesada, 2005, Santos *et al.*, 2006).

MATERIALS AND METHODS

Line transect sampling

Line transect sampling is one of the popularly used methods. This involves selecting straight lines of appropriate length, marking them in the concerned sampling units and traversing through these transects recording the animal sighted, the sighting angle and sighting distance. The main advantage with line transect sampling is that even without encountering all the animals in the area, it is possible to develop an estimate of the total number of animals or their density through appropriate statistical analysis. However, this method presupposes adequate sample size in terms of sighting without which respect density estimates cannot be obtained through the use of this method.

Total count

The total count assumes that all the animals in a given area are counted by covering the entire area. This assumption doesn't hold well in most of the census operations especially in areas with inhospitable terrain and poor visibility. The problem becomes more complex while dealing with the smaller and nocturnal animal. It would also be difficult to avoid double counting. In practice, the total counts are made after identifying smaller units (blocks) of the forest area based on natural/artificial boundaries. These smaller units are covered by teams of investigators within a given time, recording the details of animals encountered. This method also assumes that all the areas in sampling units are covered and all the animals in the area are counted. Sometimes, only a subset of sampling units are considered for counting of the animals and the projection to the population levels is made through statistical methods. Although block count is identified as valid for estimation of abundance, valuable information can be obtained on population structure through this method.

Indirect method

The small animals and nocturnal animals are difficult to sight directly and practically impossible. The index of abundance or sometimes the actual density of such animals can be estimated by recording the number of indirect evidences such as hoof mark/droppings/pellets/ dung of the animals in the given area. For the estimation of the density of indirect evidences, plots or transects can be used. This method is comparatively simpler and yields a wealth of information on the abundance and distribution. However, the use of the techniques requires skill in the identification of indirect evidences of the species concerned.

Line transect sampling was carried out in John Lawrence, Henry Lawrence, Outram and Inglis Islands. The density estimates were obtained using the software DISTANCE 6.0 developed by Thomas *et al.*, (2001).

RESULTS AND DISCUSSION

Occurrence of species

During the present study, a total of 12 species of mammals belong the 10 families were recorded from Ritchie's archipelago (Table 7.1).

Table 7.1. List of mammals observed in Ritchie's archipelago

Sl. No.	Common name	Scientific name
	Order: Insectivora	
	Family : Crocidurinae	
1.	Andaman Spiny Shrew	*Crocidura hispida* Thomas, 1913
	Order: Chiroptera	
	Family Pteropodidae	
2.	Indian Flying fox	*Pteropus giganteus* (Brunnich, 1782)
3.	Andaman Flying Fox	*Pteropus melanotus tytleri* Dobson, 1874
	Family Hipposideridae	

Sl. No.	Common name	Scientific name
4.	Fulvous leaf-nosed Bat	*Hipposideros fulvus* Gray, 1838.
	Order: Carnivora	
	Family Felidae	
5.	Jungle Cat	*Felis chaus* Schreber, 1777
	Order: Cetacea	
	Family Delphinidae	
6.	Common Dolphin	*Delphinus delphis* Linnaeus, 1758
	Order: Sirenia	
	Family: Dugongidae	
7.	Dugong	*Dugong dugon* (Muller, 1776)
	Order: Proboscidea	
	Family Elephantidae	
8.	Asian Elephant	*Elephas maximus* Linnaeus, 1758.
	Order: Artiodactyla	
	Family Suidae	
9.	Andaman Wild Pig	*Sus scrofa andamanensis* Linnaeus, 1758
	Family Cervidae	
10.	Spotted Deer	*Axis axis* (Erxleben, 1777)
11.	Barking Deer	*Muntiacus muntjak* (Zimmermann, 1780)
	Order: Rodentia	
	Family Sciuridae	
12.	Five-striped Palm Squirrel	*Funambulus pennantii* Wroughton, 1905

Distribution of mammals

Species of mammals recorded in different islands during the period of study is given in Table 7.2. Out of thirteen species of mammals, Spotted deer and Wild Boar were observed from all the six islands.

Table 7.2. Distribution of mammals in different islands in Ritchie's archipelago

Sl. No.	Common name	Havelock	John Lawrence	Henry Lawrence	Outram	Inglis	Neil
1.	Andaman Spiny Shrew		✓	✓		✓	
2.	Indian flying fox	✓	✓	✓		✓	✓
3.	Andaman Flying Fox	✓				✓	
4.	Fulvous leaf-nosed Bat					✓	
5.	Jungle Cat				✓		
6.	Common Dolphin			✓	✓		✓
7.	Dugong	✓	✓				✓
8.	Asian Elephant		✓				
9.	Andaman Wild Pig	✓	✓	✓	✓	✓	✓
10.	Spotted Deer	✓	✓	✓	✓	✓	✓
11.	Barking Deer		✓	✓	✓	✓	
12.	Five-striped Palm Squirrel	✓	✓	✓	✓	✓	✓

The above results are expected to provide valuable information for the management of spotted deer and wild pig in Ritchie's archipelago. The high density of these two species found is probably due to the absence of large top predators that could control their populations. It is clear that the existing populations of spotted deer and wild pig are no longer subjected to any natural predation pressure. The high densities of pigs may lead to some plausible impacts on ecological processes like seed dispersal and recruitment in existing forest fragments, especially primary and tall secondary forests.

