Occurrence of Serpent Eagles in North and Middle Andaman Island

Dissertation Submitted in partial fulfilment of the requirements for the award

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BY

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These study was carried out under my supervision from February 2015 to June 2015.

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Sayli Sawant

DECLARATION

I hereby declare that the dissertation report on "Occurrence of Serpent eagles in North and Middle Andaman Islands" submitted in requirement of partial fulfilment of M.Sc. Environment Management of Forest Research Institute (Deemed) University, Dehradun is a record of bonafide work carried by me under the guidance of Dr. Manchi Shirish S., Scientist, Sàlim Ali Center for Ornithology and Natural History (SACON) and that no part of this dissertation project has been submitted for any other degree or diploma.

Place: DEHRADUN

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M.Sc. Environment Management

OCCURRENCE OF SERPENT EAGLES IN NORTH AND MIDDLE ANDAMAN ISLANDS

ABSTRACT

‘Spilornis’ is a genus of bird of prey in the family Accipitradae. All adults in this group have dark crowns, bright yellow eyes and core. These raptors are found in southern Asia and are known as Serpent Eagles. There are six species in the genus out of which two are found in Andaman Island. The Crested Serpent-eagle (*Spilornis cheela*) and the Andaman Serpent-eagle (*Spilornis elegini*) are found in the Andaman Island. All the available literature indicates that the Crested Serpent-eagle and the Andaman Serpent-eagle appear to be ecologically separated by their habitats. The Andaman Serpent-eagle is known be restricted to the interior forest while the Crested Serpent-eagle is limited in the coastal forests. As the Crested Serpent- eagle across its distribution is found in diverse habitats, upto 2100m (Nouroji, 2006), it is not clear why is has to be restricted to coastal forests in Andaman Islands? In order to understand this on the present study was designed to know ‘occurrence of Serpent eagles in North and Middle Andaman Islands’. The stratified random sampling approach was taken to lay the open width line transects in different habitats. Seven different habitats were recognized in 13 5km X 5km sampling units/cells. Total 113 various length transects were laid and each transect was walked three times. Watson (2004) was followed for the fixed effort search of 20 mins. Out of 22 (Grimmet et. al, 2011) diurnal raptor species, only 6 species were recorded by us. Both known Serpent eagles were encountered during the survey. Andaman Serpent-eagle was found to be more abundant compare to the Crested Serpent-eagle. Accept Plantations all the other habitats were used by both the species. Andaman Serpent-eagle was not encountered in the Plantations. Sightings of both the species, when mapped, showed significant overlap and proved the co-occurrence/co-existence of these sympatric birds of prey.

Chapter 1

INTRODUCTION

1.1 Raptors

Birds of Prey (Falconiformes) also known as Raptors is a group of birds that include the birds at the top of food chain viz; Hawks, Eagles, Kites, Secretary birds, Ospreys, Falconets and Old World Vultures etc (Melissa Myantz, birding.about.com). Raptors are distinguished as nocturnal like Owls (Stringiformes) and Diurnal like other members of the class (Lee and Christie, 2010). Diurnal raptors have been grouped into 5 families, Accipitradae, Pandionidae, Sagittariidae, Falconidae and Catharthidae and placed in a common order Falconiformes (Dell Hoyo et al., 1994).

Raptors are usually solitary, and difficult to see. They frequent all habitat types, from Arctic tundra to dusty deserts, rich forests and Jungles, open savannahs and grasslands and even high mountain cliffs. Some taxa are restricted in distribution such as the Snake eagles, (Citracartinae) which are found only in the old world, while others such as sea-eagles (Haliaretinae) are global in distribution (Brown and Amadon, 1968; Friedmann, 1950). Every habitat could potentially be a home to raptors, but are best seen in habitats which meet the bird's need for food, shelter and nesting site (Lee and Chirtie, 2010). Raptors are apex predators and these carnivorous birds are dominant hunters (Naoroji, 2006). They feed on mammals, birds, reptiles, amphibians, fish, crabs, molluscs and insects. These predators have powerful talons, hooked bills, and acute eyesight (Grimmet et al., 2011). These birds generally have broad wings suitable for soaring.

In this order (Falconiformes) the birds share a common lifestyle, especially behaviour ecology (Wink, 1995; Wink et al., 1998). As ecologically sensitive predators, birds of prey are valuable indicators of habitat quality (Brown and Amadon, 1968). Being at the top of food chain raptors help in maintaining balance of nature by feeding on diverse organisms and maintain their populations. These top predators contribute to the overall health of the environment through scavenging on dead animals openly lying in the forest, which indirectly helps in controlling of the spread of the infections to other animals (Smith, 1970).

Around 572 species of raptors are known to be distributed in different parts of the world. Of these 572 around 18% of raptors are found in India. These 106 species across the country are distributed in almost all the habitats found in the region. Of these 106 around 69 species of raptors were known to be diurnal raptors (Grimmet et al., 2011, Naoroji, 2006). Andaman and Nicobar is an home to around 22 species of diurnal raptors viz; Crested Serpent-Eagle(*Spilornis cheela davissoni*), Andaman Serpent-Eagle (*Spilornis elegini*), Central Nicobar Serpent-Eagle(*Spilornis minimus*),

Great Nicobar Serpent-Eagle (*Spilornis klossi*), Changeable Hawk Eagle (*Nisaetus limnaeetus*), Black Baza (*Aviceda leuphotes*), White Bellied Sea Eagle (*Haliaeetus leucogaster*), Eurasian Sparrow Hawk (*Accipiter nissus*), Japanese Sparrow Hawk (*Accipiter gularis*), Chinese Sparrow Hawk(Nicobar) (*Accipiter soloensis*), Besra (*Accipiter virgatus*), Long-legged Buzzard (*Buteo rufinus*), Oriental Honey Buzzard (*Pernis ptilorhynchus*), Brahmany Kite (*Haliastur Indus*), Peregrine Falcon (*Falco peregrinus*), Booted Eagle (*Hieraaetus pennatus*), Osprey (*Pandion haliaetus*), Black kite *(Milvans migrans)*, Nicobar Sparrowhawk (*Accipiter butleri*), Eurasian Marsh Harrier (*Circus aeruginosus*), Pied Harrier (*Circus melanoleucos*) and Common Kestral (*Falco tinnunculus*) ((Grimmet et.al., 2011, Del Hoyo et al., 2001).

