FORAGING ECOLOGY OF THE CRESTED DRONGO (*Dicrurus paradiseus lophorhinus*) IN THE SINHARAJA WORLD HERITAGE RESERVE

By

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DECLERATION

The work described in this thesis was carried out by me at the faculty of Applied sciences under the supervision of Prof. S.W. Kotagama, Dr. Eeben Goodel and Ms Enoka P. Kudawidange. A report on this has not been submitted any other university for another degree.

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Affectionately Dedicated to

My parents

And

Teachers

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ABSTRACT

Preliminary study of Foraging Ecology of Crested Drongo in the mixed-spices bird flocks was carried out in the Sinharaja World Heritage site The crested Drongo *Dicrurus paradiseus lophorhinus* belong to the Family Dicruridae, is known to be a key member of mixed foraging flocks, A number of studies have been carried out on the mixed foraging flocks of Sinharaja and However, there have been no studies of the foraging ecology of Drongos in Sinharaja, Hence, this information is an important missing piece of our understanding of the Sinharaja flock system.

The study aimed to identify whether Crested Drongos kleptoparacitize, consume insect species disturbed by other birds. Change their perching behaviour based on the presence of other birds. And whether they feed more inside or outside of flock. Hypothesis was derived based on the above questions.

The methodology identified the study area initially. The study was conducted 10th February 2005 to 27th April 2005. A sampling strategy was decided and executed in seven sampling area as defined by the experimental design to obtain some selected parameters and data on the role of the crested Drongo within flocks. The observations were made using with binoculars, while tape recording the birds' vocalizations.

In total, 597 observations were made of the Crested Drongo in the 1588 minute used *Ad-libitum* sampling method. Data analysis was conducted separately for the different questions listed in the Objectives. According to the results kleptoparasitism is a rare but consistent tactic of Drongo and the nature of the event defer according to the species subjected to it. About 466 - 605 observations were made of Drongo foraged in mixed-species birds' flocks. Although kleptoparasitism occurred only 4% of the total observations and it was seen at all seven sites. A significant percentage of the foraging of the Drongos appears to be on insect disturbed by other birds, in 63% of our 488 observations. The relationship between Drano's, Orange-billed Babbler and Ashy-headed Laughing-thrush the overall relationship was provided extremely strongly significant relationship is significant for tow of the site, overall relationship is inverse Orange-billed Babbler and much less strong significant. Drongo forage more inside flock than out side as expected. The rate of sallying and hovering trip is in nearly six times more inside flocks than out side of them.

Overall conclusion the data makes it evident that Crested Drongo (*Dicrurus paradiseus lophorhinus)* benefits by association with flocks. That they adjust their feeding in flocks to take advantage of insect disturbed by other species (change their foraging height with Ashy-headed laughingthrushes) and they sometime or rarely kleptoparasitism other species implicating some cost on the birds they associate with.

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ABRIVATION

AHL : Ashy headed Laughing-thrush

ICBP : International council for bird preservation

OBB : Orange-billed Babbler

S.W.H.S : Sinharaja World Heritage Site

CHAPTER 01

Introduction

1.1 Background

The Crested Drongo *(Dicrurus paradiseus lophorhinus)* belongs to the Family Dicruridae, Genus Dicrurus. The Crested Drongo is easy to identify with its glossy black color, tufted crest on the forehead, and long deeply fork tail. The distribution of the Crested Drongo is in the wet zone forests of Sri Lanka and nearby hills up to1700 m (Harrison, 1999).

A preliminary study of the foraging ecology of the Crested Drongo in mixed-species bird flocks was carried out in the Sinharaja World Heritage Site. The Sinharaja forest reserve is one of the least disturbed and biologically unique lowland rain forests in Sri Lanka covering an extent of about 11187 hectares from east to west. It was declared a Man and Biosphere Reserve (MAB) in 1978, as a representative of tropical humid evergreen forest ecosystem in Sri Lanka and has been recognized by UNESCO as part of its International Network of Biosphere Reserves. It was declared a National Wilderness Area in 1988 and lately a World Heritage Site in 1989. It is situated in the southwest lowland wet zone of the country in the districts of Ratnapura, Galle and Matara. It lies within latitudes 6 °21 ′ - 6 ° 26′ and longitude 80 ° 21′ – 80 ° 34′.

Preliminary studies on the fauna of the Sinharaja have revealed that there is a high degree of endemism among the butterflies, fish amphibian, reptiles, birds and mammals. In fact that 95% of the endemic birds of Sri Lanka are recorded in Sinharaja. Out of the birds recorded in the western sector of the reserve, 72% were resident non-endemic and 13% migrants (De Zoysa and Raheem, 1987).

An interesting phenomenon of the avifauna of Sinharaja is the presence of mixed-species foraging birds flocks. This unique behavior of moving around in a flock improves the feeding efficiency and offers protection against predators of many kinds. Many of the rare species of birds are found in these flocks, including the Red-faced Malkoha *(Phaenicophaeus pyrrhocephalus)*, the White-headed Starling (*Sturnus albofrontatus*), and the Ashy-headed Laughing-thrush (*Garrulax cinereifrons*), which are all considered vulnerable to extinction (Bird Life International, 2001). On average, a bird flocks contain around 12 species and 40-50 birds as participants (Kotagama and Goodale, 2004). This includes members from 12 endemic species that are recorded to participate to flocks. Two species have been recognized as central or 'nuclear' species of these flocks: i.e. the Orange-billed Babbler (*Turdoides rufescens*) and the Greater Racket-tailed Drongo (*Dicrurus paradiseus lophorhinus*); the latter is the subject of this research.

Duration of the research was fifteen weeks from February to May 2005. The study investigated whether Crested Drongos kleptoparacitize other flock members and how they disturb other birds in foraging. Furthermore, statistical analyzing was used to analyze the relationship of perching behavior in the presence of other birds,and how feeding rates of Crested Drongos differ inside and outside flocks

1.2 Scope of the study

The scope is to find how Drongos benefit from being in flocks. They have been shown to increase foraging in association with other birds (Veena and Lokesha, 1993; Hino, 1998). They also have been reported to "kleptoparacitize" other birds – that is, directly steal food from other species of birds (Hino, 1998; King and Rappole 2001). However, there have been no studies of the foraging ecology of drongos in Sinharaja, other than the collection of some preliminary data. Hence, this information is an important missing piece of our understanding of the Sinharaja flock system.

1.3 Objectives:

This investigation aims to identifying answers these specific questions:

1. To investigate whether Crested Drongos kleptoparacitize (physically take) food from other birds in flocks.
2. To investigate whether Crested Drongos consume insect species disturbed by other birds.
3. To investigate whether Crested Drongos change their perching behaviour based on the presence of other birds.
4. To investigate whether Crested Drongos feed more inside or outside of flock.

1.4 Hypotheses (as pertaining questions above):

1. Based on the observations of several observers (Goodale, personal communication; Caldera, unpublished data), Crested Drongos do kleptoparacitize other species, but very rarely.
2. Based on the observations of several observers (Goodale, personal communication; Caldera, unpublished data), Crested Drongos consume insects disturbed by other species, sometimes chasing insects that other birds have already been chasing, and often perching below other birds.
3. Crested Drongo changes its perching behaviour to be close to other species that disturb insects. Specifically, It is expected that Crested Drongos that are close (in the horizontal direction) to Orange-billed Babblers will perch high, as these babblers feed in the canopy. In contrast, it is expected that Crested Drongos that are close horizontally to Ashy-headed Laughing-thrush will perch low, as laughing thrushes feed in the understory.
4. Crested Drongos forage more, and are more successful in foraging inside of flocks as opposed to outside of flocks.

CHAPTER 02

Literature Review

2.1 Avifauna of the world

Birds are at once the most beautiful, the most widely admired, the most entertaining and the most studied group of animals on the earth. In capturing our imagination they reign supreme and thus have done more to promote to wildlife conservation and care of the environment than all other creatures put together. Birds have enormous variety, including approximately 9000 species, more than twice number of mammals on earth. Survive in every habitat in every continent, some how 9000 species in the world. They get ride of their habitat unfavorable climatic condition, too hot or too cold environment and bird is arrived favorable habitat across the mountain, bars among the few birds' some species can world across ocean (Martin, 1987).

Birds are vertebrate warm-blooded animals, i.e. whose temperature remains more ore less constant and independent of the surrounding temperature. This contrasts with to reptiles, amphibians and fish, which are cold blooded. To assist in maintaining an even temperature, the body of a bird is covered with non-conducting feathers, which is the chief characteristic of a bird. The body temperature of birds, 38 ^{0}C- 44 ^{0}C is higher than that of mammals. Assisted by there non-conducting covering of feathers, birds are able to withstand great extremes of climate. Their rate of metabolism is higher than that of mammals and they lack of sweat glands (Ali, 1996).

Bird local population often fluctuate greatly through migration, seasonal food supplies, breeding success, natural disasters, pollution and habitat destruction. There are thought to be between 8600 and 9016 species in the world among the birds 265 species were list has threatened by the ICBP (International council for bird preservation 1987) red data book endangered bird of the world. The annual death rate of adult passerines is 40%-60% but the percentage of eggs that reach full adulthood average annually about 12%. The most widespread species distribution in the world is very complex subject full of variable, In accordance with long-term factor such as climatic changes and short form influences such as habitat modification by man. World wild distribution rare at the level of genera species, but among the widespread bird families are Grebes, Cormorants, Herons, Harriers, Falcons, Rails, Pigeon, Nightjars, Pipits, Thrushes and Crows. Several seabirds and shorebirds genera are virtually cosmopolitan (Martin, 1987).

Birds are extinct in the world, why it is influence environment such as climate change and natural disordered and man made pollution habitat fragmentation. So far fewer than 2000 fossil species of birds have been discovered, including 900 extinct fossil species. None is thought to have evolved in the last 25000 years or so, and it has been estimated that (based on known fossils and percent of avifauna) the total number of species, which have ever lived is about 154000 (Martin, 1987).

2.1.1 The Birds of Indian Subcontinent

The total number of bird species known to science as inhabiting the earth today has been estimated as about 8600. If subspecies of geographical races are taken into account, the figure would rice by nearly 3000. The erstwhile "Indian Empire" or "British India ", in which, besides Pakistan and Burma it was customary for biological consideration to include Sir Lanka as well, contain one of the richest and varied avifauna on the face of globe. Covering some 40 degrees latitude and about the same of longitude, it enclosed within boundaries a vast diversity of climate and physical features (Ali, 1996).

This vast subcontinent covers two-thirds of Europe in superficial area, and with its extensive coastline, affords suitable living condition to a great variety of feathered inhabitants. The second edition of the fauna of British India series on birds enumerated some 2400 forms (species and subspecies). The last checklist a synopsis of the birds of India and Pakistan list 2061 forms of which over 300 are winter visitor, chiefly from paratactic region to the north (Ali, 1996).

The area as the whole falls in to the zoogeographical division of the earth known as the Oriental Region. For the sake of convenience it has been split up into five primary subdivisions as given below (Ali, 1996).

1 The Indo-Gangetic plain
2 Peninsular India
3 Sri Lanka
4 The Himalayas
5 Assam

2.1.2 The Birds of Sri Lanka

Sri Lanka avifauna is one of the richest in the whole of Asia. It contains 435 species, comprising 331 regular species found within the land boundary of the country including the 68 species irregularly species recorded over year and 36 oceanic species.

There are 23 confirmed endemic species in Sri Lanka (Kotagama and Wijayasinha 1998). Recently, a new owl species was discovered in Sri Lanka (reference). In addition, 12 other species have been suggested as endemics in a recent book (Rasmussen and Adkissson 2005). Most of these endemic birds are threatened by rapid destruction of forest and drying off of water flows.

Important bird watching areas include: Kumana on the east coast; Bundala and Kalamatiya on the southern coast, and Sinharaja Rain Forest, Udawatta Kale, Bellanwila, Muthurajawela, Minneriya, Kitulgala and Minipe in the interior. In additions you can see birds through out the country in pockets of forests, lakes, lagoons and riversides (Virtual Library Sri Lanka, 1995-2005).

2.2 Drongos (Tribe Dicrurini)

Drongos are found in Africa and Southern Asia, and are medium size passerines with characteristic black and often glossy plumage, long, often deeply fork tails and a very upright stance when perched. They are mainly arboreal and insectivores, catching winged insects by aerial sallies from a perch. Nectar and occasionally small birds, reptiles and mammals supplement their diet. When in pursuit of insect, Drongos are very agile, twisting and turning adroitly in mid-air. Although usually solitary, they gather in flocks at good food sources, such as flowering trees, or when chasing, fleeing insects in the smock of forest fires (Ali, 1996) or when feeding on termite swarms (Goodale, personal observation). Their direct flight is swift, strong and undulating (Ali, 1996).

Drongos are bold and pugnacious, and will fearlessly drive away longer predatory birds which threaten their nest. They are typically rather noisy and have a varied repertoire of harsh call and pleasant whistles; some species are good mimics. Usually Drongos' nests are flimsy cups made of twigs grasses and other plant fiber, bound together with cobwebs, and built between twigs of horizontal fork near the end of the branch (Harrison, 1999; Henry, 1998; Grimet et al., 1998).