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SUMMARY AND CONCLUSIONS

The documentation of biodiversity and differentiation of ecosystems is the first step towards conservation and management of the area. This study was conducted in Ritchie's archipelago during April 2008 through December 2011 to understand the structure, species composition and distribution of Odonates, Butterflies, Moths, Reptiles & Amphibinans, Birds and Mammals.

The present study highlights the enormous faunal wealth of the Ritchie's archipelago. The study also point out that there are gaps in information which can be filled up only with further studies in this archipelago. Forty three species of Odonata belongs to 9 families and 28 genera, 84 species of butterflies, belong to 5 families and 58 genera, 76 species of moths belong to 10 families, 26 species of Reptiles and Amphibians belong to 12 families, 136 species of birds belongs to 15 orders and 40 families, 13 species of Mammals belong to 11 families were recorded.

Among 43 species of Odonata, *Rhyothemis variegata variegata*, *Orthetrum sabina sabina*, *Neurothemis fluctuans*, *Crocothemis servilia servilia* and *Tremea limbata similiata* were the most common and abundance species in this study area. The family Calopterygidae, Lestidae, Protoneuridae, Platycnemididae and Platystictidae were represents only one species each namely, *Vestalis gracilis, Lestes praemorsa praemorsa, Prodasineura verticalis andamanensis, Copera marginipes* and *Drepanosticta annandalei* respectively. High similarity observed between Havelock and John Lawerence, Havelock and Neil Islands and least similarity were observed between South Button and North Button Islands.

Of the 84 species of butterflies, highest numbers of species were recorded from the family Nymphalidae (29), followed by Lycaenidae (17), Pieridae (15), Papilionidae (13) and Hesperidae (10). The family Nymphalidae was the dominant account for 52.62 per cent of individuals were observed. The species like Peacock Pansy, Great Mormon, Andaman Clubtail and Common Rose were recorded in all Islands. The Shannon Index of diversity showed high values in Havalock and Neil Islands. The Andaman and Nicobar Islands is unique in endemism, the following species were recorded during the investigation, *viz.* Giant Red Eye (*Gangara thyrsis*), Tailed Jay (*Graphium Agamemnon*), Andaman Mormon (*Palilio mayo*), Andaman Clubtail (*Atrophaneura rhodifier*), Andaman Crow (*Euploea andamanensis*), Hewitson Andaman Viscount (*Tanaecia cibaritis*), Andaman Birdwing (*Troides helena*), Andaman Swordtail (*Graphium epanimondas*), Andaman Map (*Cyrestis thyodamas*) and Andaman Chestnut Palmfly (*Elymanias cottonis*).

A total of 76 species of Moths belongs to 10 families were recorded. Of these, 11 species were considered as pests of forest trees, namely *Chysodeixis eriosoma, Aporandria specularia, Cleora alienaria, Hyposidra talaca, Trygodes divisaria, Utethesia pulchelloides, Dasychira mendosa, Sylepta derogate, Striglina scitaria, Acherontia styx styx* and *Hypsa ficus.* Three species namely *Amata (Syntomis) whimberleyi, Eressa affinis* and *Cyana amabilis* are endemic to these Islands.

Twenty six species of reptiles and amphibians belonging to 21 genera and 12 families were recorded. Highest number of reptiles was observed from Havelock, followed by John

Lawerence, Neil, Inglis, Outram, Henry Lawerence and North Button Islands. Diversity index (H') was maximum in Havelock Island (2.63) and mimimum in South Button (2.04). Of the recorded species, only four species were observed form all locations namely, *Hemidactylus frenatus, Calotes versicolor, Eutropis andamanensis and Duttaphrynus melanostictus.* The species like *Copsymbotus platyurus, Calotes emma alticristatus, Dasia olivacea, Varanus salvator, Ramphotyphlops braminus, Dendrelaphis pictus andamanensis, Bungarus andamanensis* and *Opiophagus hannah* were recorded in only one or two more sites.

During the present study, a total of 136 species of birds belonging to 15 Orders and 40 Families were recorded. Of these, 85 were residents, 27 resident migrant and 24 migrants. Highest number of species were recorded from the family Scolopacidae followed by Columbidae, Ardeidae and Accipitridae. Species like Common Hill Myna (*Gracula religiosa*), White-bellied Sea-Eagle (*Haliaeetus leucogaster*), Andaman Wood-Pigeon (*Columba palumbodes*), Andaman Green Imperial-Pigeon (*Ducula aenea andamanica*), Red-brested Parakeet (*Psittacula alexandri*), Red-cheeked Parakeet (*Psittacula longicauda*), Black-capped Kingfisher (*Halcyon pileata*), White-headed Starling (*Sturnus erythropygius*), Andaman Black-naped Oriole (*Oriolus chinensis andamansis*) and Greater Racket-tailed Drongo (*Dicrurus paradiseus*) were most common in this area.