1.2 Serpent Eagles

Serpent Eagles as the name implies are birds of prey adapted to hunting reptiles. They are placed in the family Accipitridae and sub-family Circaetinae next to the snake eagles (Lenur and Mindell, 2005). They are divided into four genera namely, Circaetus, Spilornis, Deyotriorchis and Terathopius. Serpent Eagles are of complex genus, uncertain and have a confused taxonomy (Del hoyo et al., 1994). They are widespread from Indian Sub-continent and South East Asia through Islands of Malaysia, Indonesia and Phillipines. Serpent Eagles of the Island race are more vulnerable because of their restricted range, which may be limited to a group of Islands. It means any destruction of their habitat is a severe threat to their survival (Grambo, 1997).

Globally eight species of Serpent Eagles are recorded, of which five are known from India. Of the four Serpent Eagles known from these Islands only Crested Serpent-eagle (*S. c. davisoni*) is sub-species endemic, whereas other three species are endemic to the Andaman and Nicobar islands. Andaman Serpent Eagle is restricted to the Andaman group of Islands, Great Nicobar Serpent Eagle is limited to the Great Nicobar Island and Central Nicobar Serpent Eagle is known to be found only on the islands of the Central Nicobar group. (Nouroji, 2006; Grimmet et al., 2011,). The present study is focused on the serpent eagles of the Andaman Islands; therefore we restrict our detailed species account to the Serpent Eagles found in the region.

1.2.1 Andaman Serpent-eagle *Spilornis elegini*

Andaman Serpent-eagle is endemic to the Andaman Island. Because of its dark appearance, the species is also known as Andaman dark Serpent-eagle (Rahmani, 2012). It is presumed to be sedentary but immature individuals may wander on several islands in search of food or mate. It resides in forests, hill sides, agricultural fields and plantations. It is more restricted to tidal creeks and mangroves. It is medium sized (51-59cm) and relatively smaller than the Crested Serpent-eagle

(Naoroji, 2004). It's dark chocolate brown, probably the darkest of all the serpent eagles with small white spots all over the body. The species is classified under the near threatened category in the IUCN red data book. The species is also included in the Schedule-I of Wildlife Protection (1972) Act of India. It has a small crest, bare yellow lores and gives a big headed look typical of its genus. The wings are moderately long; tail is medium and featherless legs (Grimmet et al., 2011). Sexes look alike the female is probably slightly lighter (Lee and Christie, 1998). The juveniles are paler, have a whitish head, with dark feather centers, dusky patches behind the eyes, and dark streaked throat. It has white spots on wing coverts and under parts, also becomes more buff-barred on the belly and crissum (Lee and Christie, 1998). It soars with level wings circling in pairs or sometimes trios giving out a loud *chukchuk*….. sound. The food comprises mainly of frogs, lizards, snakes, rats and birds (Nouroji, 2006). It is sympatric with Andaman race of Crested Serpent-eagle. This is a forest species probably derived from ancient common stock whereas *davisoni* presumably descended from more recent second wave colonists that have tended to be restricted by competition to tidal creeks and mangroves (Lee and Christie, 1998).

1.2.2 Crested Serpent Eagle *Spilornis cheela davisoni*

The Crested Serpent Eagle is known to have 26 sub-species distributed globally (Lee and Christie, 1998), 21 in South-east Asia and 6 sub-species in India (Nouroji, 2006). Of which *S.c.davissoni* is endemic to Andaman Islands. The Crested Serpent-eagle in India is most common in the Northeastern part, Western Ghats, Deccan Peninsula, Gangetic plains and Andaman and Nicobar Islands (Naoroji, 2006). They are found up to a height of 2100mts in the Himalayan foothills. They inhabit dry deciduous forests, tropical evergreen forests, marsh surrounded by open woodland, tea plantations and mangroves. Crested Serpent-eagle is known to be widespread, common and sometimes abundant; but locally uncommon. They are sedentary and immature individuals are known to be nomadic. They are fairly large Serpent eagles adults measure over 65-75cm; the juveniles are slightly smaller around 40-50cm (Del hoyo et al; 1994). The adult being dark, the shoulders and abdomen are spangled in white. The tail and under wings have prominent broad bands, which allows it to differ from the Andaman Serpent-eagle. The wings are moderately long, tail is of medium length and legs are featherless. Both sexes look similar but in most races the female is larger and heavier (Nouroji, 2006, Grimmet et al., 2011). The juveniles are dark brown to blackish with a crest and bushy nape which is whitish in colour. It flies with strong beats and short edges, on flat or sometimes slightly raised wings. It soars high up with wings held straight out and shallow V. It is very noisy in air, especially during breeding season (Nouroji, 2006). It gives loud, shrill ascending ringing whistles. The food consists mainly of reptiles, frogs, occasionally small rodents. There is single record of crested serpent-eagle feeding on crab and eel from Andaman (Lee

and Christie, 1998). It is solitary and often in pairs when circling in the air. It displays various dives and glides in the air. One characteristic flight is the shuttle-cock flight with head, tail and wings all bent up (Lee and Christie, 1998). The species is also known to be restricted to the coastal forests and ecologically separated from the Andaman Serpent-eagle (Del hoyo et al; 2001).

1.3 Previous Studies

Even if they are known to be important part of different ecosystems, there is no record of any focused study on the raptors of the Andaman and Nicobar Islands. However, Thiolley (1998) studied distribution patterns and insular biography of South Asian raptor communities. The Avifaunal studies from 1988 – 2013 provide scarce information regarding these top predators. Limited numbers of studies have documented the number of individuals of Serpent-eagles while surveying the avifauna of Andaman Island. As per the findings of Davidar et. al. (1996), 62 individuals of Andaman Serpent-eagle were observed on 25 Islands out of 45 Islands surveyed between February and May, 1992. Davidar et al; (2007) conducted avifaunal survey, in February-May 1993 and in February 1994, where they state that this species seems to be present on Islands larger than $10km^2$. Rajammaman (2011) during an avifaunal survey found 100 individuals of Andaman Serpent-Eagles on 78 sites. Naoroji (2006) described that the Andaman Serpent-Eagle is more common in North and Middle Andaman Islands. During survey of Indian raptors, 102 individuals were sighted across Andaman Island. Based on these surveys it is always understood that the Andaman and Crested Serpent-eagle are ecologically separated (Lee and Christie, 1998; Del Hoya et al; 2001; Nouroji, 2006). As per the literature available the Crested Serpent-eagle is restricted to the coastal forests and doesn't co-exist with the Andaman Serpent-eagle, known to inhabit in the inland forests. Chao et.al. (1996) studied the spacing pattern of Crested Serpent-eagle (*Spilornis cheela hoya*) in Southern Taiwan. In this study they state that an insular syndrome was documented in forest species in inlands, including significant examples of habitat niche expansion, interspecific segregation and density compensation. And such relaxation of habitat and density constraints may enhance the survival probability of the species on Islands. Mutsyunki and Jaston (1996) studied habitat preference of Crested Serpent-eagle in Southern Japan. Nijman (2002) studied habitat segregation in two congeneric hawk eagles (*Spizaetus cirrhatus* and *Spizaetus baltersi*) in Java, Indonesia. His study revealed that, the endemic hawk eagle occurred in smaller ranges of habitats compared with *S.cirrhatus* that was found in all 7 habitats. Although significant, habitat segregation was not well marked as in some similar co-occurring *Spizaetus* species. Further he states that the relative overlap between the two species may in part result from human influences with dense continuous rain forest canopy being replaced by more open forests. Bruno et al; (2014) assessed population density, home range and habitat use of Crested Serpent-Eagle (*Spilornis cheela*