Coloration is chiefly glossy jet-black, grayish or slaty in some species. The bill is stout ~~shapely~~ and craniates; it is covered at base by dense short feathers partially concealing the nostrils. The head can beun-crested, or with a variably pronounced tuft on forehead (Ali and Ripley, 1987).

2.3 The Crested Drongo *(Dicrurus paradiseus lophorhinus)*

2.3.1 Scientific classification

Kindom: Animalia
Phylum: Chordata
Class: Aves
Order: Passeriformes
Family: Dicruridae
Sub family: Dicrurinea
Genera: *Dicrurus*
Species: *paradiseus*
Subspecies: *lophorhinus*

(Ali, 1996; Grimett et al., 1999; Elections for the Board of Trustees , 2005.)

2.3.2 The Nomenclature

Dicrurus lophorhinus, Vieill .N. Dct.d' Hist. Nat. ix. P. 587(1817);Gray, Hand-1.B.i p.285(1869).

Dicrurus lophorhinus, Gray,Hand- 1.B.i.p285.

Dissemurus lophorhinus, Holdsworth, P.Z.S.1872, p 439.

Dissemuroides edoliiformis, Shrape, Cat. Bird, iii. P. 256(1877); Tweeddale, Ibis, 1878, p.78.

English Name: Crested Drongo

Sinhala Name: Kawda; Kaputa-baya.; Konder Kauda

Tamil name: Irattai-val-kuruvi

(Legge, 1983)

2.3.3 Morphology

Crested Drongos are the size of the common myna, but with long tails. The sexes are alike, and the young merely duller, with s shorter crest and tail, (Henry, 1998).

"Length (beak to tail) is roughly 13.4 to14.1 inches; wing 5.6 to 6.0; tail-outer feathers 7.2 to 7.6, central feathers 2.3 to 2.5; tarsus 1.0 to1.1; mid toe 0.75, claw (straight) 0.3; hind toe 0.5, claw (straight) 0.4; bill to gape 1.35 to 1.4; Plumage is black, highly glossed with a metallic luster, which on the head, hind neck, throat, and chest it of steel-blue tinge, and on the back, wing-coverts, and outer web of the tail-fathers dark green; quill black, the outer webs glossed; base of r lumage; flanks an abdomen brownish black; the under tail cover glossed at the tips. irish dull brownish red or dark yellowish red; bill, legs, and feet black" (Legges, 1983).

2.3.4 Distribution in Sri Lanka

The strongholds of the Crested Drongo consists of the western province and the south west corner of the island; include the southern hill-range (Legges, 1983), wet zone forest and nearby hills to 1700 m (Harrison, 1999). Through this area the species is plentifully diffused. Drongos' northerly limit is the Kurunagala district, extending along the bases of the Matale hills and includes the southern province. It is found in all the forest and heavy jungle in the wet zone forest of the western forest, it is appearing the their prosperously in the excessively humid jungle than in those further up the west cost (Legge, 1983).

Subspecies endemic in Sri Lanka Its range is becoming contacted owing to increasing encroachment upon its forest habitat for rubber plantation etc (Ali, 1996).

2.3.5 Habits

Drongos live singly or in pairs, sometime gathering in a group of five or six birds. Drongos are very found with mixed bands of insectivores birds in forest. A (Ali, 1996). As Henry (1998) describes "Insectivorous, it loves to perch on some high, looping liana, from which it swoops down upon any flying insect disturbed by the busy searchers below".

2.3.6 Breeding

Season, April and May but very little known. The only authentic nest so fairs described as a flimsy cup rather small for the size of the bird, about ten meters up in a tail straight tree on the edge of jungle bordering. Eggs not authentically described. (Ali, 1996).

Fig 2.1 Grater Racket-tail Drongo
Dicrurus paradiseus

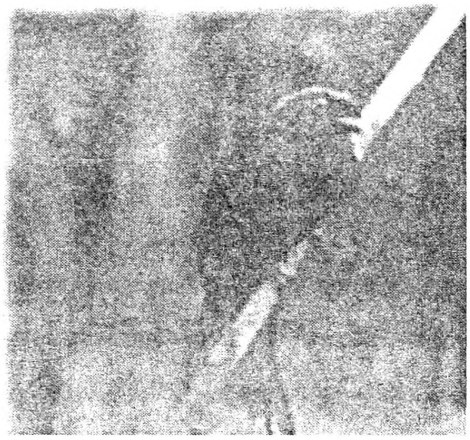


Fig2.2 Crested Drongo
(Dicrurus paradiseus lophorhinus)

2.4 Animal Behaviour

2.4.1 Introduction

The behaviour is the action, which changes the relationship between the animal, and its environment. No animal live along in the biosphere; each comes in contact with other animal during it is lifetime. All organisms maintain relation with their surrounding nonliving and living environment. This implies that an organism can change in response to a change in its environment. These changes are directional, and are known as behaviour. The animal's survival depends on the maintenance of relations with the environment; hence, this adaptive relationship between animal and its environment is also referred to as behaviour. The behaviour may occur as a result of an external stimulus. Receptors are necessary to detect the stimulus. The nerves coordinated the response and effectors carry out the action. Behaviour also can occur as a result of an internal stimulus (Ranga 2002).

Behaviour includes all those processes by which an animal senses the external world and the internal of its body and responds to stimulation it perceives. Thus behaviour can be defined as the way on organism responds to stimuli in its environment (Prasad, 2004). We can normally classify the forms of behaviour in two parts

1. Innate Behaviour: - A response of an animal to an external stimulus that is genetically encoded. It is more or less stereotyped and most similar among individuals inthe population.
2. Learned Behaviour:-Adaptive change in individual behaviour as a result of experiences.

2.4.2 Importance of Ethology

The study of animal behavior in the field is called ethology (Prasad 2004). Ethology is important because: All animals have a variety of complex relationships with members of their own species, with members of other species, and with the physical environment. The survival of species depend on its individual members' by studying animals even can learn about relationship between them and their environment' As a result conserve and protect endangered species, economically important predators, pest and parasites, furthermore domestic animal that provide our well-being, while other study animals in captivity in order to preserve and inhabit them of the education of huminity. In short the study of animal behaviour is enormously important, both scientifically and economically (Dickamer et al., 1996).

2.4.3 Approaches of Studying Behaviour

Study of animal behaviour is a very interesting field of life sciences and man has developed numerous methods for its investigation. Ethologist study subject on animal directly in nature as well as in laboratory.

The scientifically study of animal behaviour involve a variety of approaches. Behaviour can also be explained on many levels: in terms of evolutionary history, in terms of benefit that it bring to the animal, and in terms of physiological mechanism (Prasad, 2004).

2.4.3.1 Vitalistic Approach

Vitalistic approach is a behavioural activity of animals it is relation with the changes in the environment It involves the total rejection of any study of the animal outside its natural environment. The technique has its foundations in natural history and has provided a wealth of valuable data (Prasad, 2004).

2.4.3.2 Ecological Approach

Relation between the behaviour of a species and other living beings along with non–biotic components of environment is ecological approach. Ecological approaches proceed in two ways. It can focus either on a group of species or on a particular habitat. In focusing on the habitat, one would be interested in the parallel behavioural adaptations that are found in certain habitats. This suggests the convergent evolution of behaviour (Dickamer et al., 1996; Prasad 2004).

2.4.3.3 Mechanistic Approach

This approach is experimentally approach involved the study of particular aspects of behaviour under control condition in a laboratory. This technique is however, used extensively in physiology and was pioneered by Pavlov, Skinner, Kohler and Koffka. This approach may be criticized on the ground of the artificiality of the experimental situation (Dickamer et al., 1996; Prasad, 2004)

2.4.3.4 Physiological approach

It involves the physiological basis of behaviour. It branches-Ethogenetic, Neuroethology, Ethoendocrinology and pheromone–ethology deal with the relation between genetics, nervous system, hormones, pheromone and behavioural respectively (Dickamer et al., 1996, Prasad 2004).

2.4.3.5 Ehtological Approach

This is the contemporary approach of behavioral investigation an and attempt to explain responses, observed in the filed and in terms of stimuli, eliciting the behavior, it involved broth of the techniques out line above (Dickamer et al., 1996; Prasad 2004, Ranga 2002).

2.5 Commonly Used Sampling Method in Behavioral Studies

The design features for studies of animal behaviour apply equally in laboratory and field a situation. In recent years, many field studies of animal species have focused considerable attention in research strategies and methods of collecting data under field conditions. The most widely accepted methods of study of animal behaviour are given below (table 2.1) (Dickamer et al., 1996; Prasad 2004)

2.5.1 *Ad libitum* sampling

One selects the species of the animal and lives with them in their habitat for required period and behavior of the interest is noted (Prasad, 2004).

2.5.2 Focal animal sampling

Involves recording all the action and interaction of one particular animal during the prescribed time period. Using this technique, an observer may watch the large number of animals, recording the behaviour of each for short period (e.g five or ten minute per animal), or observer may recorded the behaviour of fewer focal animal, each being watched over a long time period (hour per animal) (Dickamer et al., 1996).

The selected individual of interest gets the highest priority for recording its behaviour., Different methods are adapted to identify individual members. Individual member of a species bear identifiable individual marks, with the help of natural individual marks, age, sex and in absence of natural marks animal are captured and marked either by colour, number individual in identification (Prasad, 2004).

2.5.3 Scan sampling

The technique also called instantaneous sampling, an observer using this technique watchers each animal for only a few seconds periodic interval and record the activity that the animal is performing only at the specific time at the marks indicated by the sampling scheme. The interval between samples if the behaviour of the each individual can vary, but generally, there are a few minutes to the half hour. (Dickamer et al., 1996)

2.5.4 All occurrence sampling

Only one behaviour is taking in to account and recording of all concerned unit is done carefully. While the studying interactions two species of animal one can note what kind of interaction was there, agonistic or amicable? If agonistic, then whether it was chase, overthrow, threat or sometime else? All occurrence of selected behaviour is possible if three factors exist (Prasad, 2004).

- Observation conditions are adequate.
- The behaviours are been carefully defined so that they are easily recognized.
- Behaviour do not occur more often than the observer can note them

2.5.5 Sequence sample

The attention is focused on a chain of behaviour of an individual. It observation is done right from the beginning to the end of the behaviour (Prasad, 2004).

2.5.6 One-zero sampling

One-zero sampling is recording the occurrence or nonoccurrence of each of set of behaviour patterns within the series of time period. This scheme is seen by some investigator as the best way to record a wide range of activities encompassing solitary action, objected-directed behaviour, and social interaction. This may also useful method for capturing the occurrence of behaviour patterns that either occur with very low frequency or are of brief duration (Dickamer et al., 1996).

Sampling method	Definition	State or Event sampling	Principle type of information	Advantage
Ad *libitum*	Non systematic informal observation(filed not)	Either	Non systemátic	Rear, unusual event
Focal animal sampling	Change in behaviour recorded continuously per animal	Either	Duration, participation in interaction, - frequency, rate sequence	Comeliest data record per individual
All occurrences of selected behaviour	All concurrent sylectical behaviour in member of a group of the recoded	Usually event	Synchrony rates	Concentrate on specific behaviour of the individual in a group.
Scan sampling	Behaviour is sampled at regularly periodic interval point, time sampling	state	Estimate of time spent Synchrony	easiest way to estimate % of time
One –zero sampling	A predetermined interval is established if behaviour occur during the interval given the score one; if not scored as zero finely interval time span modified frequently checklist, it answer frequency	Usually state	Modified frequency	Rabidity easy to used

Table 2.1 Most widely accepted method of study of animal behaviour (Alman, 1975).

2.6 Foraging Behviour

All animals must acquire food for energy, so foraging is clearly related to an animal's fitness. Animals are likely to be under natural selection to be effective foragers. A tool of behavioral ecologist called optimal modeling has been frequently used in the study of foraging behaviour. I Optimality models have three parts: 1)a set of decisions, 2) the currency (compare the value of deferent decisions) and 3) the constraints or limits on the animal (Drickamer et al., 1996; Prasad, 2004).

2.7 Foraging Model

Here I pay particular attention to two types of models: 1) diet selection models, and 2) prey model and patch models. The former deal with the types of prey a forager should eat while the latter deal with how long a forager should stay in food containing a patch (Drickamer et al., 1996; Prasad, 2004).

2.7.1 Choice of food items

Most species of animals are surrounded by all manner of things that they might consider eating. The scenario is that a forager is searching for food, and it find one prey at the time. Consider the three part of this model. The decision variable is whether the forager should eat the prey it has found, or whether it should search for another type of prey. An important factor is how long it takes an animal to process a food item, called the handling time. Different types of prey require different handling times and different searching times. An assumption (limitation) of these models is that the forager can't handle prey and search for it at the same time. The model predicts which that prey types should be added to the diet in order of their order of their profitability (Drickamer et al., 1996; Prasad 2004).

2.7.2 How long to stay in a patch

Whether or not to eat a particular food item is not the only problem facing foraging animals. Food resources are not distributed randomly in the environment, but instead occur in patches; foragers seeking the food must decide how long to stay in a particular patch, or when to leave and find a new patch. For example, consider a bird that eats berries. Should it search the bush so it will get every last berry, or should it move in to another bush? Two factors are important: 1) the average richness of the patch (how many berries in a bush) and the average distance between patches (how far is it between berry bushes).These factors can be looked at simultaneously with graphical model called the Marginal Value theorem (Drickamer et al., 1996).