Out of 28 endemic species to Andaman and Nicobar Islands, 13 were recorded and they are Andaman Teal (*Anas gibberifrons*), Andaman Serpent-Eagle (*Spilornis cheela*), Andaman Wood-Pigeon (*Columba palumboides*), Andaman Cuckoo-Dove (*Macropygia rufipennis*), Andaman Coucal *Centropus andamanensis*), Large-tailed Nightjar (*Caprimulgus macrurus*), Andaman Black Woodpecker (*Dryocopus hodgei*), Andaman Bulbul (*Pycnonotus fuscoflavescens*), Andaman Shama (*Copyschus albiventris*), Andaman Flowerpecker (*Dicaeum virescens*), White-headed Starling (*Sturnus erythropygius*), Andaman Drongo (*Dicrurus andamanensis*) and Andaman Treepie (*Dendrocitta bayleyi*). A positive significant correlation observed between island size and species richness ($r = 0.669$; $P = 0.05$), species abundance ($r = 0.733$; $P = 0.05$).

A total of 12 species of mammals belong the 10 families were recorded from Ritchie's archipelago. Out of thirteen species of mammals, Spotted deer and Wild Boar from all the six islands. The absolute density (individuals/km^2) of spotted deer was 32.3 Henry Lawrence, followed by Outram (28.2 individuals/km^2), John Lawrence (26.03 individuals/km^2) and Inglis (24.5 individuals/km2). The density of wild boar was 15.6 individuals/km^2 in John Lawrence, followed by Outram (14.01 individuals/km^2), Henry Lawrence (12.04 individuals/km^2) and Inglis (10.15 individuals/km^2)

The Ritchie's archipelago is one of the richest parts of Andaman and Nicobar Islands in terms of faunal diversity. For the effective conservation and sustainable utilisation of the faunal resources, all the islands of Ritchie's archipelago have to be managed in a more efficient manner. The careful management strategies and habitat improvement programmes need to be implemented in order to protect the faunal diversity depletion in this region. As this archipelago is the habitat for many endangered and endemic species, it is very essential to look into site requirements and habitat preferences of various species in an integrated manner while preparing management plans. To make Ritchie's archiepelaog as a model of faunal diversity, efforts can be initiated to implement more comprehensive conservation oriented programmes.

FURTHER RESEARCH NEEDS

Though the study has generated lot of baseline information on the selected faunal group of this archipelago, still there are information gaps in many areas pertaining to its conservation and mangement. Due to lack of manpower and time limit, the sampling carried out under various faunal groups was limited. Also, information is lacking on various lower vertebrate groups. The multi-disciplinary studies are required in order to fill the data gaps of this region.

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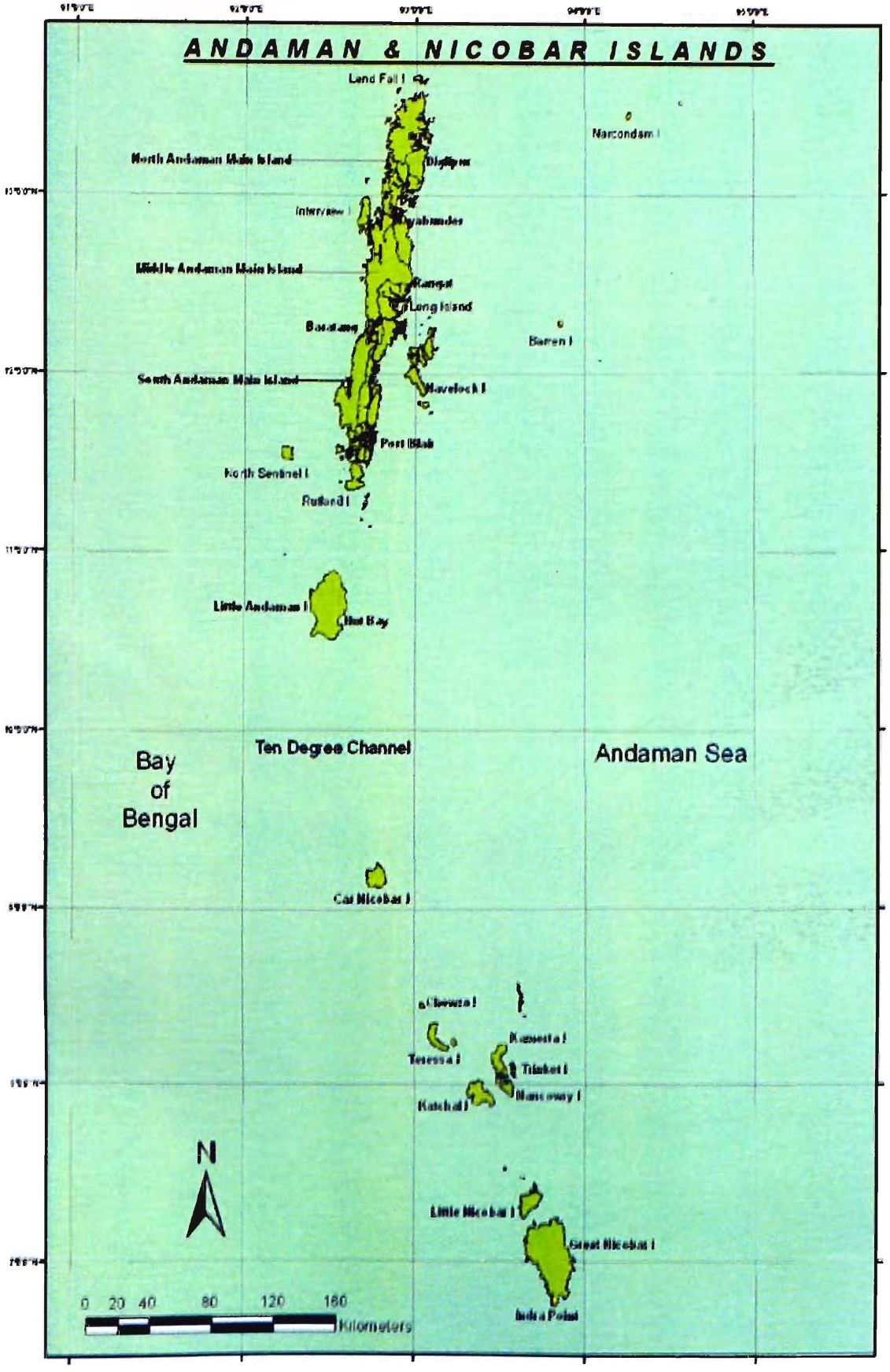