hoya) in Southern Taiwan. Where they used distance based analysis and compositional analysis to compare habitat use and the home ranges. He found that habitat use was non-random both within the study area and the home range as mixed forests covered only 24.4% of the study area. Many perch sites were near the primary monsoon forest, which was however, almost never used for hunting. On the basis of the literature available the present study is designed to understand the occurrence / co-occurrence of these two serpent eagle species in Andaman Islands.

Chapter 2

STUDY AREA

2.1 Geography

Andaman and Nicobar Islands in the north-eastern Indian Ocean, known as the southern extension of Arakan Yoma mountain range, are the peaks of a submerged continuous mountain ridge arching from Arakan Yoma in the north to Sumatra in the south, between latitude 6°45' and 13°41'N and longitudes 92°12' and 93°57'E . The islands are divided into two major groups Andaman to the north and Nicobar 160 km to the south separated by the Ten Degree Channel. The Island group comprises of over 500 islands and covers 8,249 sq. km. with the Andaman group comprising of over 325 islands covering 6,408 sq. km., and the Nicobar group, with more than 24 islands with an area of 1,841 sq. km. The length between the extremities is about 355 km, while the maximum width is about 60 km. The islands have a coastline of 1,962 km. The highest point in these island groups is Saddle Peak that rises to 732 meters above sea level, in North Andaman (Kumar 1981, Saldanha 1989, Sankaran 1998, Andrews and Vasumati 2002, Jayaraj and Andrews 2005, Sankaran et al; 2005). The Andaman group of islands is further subdivided into (a) North Andaman (b) Middle Andaman and (c) South Andaman. North Andaman includes the northernmost Lanfall Island, the Narcondam Islands which is the only live volcano of Indian region, and also the Saddle Peak. To its south lies the Middle Andaman group consists of many islands including Baratang Island. The south Andaman Island group includes the capital Port Blair and several other islands. The islands of Ritchi's Archipelago are located to the east of Middle Andaman and the labyrinth group of islands is situated southwest to the South Andaman. Little Andaman Island is 55 km south to the South Andaman Island and is the southernmost part of the Andaman Islands, across Duncan Passage. The Nicobar group is divided into three subgroups. To the south is the Great Nicobar Island group consisting of two islands larger than 100 sq. km., nine islets smaller than 05 sq. km. and a few rocks. About 58 km north of Great Nicobar is the Nancowry group, which consists of three islands larger than 100 sq. km., two islands of 36 sq. km. and 67 sq. km., and three islands less than 17 sq. km., two islets and a few rocks. The northern subgroup, comprising of Batti Malv and Car Nicobar, is 88 km north of the Nancowrygroup.

Plate1: Map of the study area with grids of 5X5Km2

2.2 Climate

Andaman and Nicobar Islands are endowed with year-round true humid, tropical coastal climate with least variation in temperature between 20oC and 32oC. Temperatures between May and December are moderated by rain. The maximum temperatures are experienced during the dry season between January and April. Since these islands are under the influence of both the south-west and north-east monsoons, they receive rain from April to December. The mean annual precipitation is around 3100 mm, unevenly distributed throughout the year with maximum rains occurring from May to December. Average relative humidity ranges from 68% to 86%. The islands receive north-eastern winds between November and March and south-western winds between May and October. Cyclone winds and gales are usually common with change of monsoons and sudden depressions in the sea around. Maximum daily sunshine of 8-10 hrs is usually observed during the dry months while in the rainy season clouds restrict this to 3-8 hrs. Due to a fairly dust-free and clean sky, solar radiation is intense during the peak of the day (Saldanha 1989, Andrews and Vasumati 2002, Jayaraj and Andrews 2005).

2.3 Geology

Andaman-Nicobar arc extends from the southern strip of Burma to the northeastern strip of the Java-Sumatra trench. The origin of these islands is believed to be in late Pliocene to Pleistocene from a single eruption. The region of the Burmese arc through Arakan and the Andaman Nicobar Islands to Sumatra and beyond is characterized by highly seismic, seismic and aseismic zones with earthquake segments of shallow to intermediate foci in the earth crust (Kumar 1981, 1990). As these islands are in a geosynclinals basin, the rocks are highly folded due to frequent tectonic movements. The tectonic activity of the Andaman area is intense along two broad belts: western non-volcanic arc comprising the Andaman Nicobar Islands, and the eastern volcanic arc. The eastern island arc is the most active belt along which a lithospheric convergence has taken place (Srinivasan 1979, Kumar 1981, Jafri et al 1993). The strongly folded thrust of segmented layer is removed repeatedly from the place of deposition. Late Cretaceous ophiolites occur in limestone, sandstone, shale and radiolarite. They are basic and ultrabasic submarine flows. Acid submarine tuffs occur inter-bedded in the fossiliferous lower Miocene or post-Pliocene rocks, along with plugs of basic and intermediate lava and agglomerate rocks (Kumar 1981). The sedimentation and the surface depositions are believed to be from the Cretaceous to the Sub-Recent period and from the Recent respectively. The present arrangement would have taken shape recently, only 26 million years ago with two volcanic islands, Narcondam and Barren Islands (ANI F&E 2001). The oldest sedimentary strata known in the Andaman-Nicobar Islands is the Archipelago group. This group

overlying the Late Cenozoic sediments of the Andaman-Nicobar region consists of well developed marine deposits near Baratang, Middle Andaman.