If an animal is maximizing its net energy gain, it should leave when the expected net gain from traveling to and foraging in a new perch is positive. As with the diet-selection model, all the assumptions of the model are not necessary met in real life. Foragers faced with two patches of unknown prey density might be expected to sample both (Drickamer et al., 1996).

2.7.3 Central-place foraging

Extension with this model has been developed for central-place foragers, animal that carry food back to a central location for storage or for feeding to an off spring. The problem here is not only when to leave the patch, but also which and how much food to collect before returning to home base. Time in patch, load size, and selectivity are predicted to increase as the travel distance increases the adult collected the prey item when the young than feeding themselves. (Drickamer et al., 1996)

2.7.4 Effect of Competitors on Foraging Behaviour

Competition by member of the same or different species may force them to forage in suboptimal habitats or to includ food items they would not otherwise consume. One way to increase net energy gain is by depend a territory against potential competition. (Drickamer et.al 1996)

2.7.5 Effect of Predators on Foraging Behaviour

Many foraging animals are also potential prey themselves. And most balance the risk of predation with the benefits of foraging. Often, an animal is less vigilant to presence of danger when it is attacking or handling prey. In addition, animal that rally on cover to avoid detection by predator may "blow their cover" when attacking prey and these become more vulnerable to attack. Risk of predation may also affect the choice of patch often these is a trade-off: high quality patches may sometime pose the greatest risk of predation (Drickamer et al., 1996; Prasad, 2004).

2.8 Feeding Techniques

Natural selection has resulting variety of techniques for maximizing the net rate of energy. Five of these techniques are discussed below (Drickamer et.al 1996).

A. Modifying food supply –

Some animal modifies their food supply so that it increases. For example, grazing animals in the grassland stimulate the growth of some species of grass and prevent succession of grassland communities to other community types such as forest. Some species of inter tidal limpets increases their food supply with the mucous they secrete that acts as an adhesive trap for alga. The mucous also stimulate alga growth along the trail, and the limpets feed on these algae as they retrace their patch home (Drickamer et al., 1996)

B. Trap Building

Some invertebrates such as ant lion (genus *Myrmeleon,* in the order Neuropetera) larvae make traps to capture food. They make funnel–shaped pits in the sand and burry themselves just below the pit. Most orb webs are flat, and a spider sites either at the hub or a connecting thread and monitors the variation of prey hitting the web. The spider pulls on the radii near the hub with its hind legs, and pull on the tension thread with its front legs, and sits motionless waiting for prey (Drickamer et.al 1996, Prasad 2004).

C. Electrogenetic Field

Usually channels of communication may be used to capture foods. For example, electric fish generate their own electric field and can identify the presence of potential prey by the alternation of this field by the prey. They can even judge the distance of the prey by comparing the amplitude and the gradient of the voltage distribution. Unfortunately for these fish, sharks can detect their electric fields too! Some mammals also can use electro-reception, e.g. Platypus (Drickamer et al., 1996).

D. Aggressive Mimicry

Fish of the order Lophiiformers have modified dorsal fin spines on tip of their snout. At the end of the modified spine may be a fleshy appendage, a tuft of the filaments or in deep sea forms, an arrangement containing light emitting bacteria such as crustacean worms etc. The rest of the fish is well camoflagueds to look like a long-encrusted rock or sponge. Small marine animals are attracted to the tip of the spine, and are then consumed by the fish. Aggressive mimicry can be purely behaviour as well as morphological (Drickamer et al., 1996).

E. Tools

The use of tools is not an exclusively human trail. It has evolved independently in several different lineages. In most cases the tool is an unmodified, inanimate object. However, sometimes animals modify the tool, such as when chimpanzees strip leaves from a twig to make a tool that they use to stick in termite mounds and eat the termites (Drickamer et al., 1996; Prasad, 2004).

2.9 Foraging and Social Behaviour

When food is spread widely and irregularly over the environment and it can't be defended, individual of a spocies may gather into a flock or herd and may associate with other species. Forage may directly benefit neighbors in several ways (Drickamer et al., 1996; Prasad, 2004).

2.9.1 Sharing Information

Foragers may get information about food sources from one another, especially if food occurs in dense, rare patches which are unpredictable in time or space. Animals may monitor the area around the other foragers that have found food. Some species produce distinctive sounds to conspecifics when they discover food. Groups may also act as "information centers" for food finding (Ward and Zahavi, 1973).In these cases, an unsuccessful foraging follows previously successful group member back to a food source.

Animals feeding in gropes may forage more efficiently because each individual spends less time scanning the environment for predators. Also, some individuals in social groups may specialize in stealing food from other individuals or in joining other that have already located food. These asymmetrical roles have been called "Producers" and "Scroungers". This creates a problem for the producers, which must decide whether to stay with the scrounger or to leave for another foraging group (Thorpe, 1956).

2.9.2 Comparative Hunting

Some animal attack down larger or more dangerous prey when they hunt as a group. For example, some tropical spider species socially and cooperatively inhabit large communal webs, which may be several meters across. Another spectacular food caching enterprise is the march of an army ants colony. Perhaps the most familiar and most intensively studied cooperative hunters are the mammalian carnivores. One member of the family Felidae and several number of the family Canidae has avoided complex social behaviour related to the cooperative capture of prey. The lion (*Panthera leo*) lives in closed social unite and is most abundant in the grassland often woodland of Africa. The used a stalk-and-rush method of hunting (Drickamer et al., 1996).

2.10 The Flock System

"Mixed-species flocks are a prominent form of social organization of foraging birds, particularly in the tropics" (Powell, 1985). Flock systems vary widely in the numbers of species and individuals involved, with some of this variation explained by factors related to predation, including the openness of the vegetation and the density of avian predators (Thiollay, 1999).

Generally, birds in flocks fall into two categories: "nucleus" species, always found in parties, either mixed or pure; and "circumference" species, which join the mixed parties, as a rule, by attaching themselves to parties of "nucleus" specie. When nucleus species often communicate information from one individual to another of their own species, other members of the party often paid little attention; the advantage of disturbance depended greatly on the feeding habits of the species concerned (Winterbottom, 1948).

Davis (1946) divided birds found in the bird parties into "regular" and "accidental," the former being, as the name implies, normally found in bird parties and only abnormally outside them, while the latter only join the flocks occasionally and are normally found outside them. The Drongo, *Dicrurus a. adsimilis*, is, as Davis pointed out, a typical "accidental" species. The other common "circumference" species, such as *Dryoscopus*, Batis and *Sylvietta* are "regular" in Davis's sense. Apart from *Dicrurus* which occupies a unique position, a number of other African species occur as "accidentals" in bird parties, but they are infrequent and do not seem to me to affect the theoretical implications. The species composing bird parties divided into four categories:

(I) "Nucleolus" species apparently much more important in the African savannah and Burmese forest than in south American forest.

(ii) Other "regular" species.

(iii) "Regular accidental" species, of which Dicrurus is the only certain example, but the American *Drymophila* may also fall into this category

(iv) "Accidental" species. Normally forming parties of its own but sometimes joining mixed parties or being joined by a few other species, One point about the advantages of the flocking habit in mixed bird parties, the aggregations afford any protection to the members, either by an intimidating influence on Predators or from an increased vigilance due to so many pairs of eyes, the " confusing effect" – when many birds flying at one time makes the predator confused (Winterbottom, 1948).

2.10.1 The Flock System in Sri Lanka

Mixed-species bird flocks are a prominent feature of the avifauna of the Indian subcontinent. Many species participate in flocks in at least some of their range, as frequently noted in S. Ali and S. D. Ripley's species accounts (Ali and Ripley 1987). In Sri Lanka, the majority of common species are more readily observed inside of mixed flocks than outside of them (Kotagama and Goodale 2004). In Sri Lanka, flock systems have been described at montane elevations (Partridge and Ashcroft 1976), and at low elevations in the wet-zone (Kotagama and Goodale 2004). Flocks without babblers were found primarily on the transect at the lowest elevation (six flocks found on the 400 m transect in the Delwala reserve) and on the transect at the highest elevation (five flocks found on the 1100 transect near the former Morningside estate in the eastern sector of the Sinharaja reserve). Such flocks were substantially smaller than those that included babblers (averaging 7.4 species and 15 individuals; comparison to babbler-led flocks. At the lowest elevation transect, babblers were not present. The one constant in flocks at this transect was the presence of Greater Racket-tailed Drongos (*Dicrurus paradiseus*), which were in every flock. At the highest elevation transect, flocks similar to the montane system co-existed with the larger babbler-led system. These flocks were led by the Sri Lanka White-eye (*Zosterops ceylonensis*) and the Grey-headed Canary Flycatcher (*Culicicapa ceylonensis*), the two most numerous species in the mountain system These observations of flocks without babblers clarify the roles of species in the wet-zone lowland flock system and the relationship between that system and the mountain flock system. Geographical variation in flocks may provide greater insight into the interdependence of flock participants on each other (Kotagama and Wijayasinha 1998).

2.10.2 The flock system in Sinharaja Forest

Kotagama and Goodale have studied mixed-species flocks in Sinharaja since 1981. They defined flocks to be two or more species moving in the same direction. Flock composition and size Flocks averaged 10.9 (±4.5, n=476) species, with 59 bird and five mammal species seen in flocks. By far the most frequent flock members were Orange-billed Babbler and Greater Racket-tailed Drongo *Dicrurus paradiseus*, each of which was present in c.90% of flocks. Nineteen other species were involved in more than 25% of flocks, qualifying as 'regular members' (Powell 1985); "Mammals (dusky palm squirrel *Funambulus ublineatus*, Layard's palm squirrel *Funambulus layardi*, Indian palm squirrel *Funambulus palmarum*, grizzled giant squirrel *Ratufa macroura*, and purple-faced leaf monkey *Trachypithecus vetulus*) were rare in flocks, although the three *Funambulus* species squirrels collectively occurred in 25% of flocks. These small squirrels appeared to be as much members of the flocks as the birds, repeatedly moving in the same direction as the flock".

"Flocks averaged 41.3 (±22.9, n=298) individuals. Although the majority of species were represented by 1–3 individuals per flock (Table 1), Orange-billed Babbler averaged 16.2 (±10.8; n=268) individuals per flock, with occasionally more than 50 individuals. When this species was present in flocks, 37% of the individuals were Orange-billed Babblers". Furthermore, at any moment in time, Orange-billed Babblers were an even larger proportion of the flock than this, since they stayed with the flock continuously whereas other species joined and then left flocks (even if a species moved with the flock only once it was counted as a flock member) (Kotagama and Goodale, 2004).

Insectivores dominate these flocks, although s, omnivores and even frugivores. Join flocks. Among insectivores, there is a wide range of foraging techniques in flocks (Appendix VII). Kotagama & Goodale (2004) characterised five species as primarily leaf-gleaning (Ashy headed Laughing-thrush, Dark-fronted Babbler *Rhopocichla atriceps*, Orangebilled Babbler, Red-faced Malkoha, and White-faced Starling), four species as hawking or hovering (Asian Paradise-flycatcher, Black-naped Monarch *Hypothymis azurea*, Greater Racket-tailed Drongo and Malabar Trogon *Harpactes fasciatus*), and two species as woodprobing or gleaning (Lesser Yellownape *Picus chlorolophus* and Velvet-fronted Nuthatch *Sitta frontalis*).

- Species roles in Sri Lankan flocks

The Orange-billed Babbler is clearly a nuclear species for the Sinharaja flocks, they are present in most flocks, rarely seen away from them, highly gregarious, lead the flocks, and are constantly active and vocal. Congeneric species have been shown to live in closely related groups and to perform kin-selected behaviours that could be exploited by other species (Gaston, 1977). Another potential nuclear species is Greater Racket-tailed Drongo, as this species is found in most flocks, it is rarely found outside flocks, leads the flock more than would be expected by chance, and is quite vocal. Drongos forage by fly catching, they are interring specifically aggressive (EG, personal observation), and have been reported to kleptoparasitise other species in mixed-species flocks (King and Rappole, 2001), so it is unlikely that other species gain any foraging benefits from associating with them. However, drongos give alarm calls that are more reliable than those of Orange billed Babblers (Goodale and Kotagama in press), so other species may gain anti-predation benefits from joining drongos in flocks. Further behavioural observations may clarify the benefits that species gain from associating in flocks.

2.10.3 Species Roles in Mixed Bird Flocks

Mixed-species bird flocks have found that 'nuclear' species, those important to flock coherence, are generally of two types: intraspecifically gregarious species and 'sentinel' species that are highly sensitive to predators. Both types of species are present in flocks of a Sri Lankan rainforest: Orange-billed Babblers (*Turdoides rufescens*) are highly gregarious, whereas Greater Racket-tailed Drongos (*Dicrurus paradiseus*) are less so, but more sensitive and reliable alarm-callers.

In the study of flock organization, patterns are emerging as to what species lead the flocks or act as the kernels around which flocks form. Species are considered nuclear if they are found in a high percentage of flocks, are rarely found outside of flocks, and lead flocks, being joined by other species more than they follow other birds (Hutto, 1994 Two types of nuclear species have been observed. One type consists of species that are intraspecifically gregarious,) the other type of nuclear species includes those not particularly gregarious but highly sensitive to the presence of predators (Greig-Smith, 1981; Munn, 1984). These two types of nuclear species are usually found in separate flock systems, but they are found together in a flock system of a Sri Lankan rainforest: Orange-billed Babblers are highly gregarious, whereas Greater Racket-tailed Drongos are less gregarious but more sensitive and reliable alarm-callers, (Goodale and Kotagama in press) determine why nuclear species are attractive to other species. : One is that they are good indications of a flock and their active movements and vocalizations make them easy to follow (Hutto, 1994) other one is that other species directly benefit from association with the nuclear species they follow.