Fig. 1.1. Andaman and Nicobar Islands

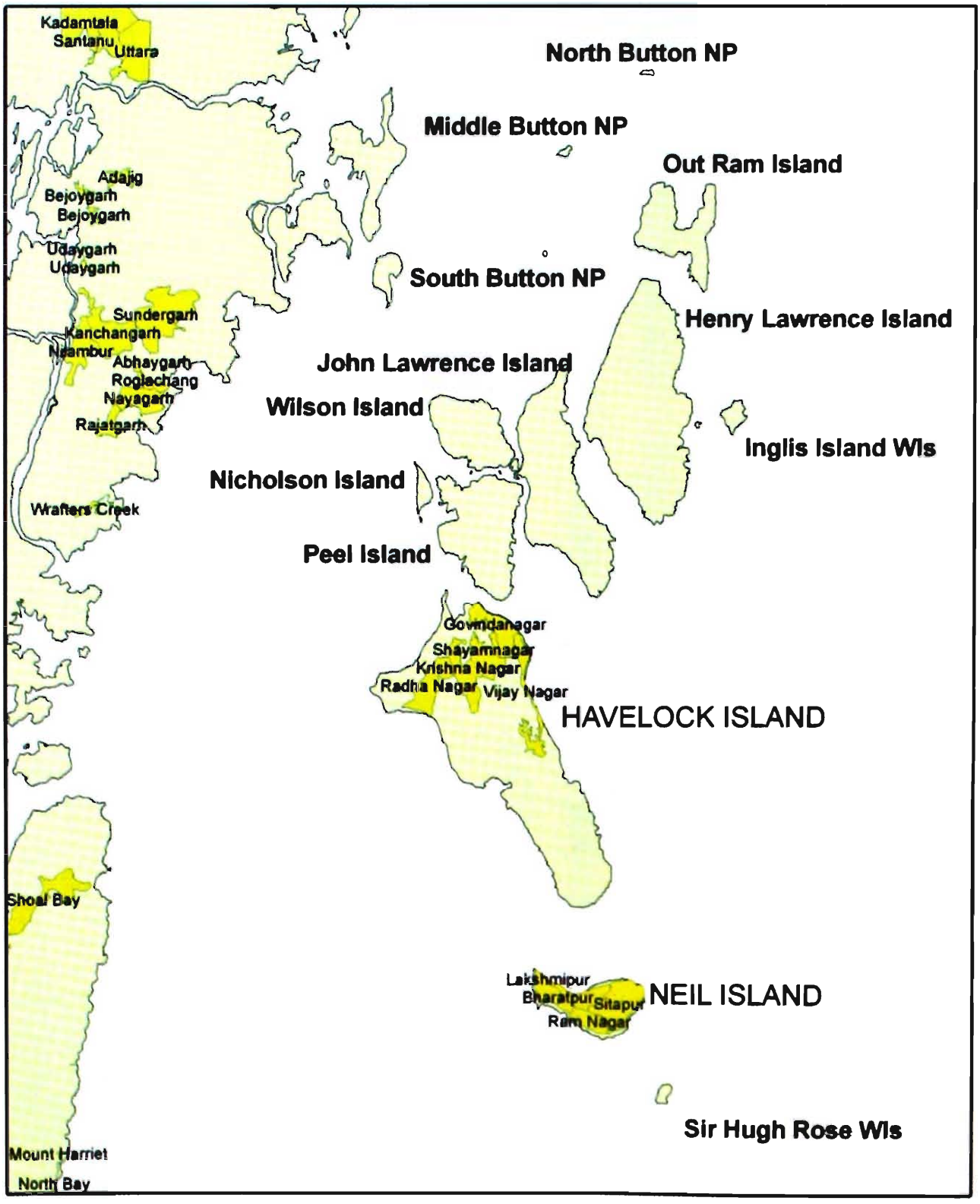
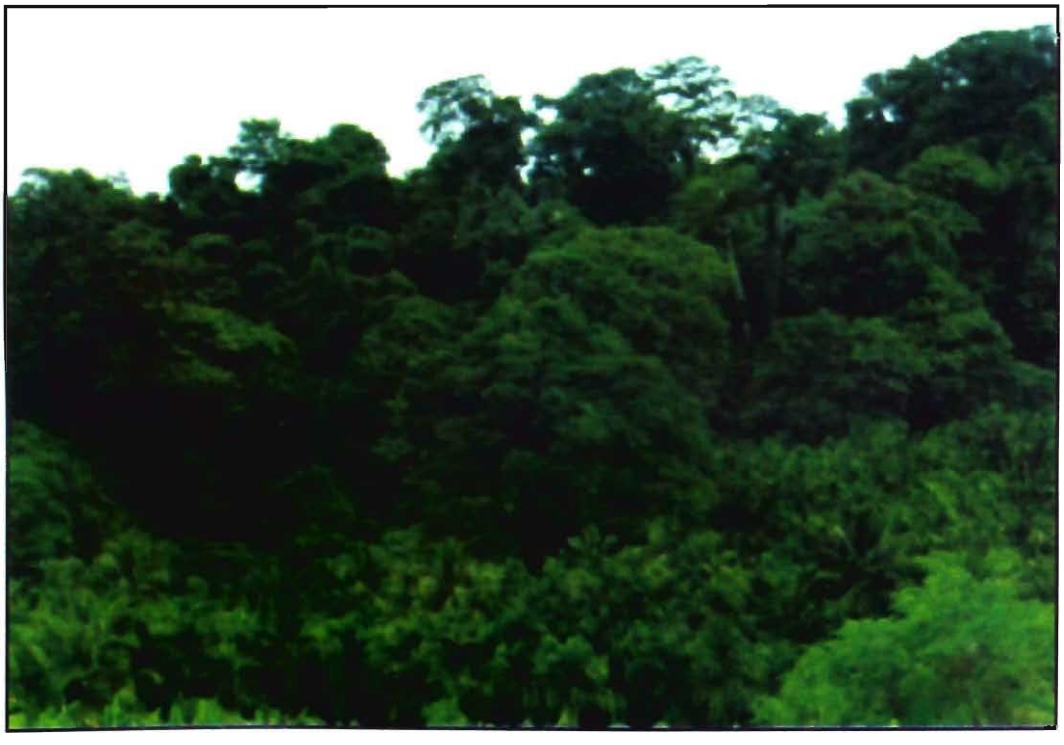