2.4 Flora and fauna

Andaman is home to many endemic species of plants and birds. About 70% of the forests in Andaman are tropical wet evergreen forest. Besides these there are semi-evergreen, moist deciduous, dry forests and coastal forests which include mangroves and littoral swamps (ANI F&E, 2011). About 2,200 varieties of plants are recorded, out of which 220 are endemic and 1,300 do not occur in mainland India (ANI F&E, 2011). The North and Middle Andaman group is characterized by following vegetation types according to Champion and Seth (1968).

1. Tropical Wet Evergreen Forests

   The annual rainfall of Andaman ranges from 2500 – 3000 mm. The trees in this region are tall dense and multi layered. Bamboos and canes occur in many locations and also the forests are full of ferns and epiphytes.
2. Tropical Semi-evergreen forests

   These forests occur in areas adjoining evergreen forests. These have poor growth of trees when compared to Evergreen forests. These forests form a transition zone between moist deciduous and evergreen forests. Bamboos, canes, ferns and epiphytes are abundant.
3. Tropical Deciduous forests

   These forests occur in areas with rainfall around 2000 mm. these forests are dominated by species like Teak (*Tectona grandis*) and others.
4. Littoral and Swamps

   These forests consist of Mangroves *Rhizospora* sp., *Avicennia* sp and others. The swamps are dominated by *Syzium cumini* and *Trewia nudiflora* sp, whereas the littoral forests consist of *Pandanus* Sp., Cane Brakes and Palms.

The Andaman Island has got around 50 species of animals. Most of them are thought to be introduced from outside and are now considered endemic due to their prolonged adaptation. Rodents are largest group having 26 species followed by 14 species of bats. There are two endemic varieties of Pigs, namely *Sus scrofa andamanensis* from Andaman and *Sus scrofa nicobarensis* from Nicobar. The spotted deer *Axis axis*, barking deer and sambar are also found in Andaman Island. Interview Island in middle Andaman holds a good population of elephants. There are 225 species of butterflies in Andaman and Nicobar Islands. Ten species are endemic to these Islands. Mount Harriet national park is one of the richest butterfly and moth diversity areas on these Islands. Apart from these terrestrial fauna, Andaman is also rich in marine life. Different kinds of shells

such as Giant Clam, Green mussel are also found in these regions. Pearl Oyster, wing oyster, Giant Clam etc are also known to occur in Andaman Sea. Andaman is also rich in coral diversity (A&N official website).

2.5 Intensive study area

The study was carried in the North and Middle Andaman Islands (Map 1). This region lies to the extreme north of Andaman Island. It is 285 km south of Myanmar and located between 12°95´Nlatitude and 92°86´Elongitude. It covers an area of about 1458 sq.km. It is a group of about 70 Islands. The Austin strait separates it from the middle Andaman region. Many small and large islands surround North Andaman leaving it in the centre. These islands include Landfall Island, Interview Island, Paget Island, Smith Island and Sound Island which are some of the important Islands. Among these Interview Island is a wildlife sanctuary and an IBA (Wikipedia.org). Along with the feral elephants the island is home to many endemic and threatened floral and faunal species. The island also bears many threatened birds like; Andaman Teal (*Anas albogularis*), Andaman Crake (*Rallina caningi*), Andaman Green Pigeon ((*Treron chloropterus*) Andaman Serpent-eagle (*Spilornis elegini*) and many more (Vijayan and Sankaran, 2000). Besides this the island is also known for having limestone caves with the cave dwelling Edible-nest Swiftlet (*Aerodramus fuciphagus*) breeding in (Manchi and Sankaran, 2008) which nest in caves. The Andaman Crake, a marsh bird also has a population with narrow range of distribution. Middle Andaman lies between North Andaman and Baratang Islands between latitudes 12° to 13°N and longitudes 92°30´ to 93°E. Total area of middle Andaman Island is 1535.60sq.km (IIRS, report). There is a Jarawa Tribal Reserve to the west of the Island from Kadamtala to Bakultala forest ranges. This Tribal reserve is a totally undisturbed patch of forest with giant canopies of trees. The forest of middle Andaman Island is moist deciduous with lots of huge trees. They also have dense understorey which consist of thorny bushes. The area of Mayabunder, Karmatang and Bakuntala were thoroughly surveyed for our study. Baratang (690.49sq.km) Island is situated between middle Andaman to its north and South Andaman to its south.

Chapter 3

METHODOLOGY

As the study was designed for limited time period we preferred collecting more spatial data than temporal. This study was limited to the selected larger islands (more than 100 km^2). We used stratified random sampling for selecting sampling units / cells. Data was collected between February 2015 and April 2015. For Stratified Random Sampling the study area was initially gridded into 5X5km^2 grid size using Q GIS software. Further, the study cells were selected randomly. These cells were surveyed to understand occurrence of raptors in the area. As the serpent eagles are long ranging and highly mobile species, Line Transects Method (Sutherland et al; 2004) was used to observe these raptors during present study. Line transects are known to be suitable for large, mobile species with low population densities like raptors. Using this method it is easy to cover the ground and record many birds efficiently. There is very little chance of double counting of birds as observer keeps moving continuously. Because of the constant movement, birds are less attracted towards the observer. The Fixed Effort Search method (Watson, 2004) was used to understand occurrence of the study species. Each transect was walked for 20 minutes. Efforts were made to keep the transects as strait as possible to avoid repetition of the individuals. The transects were mostly walked from morning hours, wherever and whenever possible the observations were extended to late afternoon also. (Nijman, 2004). Sampling in the peak afternoon hours was avoided, as the activity of eagles subsides in peak afternoon hours. Birds were observed through Nikon 8*40 Binoculars.

Each raptor individual encountered in the transect area was recorded. GPS (Garmin Oregon 550 model) locations were taken for each sighting of any raptor individuals during the observations. Broad habitat where the individuals were present was noted and categorized as Evergreen Forest, Semi-evergreen Forest, Deciduous Forest, Mangrove Forest, Littoral Forest, Plantations and Agricultural Open Lands. Other microhabitat characters like Perching height, canopy cover, weather conditions, etc. were also observed and noted. Activity of the bird was recorded as perching, flying, feeding, etc. Whenever the raptors were encountered flying in a group the group size and composition was recorded.