The benefit from sentinel species is clearly increased vigilance, but the benefits from gregarious species are more varied. They may be kin or mate selected to give warning of predator attacks, which other species can eavesdrop on (Gaddis, 1980). Further, association with gregarious species can increase other species' foraging efficiency as they may disturb insects as the flock moves through the forest (Hino, 1998), or serve as models for other species to copy foraging locations or techniques (Krebs, 1973). Thus, species in the Sri Lankan flock system could obtain very different benefits from babblers than from Drongos.

Birds outside of flocks in this Sri Lankan rainforest were attracted to heterospecific vocalizations and that species with high propensity to flock were attracted most to the two nuclear species of the flock, the babbler and the Drongo. When categorizing species by diet, we found that insectivores, but not omnivores and frugivores, preferred the babbler and Drongo vocalizations to the vocalizations of the barbet. (Goodale & Kotagama in press)

Goodale and Kotagama pointed out two possible explanations for the results: (a) both species are good indications of flocks since they so rarely occur outside of flocks, or (b) the two species both give benefits to species that associate with them, benefits most likely related to anti-predation (while babblers' alarm calls may not be as reliable as drongos, their large numbers reduce other species' risk). Both these explanations can explain the high attraction to the combined treatment because flocks with both species tend to be larger and benefits could be additive. Although they could not distinguish between these two hypotheses, they make one conclusion that was rather unexpected: a 'sentinel' species such as the drongo can be as attractive to flock participants outside of flocks as a highly gregarious species (Goodale & Kotagama in press).

2.11 Kleptoparasitism

Drongos *Dicrurus* of several species are known to occur in mixed species-species flocks during the non-breeding season. In India, the Greater Racket-tailed Drongo *Dicrurus paradiseus* has been found in flocks with Greater Yellownapes *Picus flavinucha* (Bates, 1952), and the Black Drongo *Dicrurus macrocercus* frequently associates with Common Mynas (*Acridotheres tristis)* (Dewar, 1904; ; Veena and Lokesha, 1993). In addition, Crested Drongo *(Dicrurus forficatus)* attends mixed-species foraging flock in Madagascar (Hino, 1998).

Kleptoparasitism is defined as the stealing of food already procured by another animal (Brockmann and Barnard, 1979). In African flocks, kleptoparasitism was recorded several times and it was argued to be the main advantage for drongos of joining the flock (Dean 1988; Vernon 1980). Observed kleptoparasitism between forktailed Drongos (*Dicrurus adsimilis*) and orange-throated longclaws *(Macronyx capensis)*, and speculated that kleptoparasitism between perched-hunters and ground feeding birds could be relatively common. According to Brockmann and Barnard (1979) prey beating is one of the conditions that may lead to kleptoparasitism.

Drongos may use their strident alarm call to scare and distract other insectivores birds, at the crucial movement that the foraging bird disturbed, located or caught the prey. This result that foraging bird either diving for caver or at least in a movement of a confusing hesitating while pursuing its prey, Drongo take chance catch the prey. (Herremans and Tonnoeyr, 1997) Drongo manifest a strong vigilant early warning alarm function in mixed species bird parties (Dean, 1988) and it is precisely this intraspecific predator-evasion supports service that was occasionally being exploited by Drongo as and aid Kleptoparasitism. "Drongo applied to be harsh *kraaak kraaak kraaak* alarm call on the occasionally, evident at something below it on the ground to low perched nearby. Horizontally flight a way from the observer, while emit a loud E-gek-gek-gek, nearby laughing thrushes *(Garrulax)* flashed from the ground, and flew off in same direction as the Drongo". Overt Kleptoparasitism was really observed and exceptionally cold month in singularly low availability in fling insect (Herremans and Tonnoeyr, 1997). Drongo attack laughingthrushes *(Garrulax)*, in all of the instances, were initiated from and laughingthrushes foraging on the ground (Dean, 1988).

CHAPTOR-03

Material and Methodology

3.1 Study Area

3.1.1 The Sinharaja rain forest

Sinharaja forest reserve is one of the least disturbed and biologically unique lowland rain forests in Sri Lanka covering an extent of about 11187 hectares from east to west. It was declared a Man and Biosphere Reserve (MAB) in 1978 as a representative of tropical humid evergreen forest Ecosystem in Sri Lanka and has been recognized by UNESCO as part of its International Network of Biosphere reserves. It was declared a National wilderness area in 1988 and lately a world heritage site in 1989 (De Zoysa and Ryheem, 1987).

3.1.2 Geographical Location

Sinharaja forest is situated in the southwest lowland wet zone of Sri Lanka, within Sabaragamuwa and Southern provinces. It is bounded on the north by the Napola Dola and Koskulana Ganga, on the south and south-west by the Maha Dola and Gin Ganga, on the west by the Kalukandawa Ela and Kudawa Ganga and on the east by an ancient footpath near Beverley Tea Estate and by the Denuwa Kanda, 6°21'-6°26'N, 80°21'-80°34'E.

As a sampling strategy northwestern sector of the forest, I collected data from 7 different parts of the forest: along different parts of the main road which leads to Sinhagala (near the Research Station, between the barrier to the reserve and Leopard Rock, between West Main and Heendola, between Heendola and Sinhagala), as well as along the Moulavella footpath, the Morapitiya forest near the village of Pitikelle, and the Murakelle forest above the Kudava Forest Camp (De Zoysa and Ryheem, 1987). I assumed that these birds were different from each other, because the areas were approximately 1.5 km distant from each other and drongos have home-ranges of less than 1.5 km diameter (Goodale & Kotagama, unpublished data).

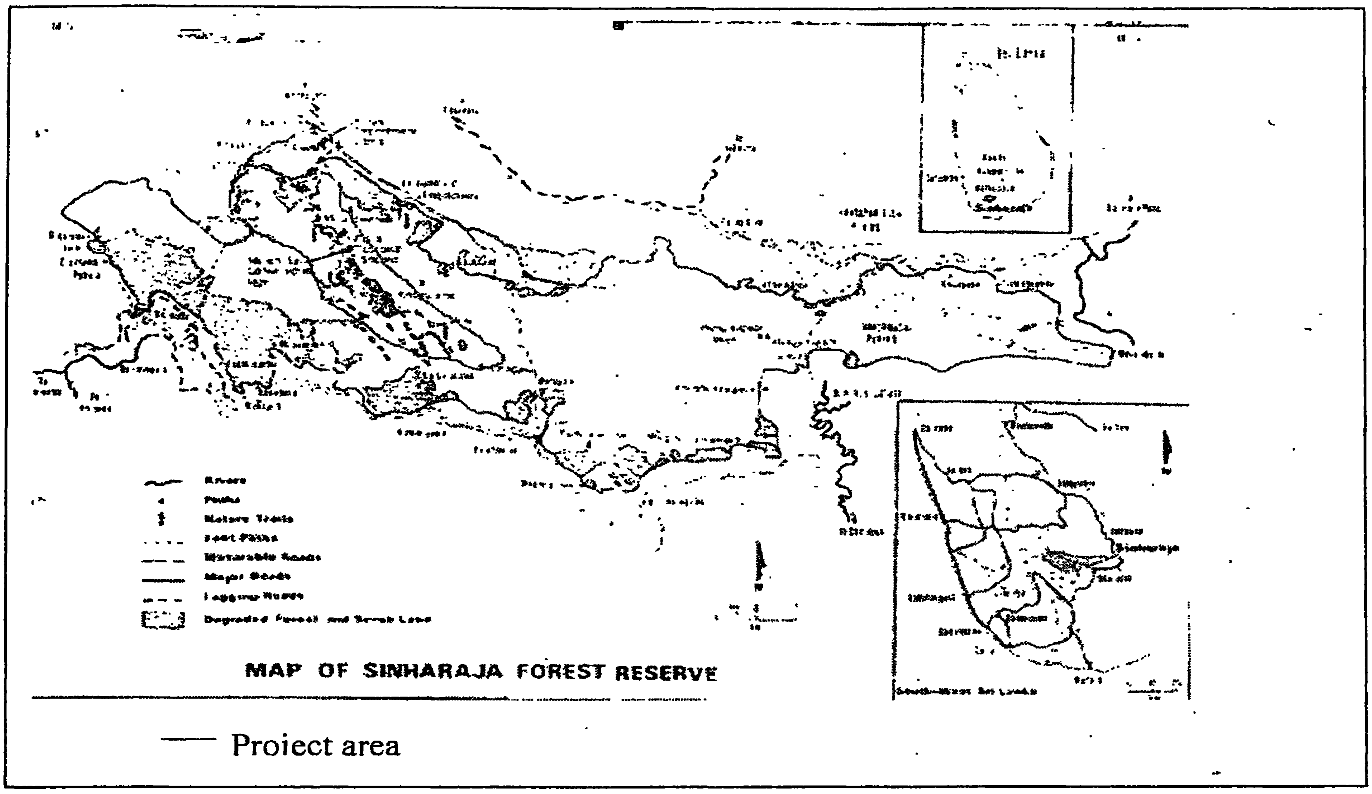


Fig 3.1 map if Sinharaja rain forest (De Zoysa and Ryheem, 1987).

3.1.3 Climate

Based on meteorological records gathered from in and around Sinharaja over the last 60 years, annual rainfall has ranged from 3614mm to 5006mm (Appendix VII) Mean annual rainfall data available for locations in and around Sinharaja and temperatures from 19°C to 34°C Temperature and relative humidity data available for Sinharaja Most precipitation emanates from the south-west monsoons during May-July and the north-east monsoons during November-January. Conditions are dry in February (De Zoysa and Ryheem, 1987).

3.1.4 The flora of Sinharaja

The vegetation of Sinharaja may be described either as tropical lowland rain forest or tropical wet evergreen forest with an endemism percentage of more than 90% of flora. The vegetation consists of dense, evergreen rainforest, dominated by *Mesua* species and *Shorea* species trees in the canopy (De Zoysa and Ryheem, 1987).

3.1.5 The fauna of Sinharaja

The complex vegetation structure of the rain forest provides a variety of dwelling places or niches for animals. Thus, not surprisingly, there is a rich diversity of fauna within a rain forest. A checklist of 262 vertebrate species has been complied which includes 60 species endemic to Sri Lanka in addition to more than 95% of the endemic birds of Sri Lanka are recorded in Sinharaja among its other fauna. Among the bird species, 72 % are resident while 13 % are migratory and approximately 160 bird species have been recorded in the forest (De Zoysa and Ryheem 1987).

3.2 Methodology

The study was conducted 10th February 2005 to 27th April 2005 in Sinharaja World Heritage Site (S.W.H.S) Sri Lanka. Sampling strategy was tried in several different areas. A total of 7 areas were planned, at least 1.5 km from each other to ensure statistical independence at one area. For one area, I was aimed to collect between 50-80 records (see description of a record below). Information was collected on foraging behaviour prior to study from a literature searched in order to plan the study (Legs 1983; Henry, 1998; Ali and Ripley, 1987; Ali, 1996), Kotagama and Goodalel 2004, De Zoysa 1987, Drickmer et al.1996), and personal communication, filed visit (trained) with Goodale.