Fig. 1.2. Ritchie's Archipelago, Andaman & Nicobar Islands

Plate 1. Study area

Kalapathar, Havelock Island



Krishna Nagar, Havelock Island

Islands of Ritchie's archipelago

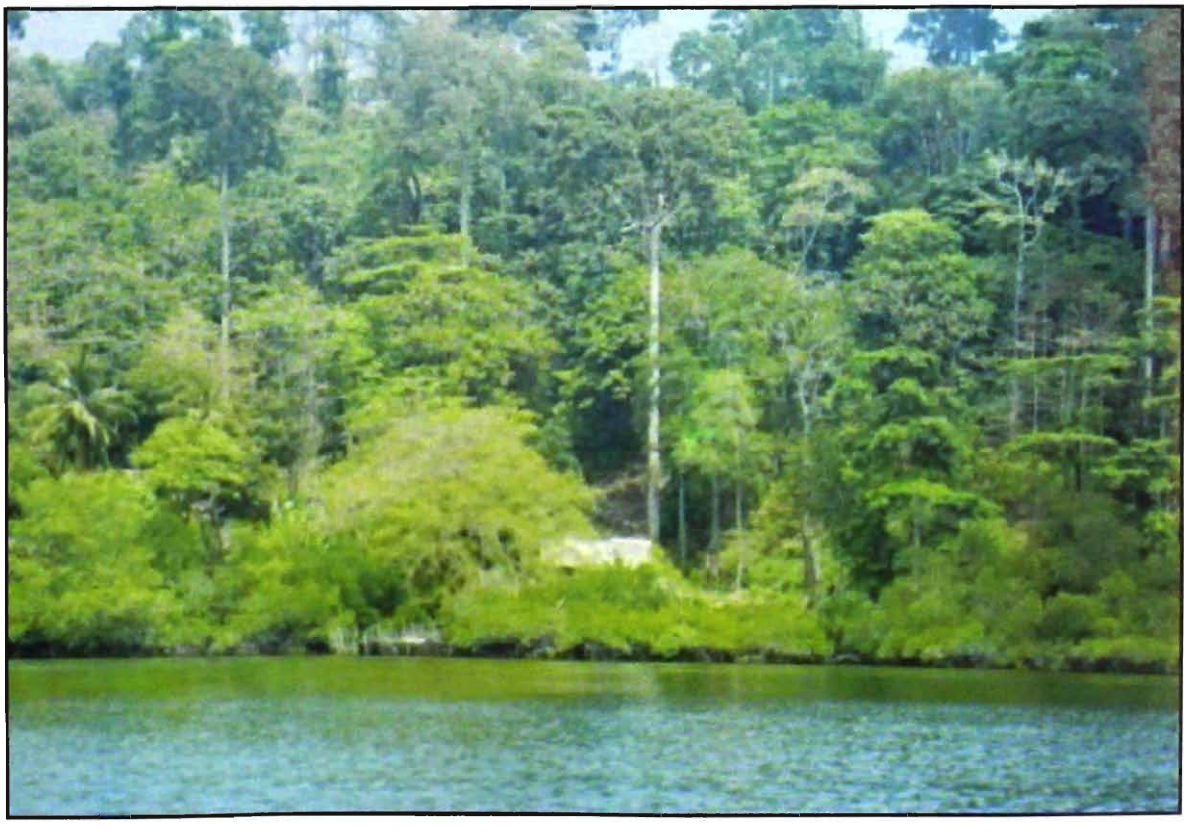
Plate 1. (Contd.)