As the observer wasn't much experienced identifying raptors by call was avoided, only sight records were considered and presence of an individuals. Apart from line transect, Opportunistic Casual Sightings of raptors were also recorded while reaching different transects. Total 110

transects were walked in 13 different sampling units/cells. Each transect was visited thrice with in a ten days of time. Around 300hrs of sampling efforts were made to cover approximately 300km of total walk along the transect. All the observations were taken by three observers. Observer 1 was an expert in bird identification, observer 2 was moderate and the third one was an amateur. Apart from the raptor species other avifauna was also noted while walking along the transects and casual encounters.

Plate 2: Photographs of the Crested Serpent-eagle (right) and Andaman Serpent-eagle (left).

All the data collected was entered in Ms Excel spreadsheet. Preliminary statistics (graphs, charts, see graph 1 and pie chart 1&2) was carried out in Excel itself. In order to find out the detection probability, we used the program PRESENCE, version 2.4, (Hines, 2006) using two species occupancy model. The co-variates were not included. The detection probability for Andaman Serpent Eagle and Crested Serpent Eagle was calculated separately. Also the encounter rate for both the species was calculated using program PRESENCE, version 2.4, (Hines, 2006).

Chapter 4

RESULTS AND DISCUSSION

Raptors being one of the top predators in the ecosystems they are found it is very important to understand their ecology, breeding biology and other conservation related issues. One such issue is the occurrence of these magnificent birds in different habitats (Del Hoyo et. al., 2001, Naouroji, 2006, Rahmani 2012). Another most important issue to be prioritised is conservation of the endemic raptor species especially the species like Andaman Serpent-eagle limited to the islands. It is also very important to understand relation of these species with their sympatric species who play an important role in their distribution and resource utilization through competition. To understand such issue an attempt was made to study the Serpent Eagles (Accipiteridae) distributed in the Andaman Islands. This study was planned to understand the occurrence of the Serpent Eagles with a special attention to their habitat sharing or co-existence.

Of total 18 diurnal raptor species, known from the Andaman Islands, only 6 Species were seen during the study (Appendix 1) The raptor species encountered during the study were Andaman Serpent-eagle (*Spilornis elegini*), Crested Serpent-eagle *(Spilornis cheela davissoni)*, White bellied sea eagle (*Haliaeetus leucogaster*), Black Baza (*Aviceda leuphotes*), Changeable Hawk eagle (*Nisaetus cirrhatus*) and Oriental Honey Buzzard (*Pernis ptilorhyncus*). Multiple times these raptors were seen flying/soaring in a flock. The Andaman Serpent eagles and Changeable Hawk eagle were seen flying side by side on two occasions. There were 2 individuals of Changeable Hawk eagle and 1 individual of Andaman Serpent-eagle in the same flock. On another occasion the Andaman Serpent-eagle, Crested Serpent-eagle and White bellied sea eagle were observed soaring together on Interview Island. This behaviour of raptors was very frequently seen on the Interview Island. Crested Serpent-eagle was seen soaring in groups of three or four individuals in Coastal forests on Baratang Island. The White Bellied Sea-eagle (*H.leucogaster*) was seen soaring over small islands in the middle of Sea. Oriental honey buzzard ((*Pernis ptilorhyncus*) was seen only once in flight on the transect. Black Baza (*Aviceda leuphotes*) was encountered, solitary and in pair several times during the survey. The species was never seen in groups of three or more. The Changeable Hawk Eagle was recorded very frequently in coastal forests, five individuals soaring together over the Mangrove Forest.

Both the Andaman and Crested Serpent-eagles were encountered during the study. When compared, detection probability of the Andaman Serpent-eagle (0.116 ± 0.002) was found to be higher than the Crested Serpent-eagle (0.033 ± 0.001). Further, the encounter rates estimated advocates higher

relative abundance of Andaman Serpent-eagle (Encounter Rate = 0.283) compare to the Crested Serpent-eagle (Encounter Rate = 0.106; Graph 1).

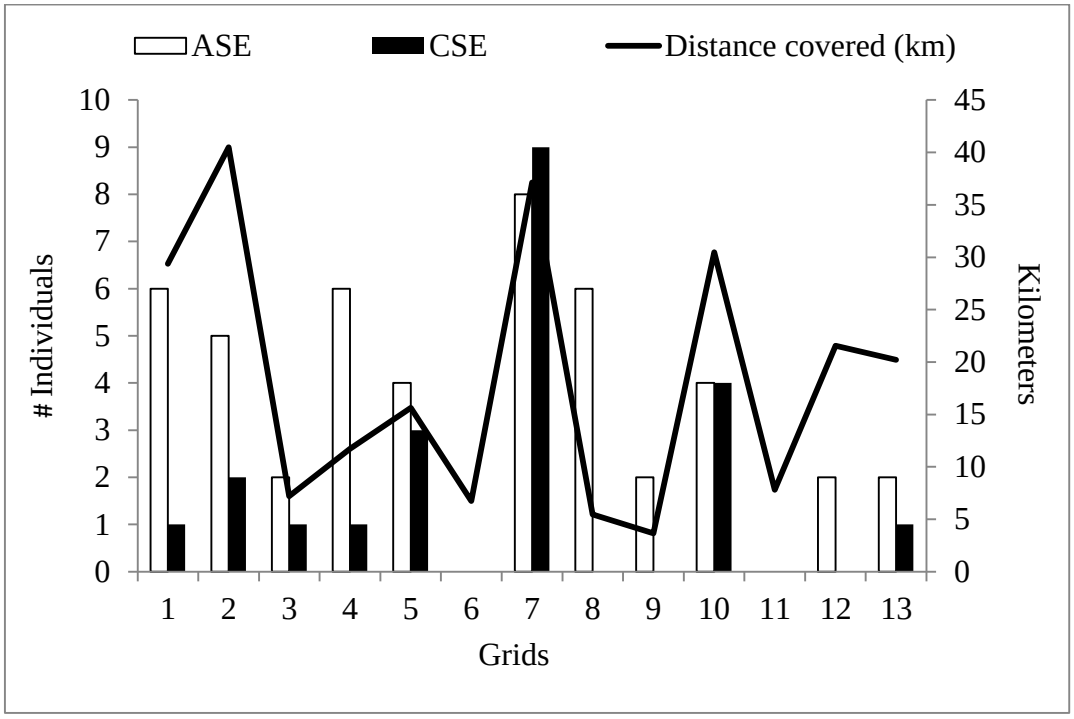

Fig. 1: Sampling efforts and individual encounters in different grids during the survey

As known earlier the Andaman Serpent-eagle is more common that the Crested Serpent-eagle in Andaman Islands. This may be because the former species is believed to be probably derived from ancient common stock whereas later species presumably descended from more recent second wave colonists that have tended to be restricted by competition (Lee and Christie, 1998). The detection probability estimated for both the species suggest that the data collected in this short period may not be enough to generate detailed results regarding occupancy of the species but it definitely gives a preliminary idea regarding abundance of the species.