Data collection: The observations were made using with binoculars, while tape recording the birds' vocalizations. The bird's behaviour was closely monitored to obtain the following data within a given time period following data was taken,

a) Date and time
b) Location of the focal bird (which area in the forest)
c) Whether the focal bird is inside (< 10 m from another bird) a large babbler (*Tudoides rufescens*) flock, associated with a flock of other species (e.g., Ashy-headed Laughingthrush *Garrulax cinereifrons*), or on the border of a flock (10-30 m. from another bird), or outside of a flock (>30 m from another bird).
d) Any physical features of the focal bird (especially crest or tail)
e) The distance of the focal bird from the observers
f) The height to the focal bird from the ground

g) The species identity of the nearest neighboring bird to the focal Drongo. The vertical and the horizontal distance between the focal bird and this closest neighbor.

h) The vertical and the horizontal distance between the focal bird and the nearest Orange-billed Babbler (*Turdoides rufescens*), if present.

i) The vertical and the horizontal distance between the focal bird and the nearest Ashy-headed Laughing thrush (*Garrulax cinereifrons*), if present.

j) The foraging maneuvers of the focal bird and whether the foraging maneuver observed is successful (whether an insect was caught), and what was the type of insect.

k) The distance from the focal bird to the closest neighboring bird, and the species identity of that neighboring bird, during flight.

l) Whether the Drongo performed any of the following behaviors:

    i) Chased another bird

    ii) Supplanted another bird (took position of another bird)

    iii) Took an insect from another birds' bill.

    iv) Caught an insect another bird was chasing.

    v) Caught an insect that was disturbed by the foraging of another bird.

m) As the species identity of the other bird involved. The vocalizations of the focal bird as one of the following:

    i) Silent

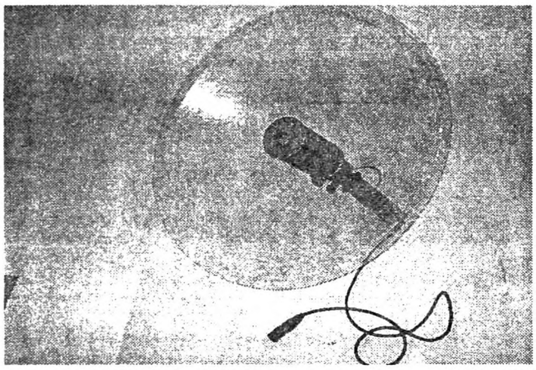
    ii) Calls on perch, followed by silence

    iii) Calls on perch, followed by immediate flight

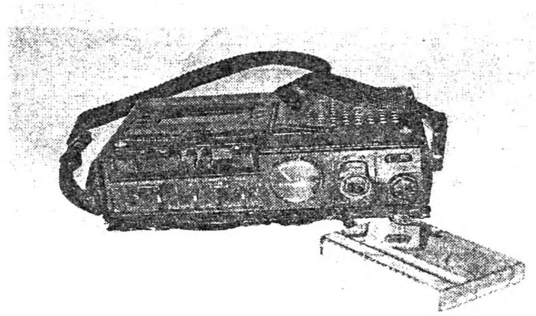
    iv) Call while flying

In total, 605 observations were made of the Crested Drongo in the 1588 minute used *Afocal* sampling method (Prasad, 2004) while vocalization records of Crested Drongo was collected. Insectivores foraging maneuvers were categorized (following Eguchi et al., 1993; Hino, 1998; Ali, 1996; Kotagama and Goodale, 2004) as: hawking, hovering, gleaning, trapping, h. in addition, I recorded whether the Crested Drongo kleptoparasited another bird, chased another birds or supplant another bird. Records on Crested Drongo mimicking other animals such as toque monkey, serpent eagle, giant squirrel and blue magpie were also recorded.

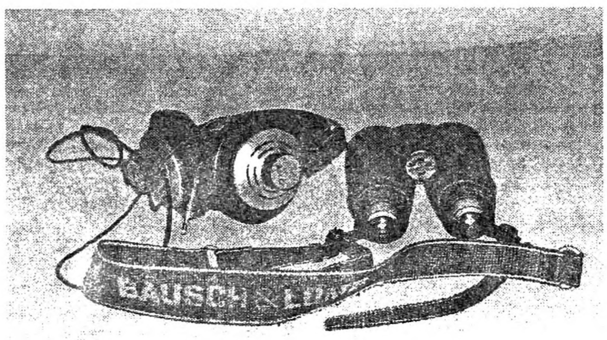
Observation and data collection were conducted with aid of 7 x 42 Bushnell binocular. Recordings were made with a Seinheiser ME 62 omnidirectional microphone embedded in a Telinga parabola and attached to n a Marantz PMD 222 .The duration of the behaviours was determined by stopwatch.



Parabolic mike



Marantz PMD 222 or 430 cassette recorder



7 x 42 Bushnel binocular Seinheiser ME 62 omnidirectional microphone

Fig 3.1 Apparatus Used

3.3 Analysis of Data

Data analysis was conducted separately for the different questions listed above Objectives.

1. For objective one and two (whether Crested Drongo takes food from other birds, or catches food disturbed by other birds): the analyses for these questions were simply to count the number of observations of each behaviour (see data collection, point: I). Count was presented as a percentage of the total foraging observations seen.
2. For objective three (whether Crested Drongo changes perching behaviour based on presence of other species): On this question, relationship between the horizontal and vertical distance of these species from focal Drongos was expected (see data collection, points h and i). it was tested by simple linear regression (13.20 version Minitab, Inc) The regression had conducted separately for the different forest areas.
3. For objective (whether Crested Drongo forages inside or outside of flocks). For this question, the foraging rates of Crested Drongo s inside and outside of flocks were compared. For each observation, calculated the number of sallies per minute, the number of hovers per minute and the number of insects captured per minute. (13.20 version Minitab, Inc), and compared using a t-test for unequal sample sizes to observe, whether these rates are higher inside flocks or outside of flocks.

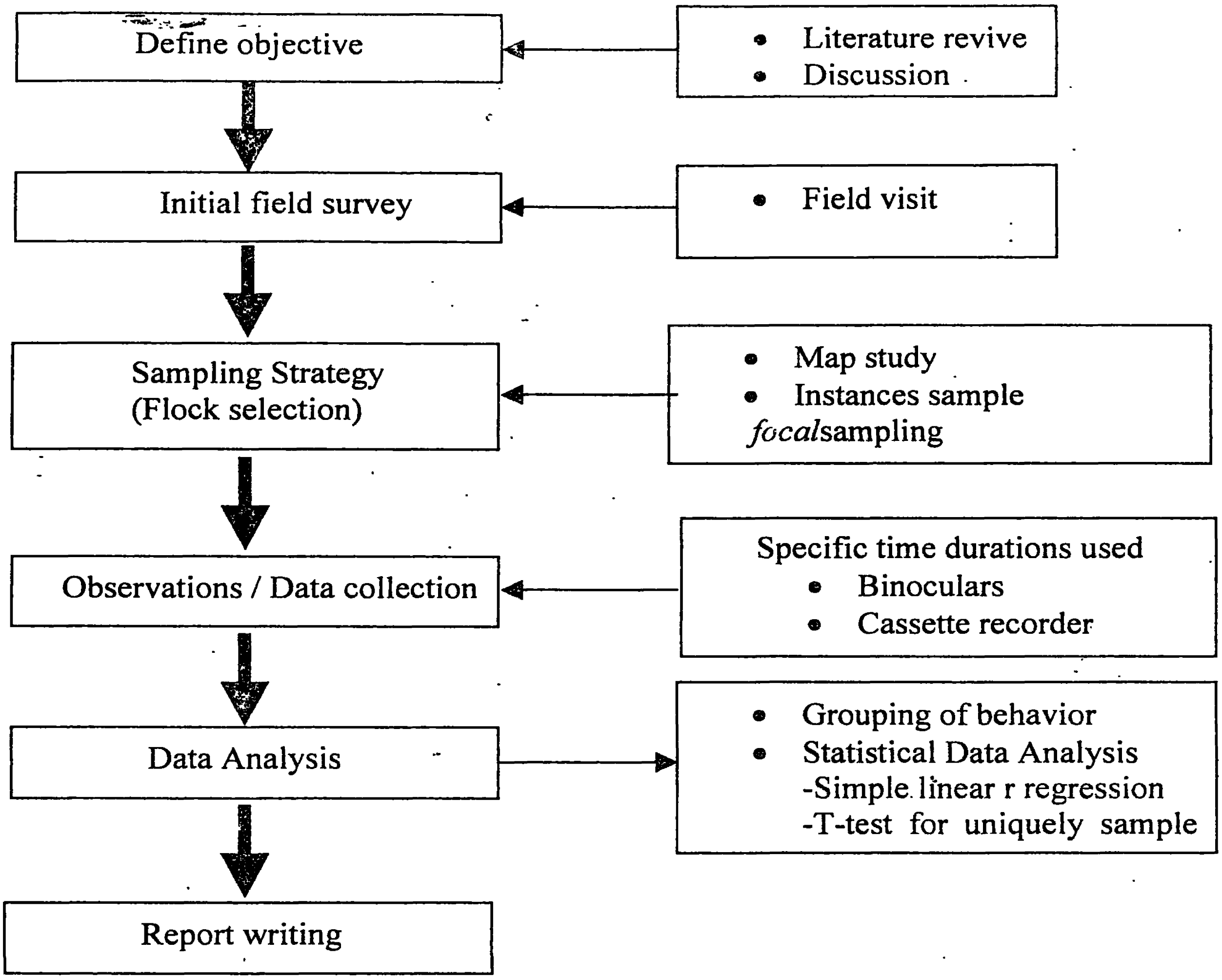


Fig 3.3 Flow Chart of methodology

CHAPTER 04

Result and Discussion

The study aimed to assess some selected components of the role of Crested Drongo in mixed foraging flocks with relevance to feeding. In total, 598 observations were made of the Crested Drongo in 1588 minute of *focal* sampling.

4.1 Social foraging of the Crested Drongo *(Dicrurus paradiseus lophorhinus)* Kleptoparasitism

Kleptoparasitism is a rare but consistent tactic of Drongo. About 466-598 observations were made of Drongo foraging in mixed-species birds' flocks. Although kleptoparasitism occurred only 4% of the total observations, it was seen at all seven sites (Table 4.1). The majority of the kleptoparasitism observations were of Drongo taking food directly from the bill of another species (18 of 23 observations; in the rest of observation Drongo chased and captured insects another birds had been chasing). Drongos mostly parasitized the leaf gleaning babblers: 17 of 23 kleptoparasitism observation were of Orange-billed Babblers and other observations were of another species from the babbler family and only one of Malabar Trogon.

Table 4.1 Kleptoparasitism (physical take) food from other birds in flock by Crested Drongo

Site	Total # Data	Take from Beak	Take from chase	Total	% Kleptoparasitism
Deniya to Heendola	89	3	0	3	3
Camp to West Main	132	4	3	7	5
Sinhagala	74	1	1	2	3
Wathurawa	133	5	0	5	4
Pitakelle	61	3	0	3	5
Lankagama	38	1	0	1	3
Murakelle	78	1	1	2	3
Total	598	18	5	23	4

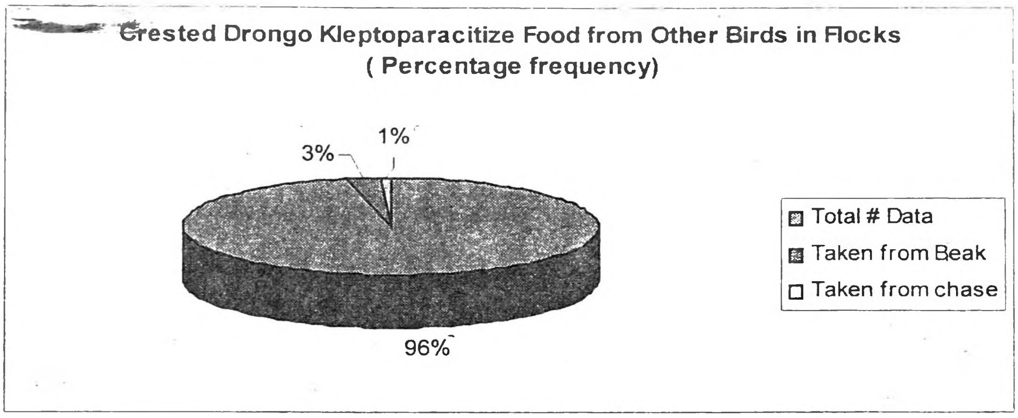


Fig 4.1 Crested Drongo kleptoparacitizing Food from Other Birds in Flocks – Percentage frequency

Indirectly Drongos behaved kleptoparasiticaly with insectivorous birds species. Drongo also act aggressively towards other species in flock in another way. In 4% observations, and in seven sites, Drongo chased or supplant another species (table 4.2) the aggregation was largely aimed at the sallying species. Nine times the aggressive behaviors were aimed at Malabar Trogons and another 8 times it was aimed at Asian Paradise Flycatchers.

Table 4.2 Incidents of inter-specific aggregation in flocks by Crested Drongo

Site	Total # Observation	Chased	Supplant	Total	% Aggressive
Deniya to Heendola	89	1	1	2	2
Camp to Wst Main	132	4	5	9	7
Sinhagala	74	0	2	2	3
Wathurawa	133	4	2	6	5
Pitakelle	61	0	0	0	0
Lankagama	38	2	1	3	8
Murakelle	78	2	3	5	6
Total	605	13	14	27	4

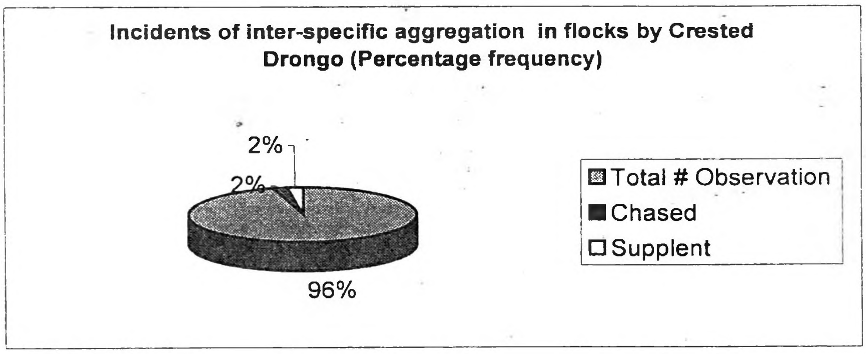


Fig 4.2 Incidents of inter-specific aggregation in flocks by Crested Drongo (Percentage frequency)

A total number of 27 observations (see appendix I) of intra-specific aggregations by Crested Drongos was made during the study period.