Radha Nagar, Havelock Island

John Lawrence Island

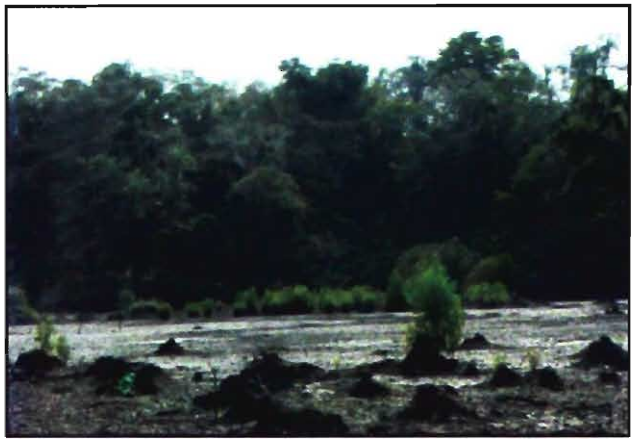
Plate 1. (Contd.)

Havelock Island



John Lawrence Island

Plate 2. Study area



Inglis Island

South Button Island

Inglis Island

North Button Island

Henry Lawerence

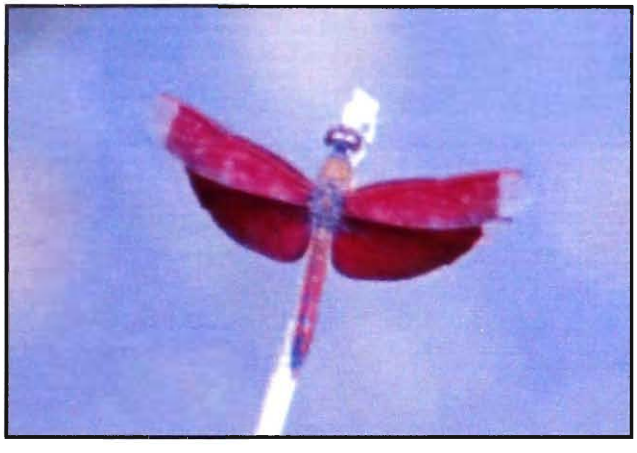
Henry Lawrence

Islands of Ritchie's archipelago

Plate 3. Odonata of Ritchie's Archipelago

Brachydiplax chalybea chalybea Brauer

Anax guttatus (Burmeister)



Neurothemis fluctuans Fabricius

Tramea limbata similata (Rambur)

Orthetrum sabina sabina Drury

Lathrecista asiatica asiatica (Fabricius)

Plate 4. Butterflies of Ritchie's Archipelago

Common Rose *Atrophaneura aristolochiae* (Fabricius)

Andaman Viscount *Tanaecia cibaritis* Hewitson

Clipper *Parthenos sylvia* (Cramer)

Lime Butterfly *Papilio demoleus* (Linnaeus)

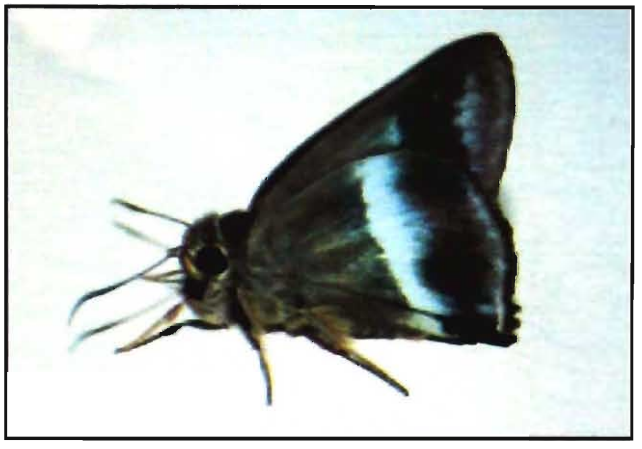
Tailed Jay *Graphium agamemnon* (Linnaeus)