Except in Plantations all the habitats (Evergreen Forest, Semi-evergreen Forest, Deciduous Forest, Littoral Forest, Mangrove Forest and Agriculture Open land) were occupied/used by both the species. Andaman Serpent-eagle was encountered most in the Deciduous Forest; conversely none was seen in Plantations. The Crested Serpent-eagle was encountered more in Mangrove Forest (Fig. 2). The Andaman Serpent-eagle was not encountered in the Plantations may be because of the timing of survey. Most of the plantations in the study area are of Teak (*Tectona grandis*) which is a dry deciduous species and doesn't bear leaves on branches (Drivedi,). This in turn results in the high leaf litter on the ground, which may provide enough space for the reptiles (food of the Andaman Serpent-eagle) to hide. Also the perching areas are open under the hot sun which also

may restrict this forest dwelling species to visit these types of habitats during hot summer. Whereas, the Crested Serpent-eagle being known to occur in different habitats across its distribution (Naouroji 2006, Del Hoyo et. al., 2001) must have some reasons to visit the open dry deciduous forests in Andaman Islands. In future studies, it will be interesting to know the resource utilization by these species in different habitats.

Using the GPS locations of the sighting of the serpent eagles (along the transect and also opportunistic encounters) the map was plotted to understand co-existence of these two species (Map 2). The hypothesis that "the Andaman Serpent-eagle and the crested Serpent-eagle are ecologically separated in the Andaman Islands" is proved to be false. The map clearly shows that these species are confirmed to be co-existing/co-occurring. The Crested Serpent-eagle is certainly not restricted to the coastal forests as it was documented. The species is surely more common in the coastal forests, which may be the basic reason for such earlier understanding. Though raptors are known to be ecologically separated from their sympatric species in other island ecosystems (Rahmani, 2012, Nouroji, 2006), it isn't true in case of the serpent eagles in Andaman Islands.

Other than raptors we encountered 70 different bird species. This makes these forests of North and Middle Andaman islands very important as far as the Avifaunal conservation is concerned in the region.

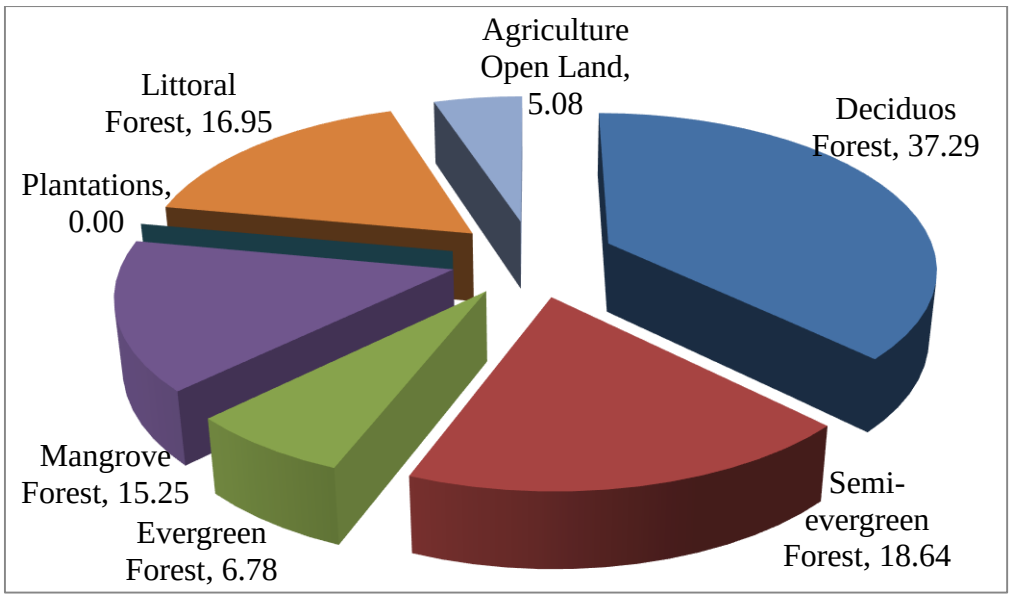

Fig.2: Occurrence of the Andaman Serpent-eagles in different habitats surveyed in North and Middle Andaman Islands.

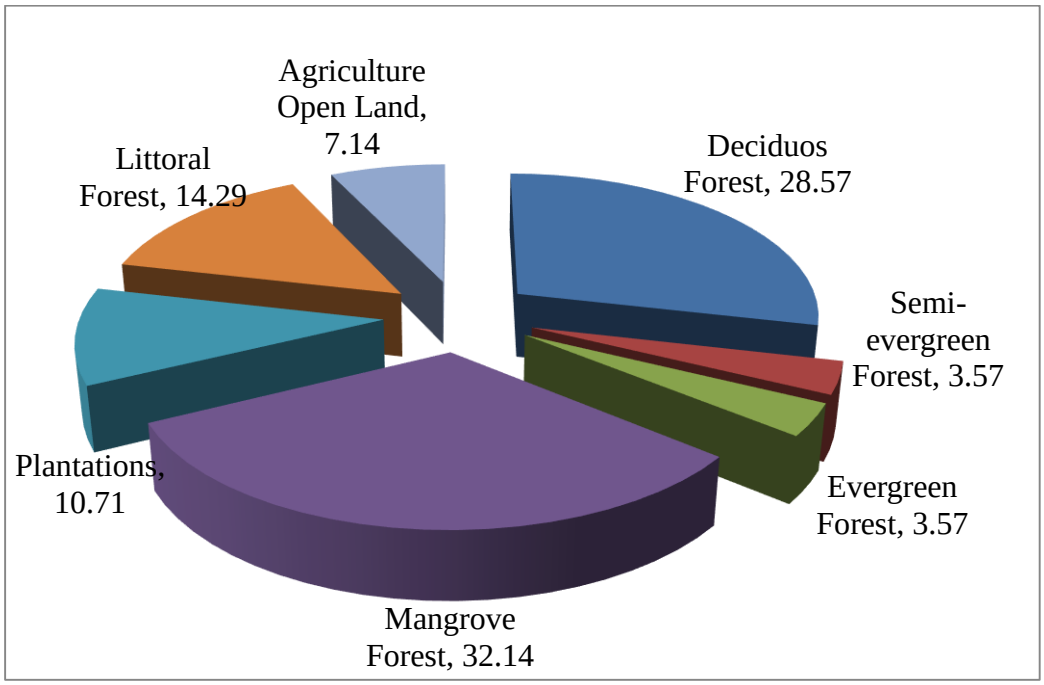

Fig.3: Occurrence of Crested Serpent eagles in different habitats surveyed in North and Middle Andaman Islands.