4. 2 Crested Drongo's insect consumption disturbed by other birds

A significant percentage of the foraging of the Drongos appears to be on insect disturbed by other birds. In 63% of our 488 observations inside babbler flocks, we believed that Drongo were been attempting to captured disturbed insects, as judged by the presence of the falling debris in the area (Table 4.4) Drongos at different site were generally consistent in the proportion of time they foraged on disturbed insects (between 36%-63% of observation)

Table 4.3 Observation in which Drongos appeared to forage on insect disturbed by other birds

Site	Total observation	Appear to forage in area with debris	Catch insect	Identified inset	% Appeared disturbed insect (all record)	% Catch disturbed insect (all record)
Deniya to Heendola	85	50	38	10	59	12
Camp to Wst Main	115	74	47	18	64	16
Sinhagala	57	35	26	7	61	12
Wathurawa	94	58	36	20	62	21
Pitakelle	41	33	23	5	80	12
Lankagama	30	20	14	8	67	27
Murakelle	66	38	24	14	58	21
Total	488	308	208	82	63	17

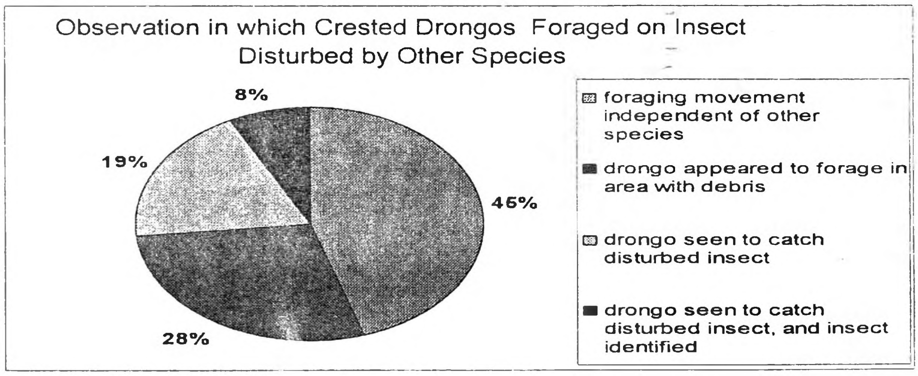


Fig 4.3 Observation in Which Crested Drongo to Forage on Insect Disturbed by Other Birds Species

In foraging for disturbed insects, drongos usually positioned themselves under Orange-billed Babblers (table 4.5). In 66% of the observations, the drongos were underneath this species; other species that are perched under include the Indian Scimitar Babbler (6%) and the class of wood gleaning species, considered together (nuthaches and woodpecker; 9% of observation). Insects were usually small and unclassifiable, but occasionally the insects were large enough to identify generally (46 grasshoppers, 19 worms or caterpillars, 6 cicadas).

Table 4.4 Drongos were usually positioned underneath certain other species. Abbreviations: OBBA = Orange-billed Babbler; SCBA = Scimitar Babbler

Site	n	Under Any species	Under OBBA	%Under OBBA	Under SCBA	%Under SCBA	Under Wood Gleaning species	%Under Wood Gleaning species
Deniya to Heendola	84	49	39	80	6	12	3	6
Camp to West Main	115	49	36	73	4	8	6	12
Sinhagala	57	16	14	88	1	6	1	6
Wathurawa	94	43	26	60	3	7	7	16
Pitakelle	41	30	28	93	0	0	2	7
Lankagama	30	17	13	76	0	0	2	12
Murakelle	66	32	0	0	0	0	0	0
Total	487	236	156	66	14	6	21	9

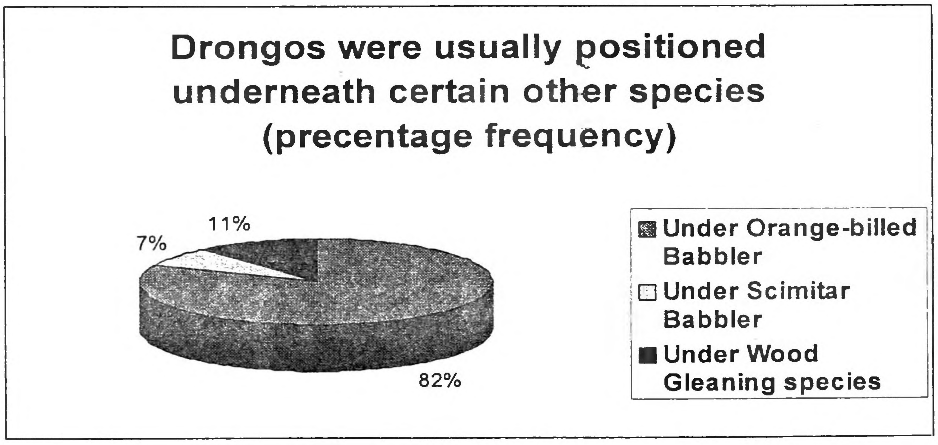


Fig 4.4 Observation Drongo perched under the Other Species. Note: this is not correct – see note

In Sinharaja flocks system: some species increase their foraging efficiency by association with orange bellied babbler, Hawking and hovering above four species closest on benefit from a "beating effect" where they catch insect disturbed in to the air by leaf- gleaning Babblers (Kotagama and Gooder, 2004)

However, there are also cost associate with flocking to part or all of the flock members in the form of increase competition for food (Alatalo et al., 1985) furthermore advantage effect of mixed species flocks can be proposed social learning kleptoparasitism, Beating, More time to feed and predation avoidance (Barnard and Thompson, 1985).

In my study period Drongos were observed to forage disturbed insects by other species. One of nuclear species for the flock, the orange billed babbler, foraged usually in the upper part of the tree above the drongos (Average foraging height was 8.3 m usually Drongo foraging height 5.85 m (Kotagama and Goodel 2004).

The Crested Drongo, hawking and hovering were used to catch insect in our observations 63% Drongo had appeared insect and 47% had been observed catch insects above information accounted to total 488 observation (in flock or other flock observation) farther more seven areas, in above observation Dronos were had range spared appear disturbed insect 58% - 80% also caught insect (Caterpillars, Cicada, Grasshoppers etc.) range, 36% -63% above data was evidence 47% of foraging attempts are successful.

Using my data it can be pointed out that Drongos forage most of time underneath orange-bellied babbler prominently (66%) In addition 6% under scimiter Babbler and 9% under wood-gleaning species occurred; Rarely Crested Drangos foraged under the starling and squirrel. All of these species disturb insects as they forage, and the insects fall down on the dorngo below. In Madagascar the organization of malt-species flock was mainly base on mutualism and communalism some time (rarely) seen orange bellied babbler flow the large insect Drongo suddenly go and caught that is amensualism (occasionally interaction between species occur one species inhabits effect whist the other benefited (Hino, 1998). Mutualism was seen most of the time, but rarely commensalisms behaviours of Crested Drongos were observed. The reason it, I suggest that rich of food in Sinharaja rainforest.

4.3 Parching behaviour changes based on the presence of other birds.

The relationship between Drongo's, Orange-billed Babbler and Ashy-headed launghing-thrushes (Forage with broth Babbler family) (Table 4.6) (appendix III)

Table 4.5 Average Foraging Height Drongo, Orange-billed Babbler and Ashy-headed launghing thrushes

Birds	Average Foraging Height	Standard deviation
Drongo	9.829	5.203
Orange-billed Babbler	13.077	5.368
Ashy-headed launghing thrushes	3.340	3.403

Drongo forage at lower heights when they are horizontally close to Ashy-headed laughing thrushes, as expected, the overall relationship wasprovided extremely strongly significant and provides evidence that Drongos' absolute foraging height (y) is related significantly to their horizontal distance to Ashy-headed laughing thrushes (x) (data pooled, n =125, $F_{1, 124}$ =37.21, P<0.000) and relationship is significant for two of the site (table 4.7) (See Appendix IV)

Table 4.7 The relationship between Drongo's perching height and their horizontal distance to Ashy-headed Babbler.

Site	n	df	F	P	R^2adj %	Equation
Deniya to Heendola	24	1,22	6.93	0.015	20.5	V = 6.72 + 0.483 AHB
Camp to West Main	57	1,56	20.90	0.000	25.9	V= 6.30 + 0.866 AHB
Sinhagala	13	1,12	0.11	0.750	0.000	V = 6.61 + 0.127AHB
Waturava	27	1,26	10.27	0.004	25.5	V= 5.52 + 0.839 AHB
Pitakelle	0	0	0	0	0	-
Lankagama	0	0	0	0	0	-
Murakelle	0	0	0	0	0	-
Total	125	1,124	37.21	0.000	22.5	V= 6.577 +0.597 AHL

A different pattern was seen when analyzing relationship between Drongos' foraging height and their horizontal distance to Orange-billed Babblers. As expected, the overall relationship is inverse (the closer to Orange-billed Babblers, the higher Drongo perch) and much less strong it is still significant when the data are pooled (table 4.8; n = 442, $F_{1,141} = 5.40$, $P < 0.021$). None of sites when analyzed separately are significant. (See Appendix V)

Table 4.8 The relationship between Drongo's perching height and their horizontal distance to Orange-billed Babbler

Site	n	df	F	P	R^2adj %	Equation
Deniya to Heendola	82	1,81	3.83	0.054	3.3	V= 13.4 - 0.917 OBB H
Camp to West Main	104	1,103	1.54	0.218	0.5	V= 11.1 - 0.310 OBB H
Sinhagala	52	1,51	1.98	0.166	1.8	V= 14.6 - 0.946 OBB H
Waturava	68	1,67	2.41	0.125	2.0	V = 9.17 - 0.356 OBB H
Pitakelle	40	1,39	2.48	0.148	2.9	V = 8.61 + 0.871 OBB H
Lankagama	25	1,24	0.01	0.907	0.000	V=9.17-0.047OBB H
Murakelle	65	1,64	1.49	0.226	0.8	V = 7.06 + 0.247 OBB H
Total	442	1,441	5.40	0.021	1.0	V = 10.7 - 0.356 OBB H

The Position was studied of drongos perching relative to Ashy-headed Launhing-thrush (AHLT). They forage very close to ground: average foraging height 2m is much lower than the that of Drongo 5.85m (Kotagama and Goodale, 2004) The vertical distance of the Drongo's foraging height is related to its horizontal distance from AHL. I also investigated the relationship between Drongo absolute foraging height and the horizontal distance to Orange- Billie Babbler. The babbler has a considerable range of foraging height and their average height is 8.3m (Kotagama and Goodel, 2004). The relationship between the drongos' height and their horizontal distance to babblers was weak.

In 106 of 605 total observations Drongo foraged both above babblers (OBB and AHL), but Kotagama and Goodel 2004 pointed out Drongo average foraging height 5.85m with AHL. Above result impression Drongo forage average height 9.82m and standard deviation 5.20, AHL 3.340 standard deviation 3.40m and OBB average foraging height -13.077m and standard deviation 5.368. Kotagama and Goodel mentioned that OBB have a considerable range of foraging height and their average height is 8.3m. (Kotagama and Goodale, 2004).

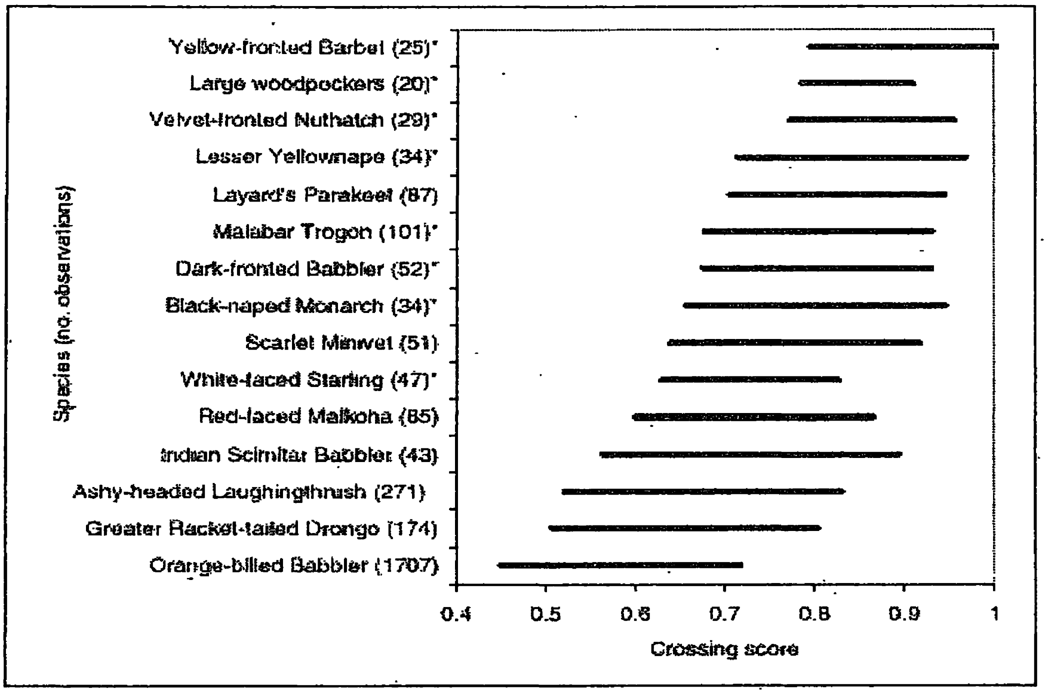


Fig 4.5. Species varied significantly their crossing score (Kotagama and Goodale, 2004).

When the position of the drongos relative to Ashy-headed Laughing-thrushes was investigated, I found that drongos forage at lower height when they are horizontally close to Llaughing thrushes. The overall relationship is not very strong (explaining only 17% of the variation), but it was highly significant. I believe there are many factors that may explain the foraging height of drongos. It is only when they are very close to laughing-thrushes that the effect of the laughing-thrush is high; thus, the proximity to laughing-thrushes does not explain a high proportion of the variation.