Peacock Pansy *Junonia almana* (Linnaeus)

Plate 5. Butterflies of Ritchie's Archipelago

Andaman Mormon *Papilio* mayo Atkinson

Great Mormon Papilio memnon Linnaeus



White banded awl *Hasora taminatus* Hubner

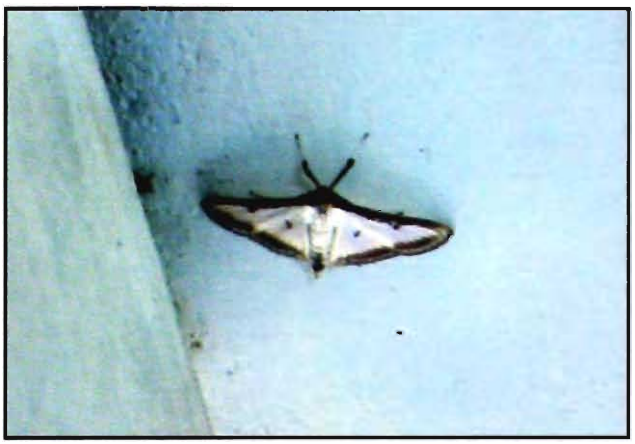
Stripped Tiger *Danaus genutia* Cramer

Common albatross Appias albino (Linnaeus)

Andaman Birdwing *Troides helena* (Linnaeus)

Plate 6. Moths of Ritchie's Archipelago

Gangarides rosea (Walker)

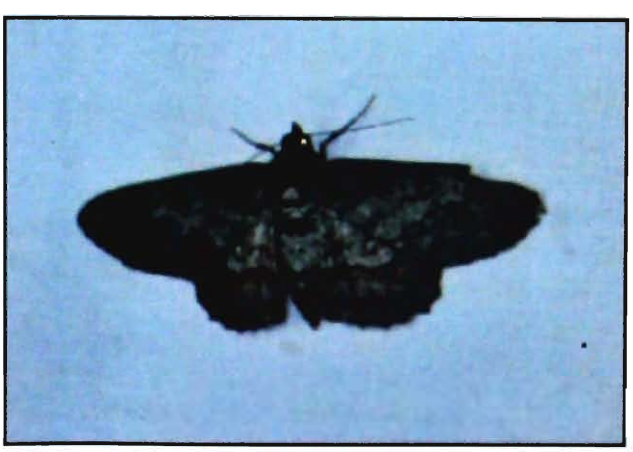


Sisyrophora pfeifferae Lederar

Tridrepana fulvata Snellen

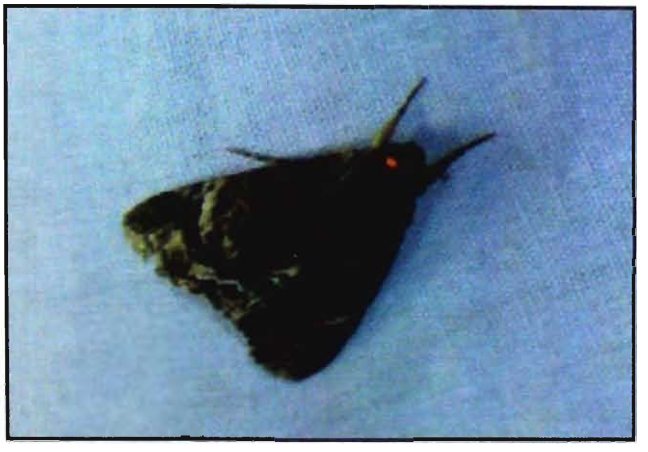
Padenia deplicana (Walker)