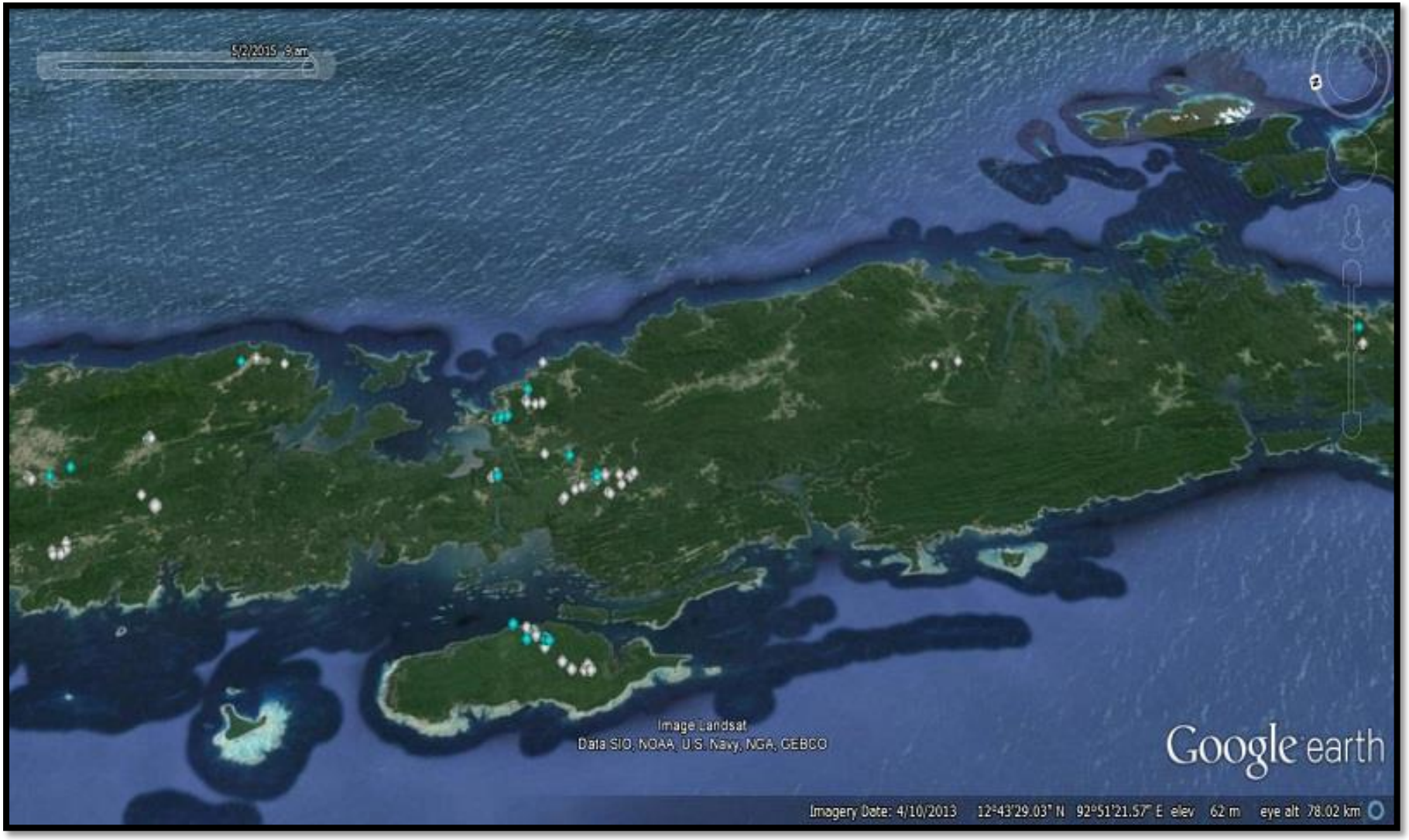

Plate 3: Google Earth snapshots depicting the distribution of both the species in different areas. *Light blue- Crested Serpent-eagle, *White- Andaman Serpent-eagle

Chapter 5

CONCLUSION AND RECCOMENDATIONS

As first ever scientific exploration focused on the raptor species in the Andaman and Nicobar islands present study lays a foundation stone for further scientific exploration in the study of raptors. The study may also be a first of its kind related to the forest dwelling raptors in the country.

As major outcome of the study it is now proved that the two sympatric serpent eagles are not ecologically separated by their habitats i.e. they do co-occur/co-exist. As the study was designed by keeping the conservation requirements of the endemic and threatened Andaman Serpent-eagle in mind the outcomes of the study are the baselines towards formulating the strategies for the same. The co-existence of these sympatric species in different habitats depicts that there is a competition between these species, which should be understood in detail through future scientific explorations.

The outcome related to estimation of detection probabilities depicts that further more data is required to generate detailed occupancy model of the species population and habitat relation. Similarly, existence of the species in different habitats can be a baseline for the further habitat utilization studies of the species. Absence of the Andaman Serpent-eagle in plantations has to be investigated further.

On the basis of the information collected other that scientific data, it was learned that major threat to the Raptors in Andaman Island is habitat destruction through legal and illegal felling. The local forest department is therefore suggested to take immediate steps to control the deforestation in the islands.

Overall this small, short term study, with its focused objective has contributed significantly towards research of this splendid genus of birds of prey.