As expected, when I looked at the relationship between drongo foraging height and Orange-billed Babblers, I found an inverse relationship, which makes sense because babblers are usually above drongos whereas laughing-thrushes are usually beneath them.

4.3.1 Importance of simple correlation coefficient

Regression is a way of measuring the linear relationship between two variables, x and y. A r near zero implies that there is little linear relationship between x and y and r close to one demonstrates that x and y have strong tendency to move together. When r is positive, the two variables vary together with an increase in one linked to an increase in the other. In my results, I found a significant linear relationship between the horizontal distance to the closest Ashy-headed Laughing-thrush and the foraging height of the drongo. This relationship was positive: the farther away from laughing-thrushes, the higher drongos perched. In contrast, the relationship between the foraging height of drongos and their horizontal distance to babblers was inverse: the farther away from babblers, the lower drongos perched. It is important to remember that correlation doesn't imply a cause and effect relationship exists. The correlation doesn't mean that a change in x causes change in y; instead, some other variable or variables could be causing the change in both x and y simultaneously (Bowerman and O'Connell, 1997).

4.3.2 Importance of the coefficient determination

Regression R^2 is the proportion of the total variation in the number of observed values of the dependent variable that is explained by the simple linear regression model. The nearer R^2 is to one, the larger is the proportion of the total variation that is explained by the model and the greater is the utility of the model in predicting y. R^2 close to zero implies that zero the he independent variable in the model doesn't provide accurate prediction of y. In such cases, in deferent predictor variables must be found in order to accurately predict (Bowerman and O'Connell, 1997).

Here we tested the relationship between the drongos' foraging height and two variables: the horizontal distance to babblers and to laughing-thrushes. Hypotheses The model of simple linear regression relationship was tested and founded above information. Some other factors influence on the drongo's foraging behaviour. Because, mixed-species foraging flock has been created, deferent species birds and deferent foraging behaviours, but it are seen rather same behaviour (scimitar babbler wood gleaning species woodpecker and Nuthch) consequently Drongo sometime search most probably position for foraging relatively to other birds. Sometime the environment factors effected of the foraging behaviour, commonly birds are foraging in canopy or top of the tree in the morning (around before eleven) if had may faced relationship ALH and OBB.

The testing the significant of the regression relationship between y and x by using the overall F statistic and it related p-value is equivalent to doing this test by using the t statistic and it related p-value. In fact the p-values related to t and F (model) can be show to be equal. Indeed, MINITAB output included the result of the F test as the part of the regression output (see Appendix V). This is because both ANOVA analysis and regression analysis are part of the same generalized linear modeling approach (Bowerman and O'Connell 1997).

4.4 Crested Drongo's feeding differences inside flock and outside flock

Drongo forage more inside flock than out side as expected. The rate of sallying and hovering trip in nearly six time more inside flocks than out side of them (0.454 per minute versus 0.078 per minute; pooled data F =10.27, P = 0.000,df =148) the deferent in foraging in is also significant in three of the four deferent area where it can be tested (table 4.8) (appendix vi).

Table 4.8 The rate of Drongo foraging inside and outside of babbler flocks

Site	Mean of foraging maneuvers inside babbler flock	Mean of foraging maneuvers outside flock	Inside v outside
Deniya to Heendola	0.512 (83)	0.000 (1)	Not testable (too few sample)
Camp to west Main	0.367 (105)	0.083 (12)	T=3.01, p=0.008,df=17
Sinhagala	0.500 (57)	0.240 (4)	T=1.60, p=0.170,df=5
Wathurawa	0.442 (87)	0.072 (22)	T = 5.46, p =0.000, df= 70
Pitakelle	0.684 (42)	0:217 (6)	T=4.42,p=0.00,df=22
Lankagama	0.442 (26)	0.000 (8)	Not testable (too few sample
Murakele	0.368 (66)	0.000 (5)	Not testable (too few sample
Total	0.910 (467)	0.164 (59)	T=10.27, p=0.000,df=148

To determined the how match Drongos are foraging, I combined the amount of sallying and hovering. I conclude that drongos feed more inside than outside of flocks, assuming that their rate of success in foraging is similar in the twpo different contexts (unfortunately, we did not have enough data to test for this effect).

Thus, I show that feeding maneuvers of drongos (sally, hover trips) are nearly six time more inside flocks than outside of them. In some areas I did not have enough data to test this relationship, however. Kotagama and Goodale (2004) have pointed out that Crested Drongos are in a high percentage of flocks and rarely outside of flocks. This limited my ability to see how the group composition affected foraging rate.

4.5 Other observation

During the study period, important observations other than what is aimed from objectives were also recorded with the objective of gathering natural history information on the species that can be used as a foundation for further studies. One such important observation is recorded as follows.

The drongo nesting period has been reported as occurring from March to May (Harrison, 1999). But during the study period an observation was made of drongo nest building in February. I observed a Drongo bringing spider webs and moving away from flock to a tree. Drongos normally nest on high trees in the forest, as mentioned in literature (reference – Harrison?). During my study I observed four other nests all on tall trees (Aristonia) and on the end of branches (Harrison, 1999; Henry 1971). But this nest was not in a tall tree the nest was found 10m-12m from graund and about 1km from research center close to a flat road. Three Drongo were found to be involved the event. Drongos involved in nest building perched on high points near the location and were found to be making alarm calls. These observations were made on 17th of February.

On 19th February observations were made in the same area from 11am to 1.05pm and 3.55pm to 5.50pm. I observed the same activity of bringing spider webs, fibers and pieces of barks w. A special observation was that one of the three drongos tried to get involved in the nest building activity and was chased away by the others. It then just observed the nest-building activity from a high perch while giving out alarm calls. The nest building was quite intense on this day and more intense in the evening than the morning. The Drongos seemed to be aggressive and highly active.

On 20th of February one drongo was observed bringingLong fibers and arranging while the other removed these fibers and broke them in to small parts and rearranged. The interfering third Drongo was completely chased away on this day. The damaged end of the left fork of the tail could easily identify it.

On the 27th three eggs were observed in the cup of nest and drongo was observed incubatinging them. On 28th of February the nest was not found. There was no sign of the nest or even a part of eggs on or around the tree. It seemed that the cup was completely destroyed or removed or the nest was a natural failure, because normally drongo build nests on highest tree and at the ends of the branch but this nest was built on a small tree about 10m high.

A discussion with a person who is familiar with the area (Mr. Thandula) mentioned that since the nest is below the other trees it must have been easily exposed to a predator such as an owlet. It is also possible that a Toque monkey removed it since monkeys were observed to come to nest building area and was repelled by the drongos uttering alarm calls. If a reptile were the predator, the nest would most likely have been left. As I think, often Drongos select edges of areas where flocks move so that they can move in and out of the flock for nesting at they same time forage with the flock.

Another especially interesting observation was made on the 21st of April, between Maguruwala and leopard rock area, where I observed adult drongos and one drongo fledgling. The fledgling was very small with its tail about one inch long and beak of an ashy white colour. All the birds were perched in a tree branch. At that moment the flock arrived in the area. , One adult drongo mimicked like crested serpent Eagle and Sri Lanka Blue Magpie call. Drongos can mimic other species (Goodale & Kotagama unpublished manuscript; Ali, 1998; Henry, 1971). It appeared that the flock moved away after this mimicry. After this occurrence, one adult stayed with the fledgling and the other one went to the flock for foraging and came back with food f. This occurred for one hour and then both adults moved back into the flock. The kid got sleep into the branch of tree nest? While the adults were gone and reappeared when they came back and called like the serpent eagle. The way that I interpret this observation is that the drongos wanted to divert the flock from the fledgling, as the flock attracts easy attention for predator.

On 4^{th} of April I observed two adults and three rather mature fledglings that could fly and catch insects. They stayed close to the edge of the flock as the adult drongos many time mimicked serpent eagles' call. The adults made alarm calls when I tried to approach the kids too.

On 25^{th} April in Murakale area two adults and three fledglings were recorded near the flock, The fledglings competed with each other for food that the parents brought in and those who could compete high got more food. Some times drongos foraging with other birds' parties (without babblers) such as Velvet Fronted Nuthatch *(Sitta frontalis)*, Lesser Yellownape *(Picus chlorolophus wellsi)*, Red Back Woodpecker *(Dinopium benghl psarodes)*, Indian scimitar babbler (*Pomutorhinus horsfieldii*) White faced starling (*sturnus senex*), squirreler, etc. Nuthatch woodpecker and squirrel removed tree bark and drongos caught insect by staying below the perch by them.

Most of time drongo was caught Cicada, how the nuthatch and squirrel go to around the tree clumped/trunk as a result cicada fly out suddenly drongo catch them. Also Cicada suddenly calls then drongo fly in the call direction and caught them sometime drongo fly around the trunk and caught cicadas.

In the morning birds parties forage on the top of the tree but during mid day 10.30am -11.00am) birds gradually come down the trees. My personal view is that since in the morning the light intensity is low and therefore it's difficult to identify insect down the trees. The Other explanation is that birds like to morning sun rays on their bodies or morning dew drops yet retaining on leaves may be that's the reason birds forage more on tree tops in the morning and evening about at 6pm to 6.30pm. Near the research center and near the Burial drongo forage with Orange-billed babbler flocks.

My study period covered some breeding pairs of Drongos who moved in and out of flocks. They come in, do aggressive foraging for an about 20 minutes and move out. This happens continuously. My explanation from the observations is that they move in to the flocks to forage and go back to feed the kids in nest outside flock moving areas. This needs further studying.

CHAPTER 05

Conclusion and Further study

5.1 Conclusion

Overall conclusion the data makes it evident that Crested Drongo (*Dicrurus paradiseus lophorhinus)* benefits by association with flocks (they foraged more than when outside of them; nearly six times more inside flocks than outside), that they adjust their feeding in flocks to take advantage of insect disturbed by other species (change their foraging height with Ashy-headed laughing thrushes) and they sometime or rarely kleptoparasitism other species implying some cost on the birds they associate with.

5.2 Further study

I believe I observed false alarm calls (alarm calls used in non-threatening situations to startle other birds into dropping food) nine times. However, this needs to be investigated in a highly systematic way and with acoustic analysis. Other subjects that require more study include the factors that affect the perching location of Crested drongo other than the proximity of laughingp-thrushes and babblers the nesting behaviour of the species also needs further attention, specially the use of false alarm call near nests and fledglings.

REFERENCES

Alatalo, R.V., Gustafsson, L., and Liden, M. (1985). Interspecific competition and niche shifts in tits and goldcrest: an experiment. Journal of Animal. Ecology, 54, 977-984.

Ali, S. (1996) The Book of Indian Birds. Bombe Natural History Society, Oxford University Press, Mumbai, Delhi, 384 pp.

Ali, S. and Ripley, S. D. (1987), Compact handbook of the birds of India and Pakistan, together with those of Bangladesh, Nepal, Bhutan and Sri Lanka. Bombe Natural History Society, Oxford University Press, Mumbai, Delhi, 2nd Ed, v.5, 354p.

Alman, J. (1975) Observational study of behaviour: sampling methods. Behaviour XLIX put in regular numbers, pp.225-267

Bates, R.S.P. (1952) A possible association between the Yellonap Woodpecker *(Picus flavinucha check spelling)* and the Large Racket-tailed Drongo *(Dicrurus Paradiseus)*. Journal of the Bombay Natural History Society. 50, pp.941-942.

Bird Life International, (2001) Threatened Birds of Asia. Cambridge, UK, Bird Life International.

Boonsong, L. and Round, P.D. (1991) A Guide to the Birds of Thailand. Bangkok, Saha Karn Bhaet, 457p.

Bowerman, B. and O'Connell, R.T (1997) Applied Statistics (?) Improving Business Processes. Times Mirror Higher Education Group, America, 1273p.

Brockmann, H.G. and Barnard, C.J. (1979) Kleptoparasitism in birds. Animal Behaviour. 27, pp. 487-514

Coates, B.J and Bishop,K.D. (1997) A guide to the bird of Wallacea:Sulawesi, the Moluccas and Lesser Sunda Island, Indonesia.Alderley. 15/10/1998

Coraco, T. (1979) Time budgeting and group size: a theory. Ecology, 75, pp.1615-1625.

Croxall, J.P. (1976) the composition and behaviour of the mixed-species bird flock in Sarawak. Ibis, 118, pp. 333-346.

Davis, D.E 1946 A seasonal analysis of mixed flock of birds in Brazil. Ecology, v. 27, pp168-181.

De Soysa, N. and Raheem, R. (1987) Sinharaja, a rain forest in Sri Lanka. March for Conservation, Colombo, 60 pp.

Dean, W.R.J. (1988) Intra and inter-specific kleptoparasitism in Mixed–species foraging flocks. Honeyguide, v. 34, pp 30-31.

Dewar, I. C. S. (1904) King-crow and myna as mess-mates. Journal of the Bombay Natural History Society.16, pp. 364-366.

Dickamer, L.C., Vessey, S.H., Jakob, E.M (1996) Animal Behaviour Mechanisms: Ecology: Evolution. Check title. McGraw-Hill Company, New York, 422 pp.