Maruca testulalis Geyer



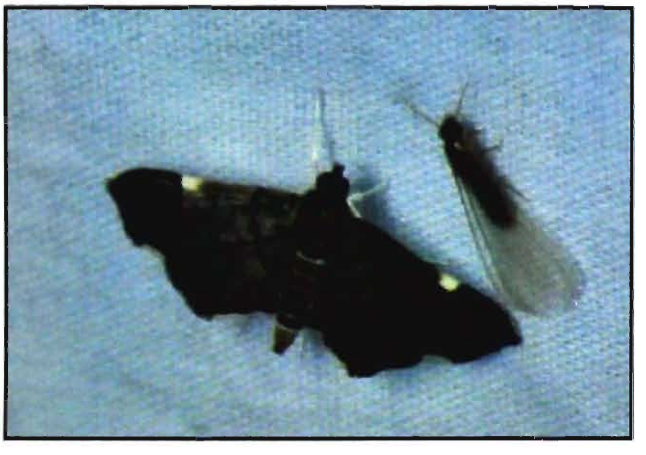
Cleora injectaria Walker

Plate 7. Moths of Ritchie's Archipelago



Ercheia cyllaria Cramer

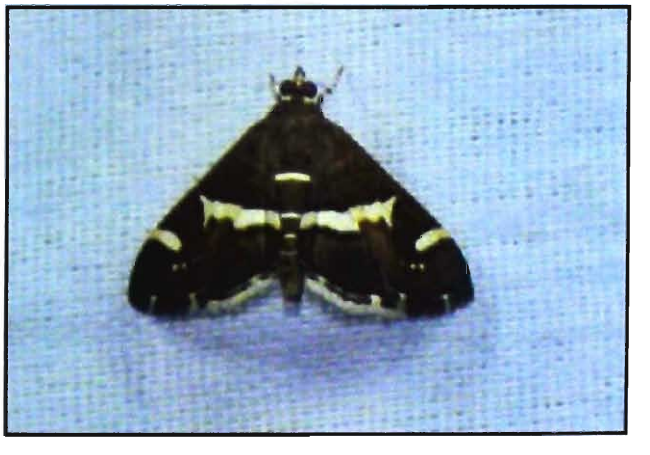
Heterostegane sp.



Phostria maculicostalis Hampson

Xanthomelaena schematias (Meyrick)

Telanga sexpunctalis Moore



Borbonata nivifascia Walker

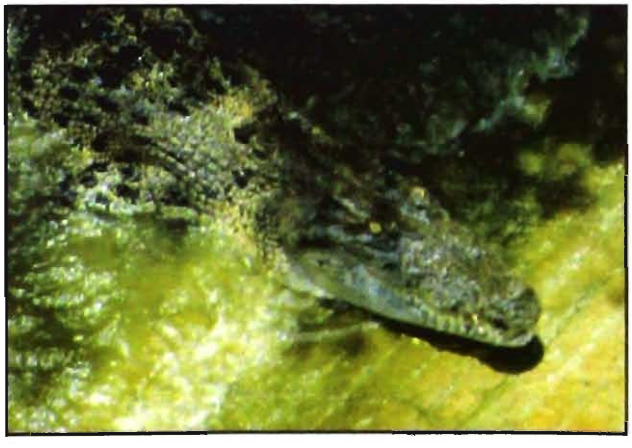
Plate 8. Reptiles and Amphibians of Ritchie's archipelago

Coryphophylax subcristatus (Blyth)

Eutropis andamanensis (Smith)

Phelsuma andamenense (Blyth)

Calotes versicolor (Daudin)



Crocodylus porosus Schneider

Duttaphrynus melanostictus (Schneider)

Plate 9. Birds of Ritchie's archipelago

White-headed Starling
Sturnus erythropygius (Blyth)

Pompadour Green Pigeon
Treron pompadora chlorptera Blyth

Nicobar Pigeon *Caloenas nicobarica* (Linnaeus)

Andaman Teal *Anas gibberifrons* (Muller)

Blacknaped Monarch
Hypothymis azurea (Boddaert)

Beach Stone-Plover
Esacus magnirostris (Vieillot)

Plate 10. Birds of Ritchie's archipelago

Black-naped Oriole
Oriolus chinensis andamansis Tytler

Red-breasted Parakeet
Psittacula alexandri (Linnaeus)

Orange Headed Thrush
Zoothera citrina (Latham)

White-bellied Sea-eagle
Haliaeetus leucogaster (Gmelin)

Oriental Broad-billed Roller
Eurystomus orientalis (Linnaeus)

Andaman Coucal
Centropus andamanensis Beavan

Plate 11. Birds of Ritchie's archipelago

Eurasian Golden Oriole
Oriolus oriolus (Linnaeus)

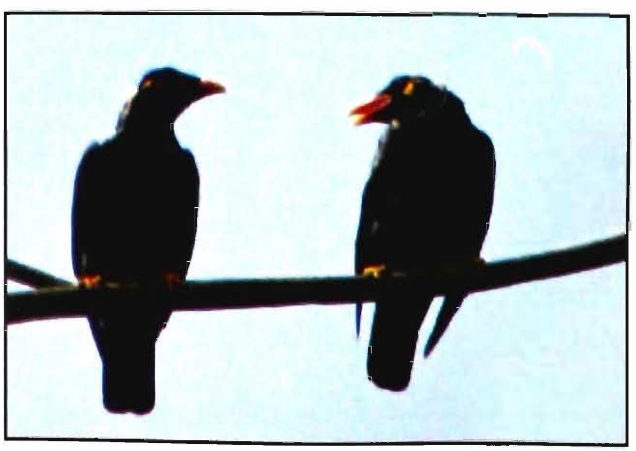
Andaman Collared Kingfisher
Halcyon chloris davisoni Sharpe

Oriental White-eye
Zosterops palpebrosus (Temminck)

Plate11. (Contd.)

Olive-backed Sunbird
Nectarinia jugularis Linnaeus

Ruddy Kingfisher
Halcyon coromanda (Latham)



Common Hill-Myna
Gracula religiosa Linnaeus

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