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Appendix 1

List of Raptors in Andaman Islands

Sr.No.	Common Name	Scientific Name	Family
1.	Crested Serpent eagle	*Spilornis cheela*	Accipitridae
2.	Andaman Serpent eagle	*Spilornis elegini*	Accipitridae
3.	*Great Nicobar Serpent eagle	*Spilornis klossi*	Accipitridae
4.	Changeable hawk eagle	*Cirrhatus limnaeetus*	Accipitridae
5.	*Long legged Buzzard	*Buteo ruffinus*	Accipitridae
6.	*Eurasian sparrowhawk	*Accipiter nisus*	Accipitridae
7.	Oriental honey buzzard	*Pernis ptilorhynchus*	Accipitridae
8.	*Osprey	*Pandion haliaetus*	Accipitridae
9.	Black Baza	*Aviceda luphotes*	Accipitridae
10.	*Booted eagle	*Hieraateus pennatus*	Accipitridae
11.	*Common Kestral	*Falco tinnunculus*	Accipitridae
12.	*Chinese Sparrowhawk	*Accipiter soloensis*	Accipitridae
13.	*Central Nicobar Serpent eagle	*Spilornis minimus*	Accipitridae
14.	*Japanese Sparrowhawk	*Accipiter gularis*	Accipitridae
15.	*Besra	*Accipiter virgatus*	Accipitridae
16.	White bellied sea eagle	*Haliaeetus leucogaster*	Accipitridae
17.	*Peregrine Falcon	*Falco peregrinus*	Falconidae
18.	*Brahmany Kite	*Haliastur indus*	Accipitridae
19.	*Nicobar Sparrowhawk	*Accipiter soloensis*	Accipitridae
20.	*Black Kite	*Milvus migrans*	Accipitridae
21.	*Eurasian Marsh Harrier	*Circus aeruginosus*	Accipitridae
22.	*Pied Harrier	*Circus melanoleucos*	Accipitridae

Note: Species marked with * were not encountered on the tansects or any time during our survey in Andaman Islands.

Appendix – 2

List of birds observed encountered on the transect during the survey of Serpent-eagles.

Sr.No.	Common Name	Scientific Name	Family
1	Changeable Hawk eagle	*Cirrhatus limnaeetus*	Accipitridae
2	Oriental Honey Buzzard	*Pernis ptilorhynchus*	Accipitridae
3	Black Baza	*Aviceda leuphotes*	Accipitridae
4	White bellied Sea eagle	*Haliaeetus leucogaster*	Accipitridae
5	Common Kingfisher	*Alcedo atthis*	Alcedinidae
6	Collared kingfisher	*Todiramphus coromanda*	Alcedinidae
7	Ruddy Kingfisher	*Halcyon smyrensis*	Alcedinidae
8	Stork billed Kingfisher	*Pelargopsis capensis*	Alcedinidae
9	Brown throated needle tail	*Hirundapus giganteus*	Apodidae
10	White breasted woodswallow	*Artamus leucorchyrechus*	Artamidae
11	Andaman Cuckooshrike	*Coracina dobsoni*	Campephagidae
12	Scarlet minivet	*Pericrocotus speciosus*	Campephagidae
13	Small minivet	*Pericrocotus cinnamomeus*	Campephagidae
14	Andaman Night Jar	*Caprimulgus andamanicus*	Caprinurlgidae
15	Nicobar Pigeon	*Colonas nicobarica*	Columbidae
16	Emerald Dove	*Chalcophaps indica*	Columbidae
17	Andaman wood pigeon	*Columba palumboides*	Columbidae
18	Green Imperial Pigeon	*Ducula aenea*	Columbidae
19	Andaman Cuckoo Dove	*Macropygia rufipennis*	Columbidae
20	Red Collared Dove	*Streptopelia tranquebarica*	Columbidae
21	Andaman Green Pigeion	*Treron chloropterus*	Columbidae
22	Dollarbird	*Eurystomus orientalis*	Coraciidae
23	Eastern Jungle Crow	*Corvus levaillantii*	Corvidae
24	Andaman tree pie	*Dendrocitta andamanensis*	Corvidae
25	Andaman Coucal	*Centropus andamanensis*	Cuculidae
26	Asian Koel	*Eudynamys scolopacea*	Cuculidae
27	Andaman Flowerpecker	*Dicaeum virescens*	Dicaeidae

28	Andaman Drongo	*Dicrucus andamanensis*	Dicruridae
29	Grester racket tailed Drongo	*Dicrucus paradisueus*	Dicruridae
30	Asian Ferry Blue Bird	*Irena purella*	Irenidae
31	Brown backed shrike	*Lanius cristatus*	Lannidae
32	Chestnut headed Bea-eater	*Merops leschenaultii*	Meropidae
33	Black napped Monarch	*Hypothymis azurea*	Monarchinae
34	Andaman Shama	*Copsychus malabaricus*	Muscicapidae
35	Oriental Magpie Robin	*Copsychus saularis*	Muscicapidae
36	Olive backed Sunbird	*Cinnyris jugularis*	Nectarinidae
37	Black napped Oriole	*Oriolus chinensis*	Oriolidae
38	Andaman Woodpecker	*Dryocopus hodgei*	Picidae
39	Spot breasted woodpecker	*Dendrocopos analis*	Picidae
40	White rumped Munia	*Lonchura striata*	Ploceidae
41	Vernals hanging Parrot	*Loriculus vernalis*	Psittacidae
42	Red breasted Parrakeet	*Psittacula alexandri*	Psittacidae
43	Alexandrine Parakeet	*Psittacula eupatria*	Psittacidae
44	Long tailed Parakeet	*Psittacula longicavda*	Psittacidae
45	Andaman Bulbul	*Pycnonotus striceps*	Pycnonotidae
46	Red Whiskered Bulbul	*Pycnonotus jocosus*	Pycnonotidae
47	White breasted water hen	*Amaurornis pheonicurus*	Rallidae
48	Andaman Crake	*Rallina caningi*	Rallidae
49	Humes Hawk Owl	*Ninox obscura*	Strigidae
50	Asian glossy starling	*Aplonis panayensis*	Sturnidae
51	Hill Myna	*Gracula religiosa*	Sturnidae
52	Common Myna	*Acridotheres tristid*	Sturnidae
53	White headed starling	*Sturnia erythropygia*	Sturnidae
54	Indian Pond Heron	*Ardeola grayii*	Ardeidae
55	Cattle egret	*Bubulcus ibis*	Ardeidae
56	Cinnamon bittern	*Ixobrychus cinnamomeus*	Ardeidae
57	Terek sandpiper	*Xenus cinereus*	Scolopacidae
58	Common sandpiper	*Acitis hypoleucos*	Scolopacidae
59	Common Snipe	*Gallinago gallinago*	Scolopacidae
60	Swinehoe’s Snipe	*Gallinago stenura*	Scolopacidae

Appendix- 3

Abbreviations used

et. al	and others
°	Degrees
E	East
=	equal to
`~	Equivalent to
Etc	et cetera
e.g.	Example
Fig	figure
Km	kilometre
m	meter
mm	mili meter
'	Minute
Viz	namely
N	North
/	Per
i.e.	That is
%	Percentage
‘‘	seconds