Eguchi, K., Yamagishi, S. and Randrianasolo, V. (1993) The composition and foraging behaviour of mixed-species flocks of forest-living birds in Madagascar. Ibis, 135, pp. 91–96.

Elections for the Board of Trustees (2005) of the Wikimedia Foundation. http://en.wikipedia.org/wiki/Drongo. Acessed: 20/03/2005.

Gaddis, P. (1980) Mixed flocks, Accipiters, and antipredator behavior. Condor, 82, pp. 348-349.

Ganesh,T. (1992) A Silent association. Journal of the Bombay Natural History Society 18, 89-374..

Gaston, A. J. (1977) Social behaviour within groups of Jungle Babblers (*Turdoides striatus*). Animal Behavior 25, 828–848.

Goodale, E. and Kotagama, S. W. 2005 Alarm calling in Sri Lankan mixed-species bird flocks. Auk 122, 108-120.

Goodale, E. & Kotagama, S.W. In press a. Testing the roles of species in mixed-species bird flocks of a Sri Lankan rainforest. Journal of Tropical Ecology.

Goodale, E. & Kotagama, S.W. In press b. Some observations on the geographic variation of mixed-species bird flocks in Sri Lanka. Journal of the Bombay Natural History Society.

Grimett, R., Inskipp, C. and Inskipp, T. (1999) A guide to the birds of India, Pakistan, Bangladesh, Bhutan, Sri Lanka and the Maldives. Princeton University Press, Princeton, 888 pp.

Harrison, J. (1999) A Field Guild to the Bird of Sri Lanka. Oxford University press, New York 219 pp.

Henry, G.M. (1971) A Guide to the Birds of Ceylon. Oxford University Press, Oxford 2nd Ed, 458 pp.

Herremans, M. and Herremans-Tonnoeyr, D. (1997) Social foraging of the forktailed drongo *Dicrurus adsimilis*: beater effect or kleptoparasitism? Bird-Behavior, USA, 12, pp. 41-45.

Hino, T. (1998) Mutualistic and commensal organization of avian mixed-species foraging flocks in a forest of western Madagascar. Journal of Avian Biology,29 pp.17-24.

Hutto, R. L. (1994) The composition and social organization of mixed-species flocks in a tropical deciduous forest in Western Mexico, Condor, 96,105–118.

King, D.I., and Rappole, J.H. (2001) Kleptoparasitism of laughingthrushes *Garrulax* by greater racket-tailed drongos *Dicrurus paradiseus* in Myanmar. Forktail,v.14,v.17 ,121-122.

Kotagama, S.W. and Goodale, E. (2004) The composition and spatial organization of mixed-species flocks in a Sri Lankan rainforest. Forktail,20, 55-70.

Kotagama, S.W and Wijayasinha, A. (1998) "Sirilanka Kurullo". The Wildlife Heritage Trust of Sri Lanka, Colombo, 394 pp.

Krebs, J. R. (1973) Social learning and the significance of mixed-species flocks of chickadees (*Parus* spp.). Canadian Journal of Zoology, v.51, 1275-1288.

Leggee,R.A check name (1983) A History of the Birds of the Ceylon. Thisara Prakasakaya Ltd., Dehivala, Sri Lanka,v. 1642 pp.

Legge,R.A (1983) A History of the Birds of the Ceylone. Thisara prakasakaya LTD, Dehivala, Sri Lanka, v.2, 657p.

Martin, B.P. (1987) World birds: (?) which bird is the deepest diver, highest flier, has the longest wingspan, makes the smallest nest and which birds drink blood. Check title. Guners Superlatives Ltd., Middlesex, Great Britain, 652 pp.

Perrins, C.M. and Middleton, A.L.A (1985) The encyclopedia of birds. George Allen and Unwin, London.

Powell, G. V. N. (1985) Sociobiology and adaptive significance of interspecific foraging flocks in the Neotropics. Ornithological Monographs,36, pp.713-732.

Prasad, S. (2004) Animal Behaviour. CBC Publisher, Niw Delhi, Bangalore, India, 348p.

Ranga, M.M. (2002) Wildlife Management and Conservation. Agrobios, New Dilli India, 312p.

Terborgh, J. (1990) Mixed flocks and polyspecific associations: costs and benefits of mixed groups to birds and monkeys. American Journal of Primatology, 21. 87-100

Thorpe, W.H (1956) Learning and Instinct in Animals, Harvard University Press, Cambridge.

Veena, T., and Lokesha, R. (1993) Association of drongos with myna flocks: are drongos benefitted?. Journal of Biosciences, 18, 111-119.

Vernon, C. J. (1980) Birds parties of central and South Africa. Proceeding of the the IV Pan-African Ornithological Congress, pp. 313-315

Virtual Library Sri Lanka, (1995-2005) Sri Lanka wildlife, fauna and flora WWW Virtual Library Sri Lanka. http://www.lankalibrary.com/wlife.html. 05/04/2005.

Ward, P. and Zahavi, A. (1973) The Importance of certain assemblage of bird as an "information center" for food-finding. Ibis,115, 517-34.

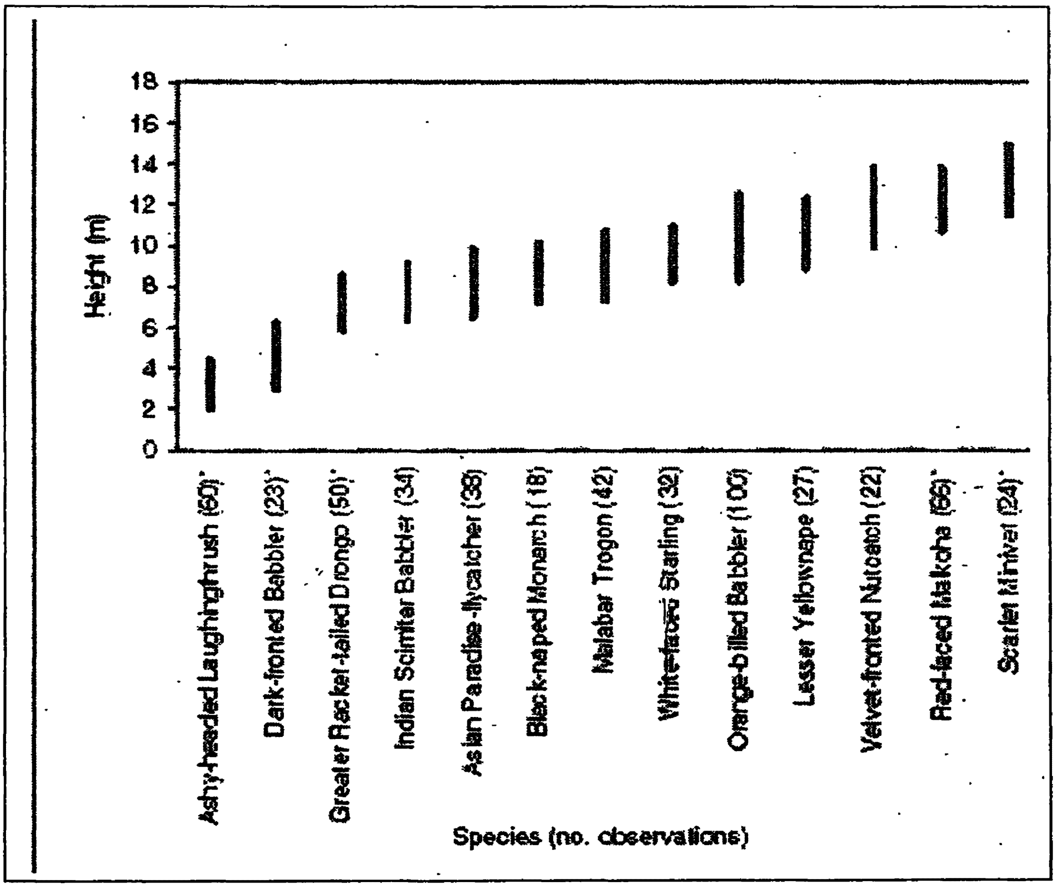
Winterbottom, J. M. (1943) On woodland bird parties in Northern Rhodesia. Ibis, 85, 437-442.

Appendix-1

Intra-specific Kleptoparasitism

Site	n	Chased	Supplent	total	% Aggressive
Deniya to Heendola	89	1	1	2	2.247191
Camp to Wst Main	132	4	5	9	6.818182
Sinhagala	74	0	2	2	2.702703
Wathurawa	133	4	2	6	4.511278
Pitakelle	61	0	0	0	0
Lankagama	38	2	1	3	7.894737
Murakelle	78	2	3	5	6.410256
Total	598	13	14	27	2.644628

Appendix-II



(Kotagama and Goodale, 2004).

Appendix-III

Regression Analysis: Drongo versus OBB, AHB

The regression equation is
Drongo = - 0.678 + 0.731 OBB + 0.282 AHB

Predictor	Coef	SE Coef	T	P
Constant	-0.6783	0.7038	-0.96	0.337
OBB	0.73149	0.05598	13.07	0.000
AHB	0.28181	0.08830	3.19	0.002

S = 2.723 R-Sq = 73.1% R-Sq(adj) = 72.6%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	2	2058.6	1029.3	138.80	0.000
Residual Error	102	756.4	7.4		
Total	104	2814.9			

Source	DF	Seq SS
OBB	1	1983.0
AHB	1	75.5

Appendix-IV

Crested Drongo change their perching behaviour base on presence of other Birds

Total result Ashy Headed Laughing-thrushes (AHL)

Correlations: Drongo perch height(m), Horizontal AHL(m)

Regression Analysis: Drongo perch height versus AHL Horizontal distance

The regression equation is
Drongo perch = 6.57732 + 0.596968 Horisontal d

S = 3.89791 R-Sq = 23.1 % R-Sq(adj) = 22.5 %

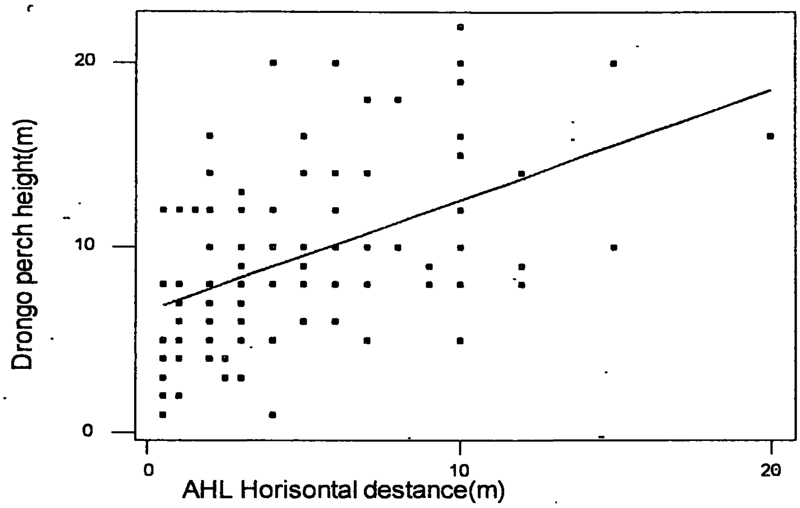
Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	565.41	565.414	37.2138	0.000
Error	124	1884.01	15.194		
Total	125	2449.43			

Regression Plot

Drongo perch height = 6.57732 + 0.596968 AHL Horizontal destance

S = 3.89791   R-Sq = 23.1 %   R-Sq(adj) = 22.5 %



Result Camp to west main

Drongo Perched height (m), AHL Horizontal Destans(m)

```
The regression equation is
Drongo perch height(m) = 6.30 + 0.866 AHB horizontal destonce(m)

Predictor          Coef      SE Coef          T        P
Constant         6.2972       0.8421       7.48    0.000
AHB hori         0.8658       0.1894       4.57    0.000

S = 3.955       R-Sq = 27.2%      R-Sq(adj) = 25.9%

Analysis of Variance

Source            DF          SS          MS         F        P
Regression         1      326.85      326.85     20.90    0.000
Residual Error    56      875.93       15.64
Total             57     1202.78
```

Result Deniya to Heendola

Drongo Perched height (m), AHL Horizontal Destans(m)

```
The regression equation is
Drongo perch height(m) = 6.72 + 0.483 AHB horizontal destonce(m)

Predictor          Coef      SE Coef          T        P
Constant          6.719        1.635       4.11    0.000
AHB hori         0.4831       0.1835       2.63    0.015

S = 4.465       R-Sq = 24.0%      R-Sq(adj) = 20.5%
```

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	138.28	138.28	6.93	0.015
Residual Error	22	438.68	19.94		
Total	23	576.96			

Result sinhagala

Drongo Perched Height (m), Horizontal Distend AHB

The regression equation is
Drongo perch height(m) = 6.30 + 0.866 AHB horizontal destonce(m)

Predictor	Coef	SE Coef	T	P
Constant	6.2972	0.8421	7.48	0.000
AHB hori	0.8658	0.1894	4.57	0.000

S = 3.955 R-Sq = 27.2% R-Sq(adj) = 25.9%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	326.85	326.85	20.90	0.000
Residual Error	56	875.93	15.64		
Total	57	1202.78			

Result Wathurawa

Drongo Perched height (m), AHL Horizontal Destans(m)

The regression equation is
Drongo perch height(m) = 5.52 + 0.839 AHB horizontal destonce(m)

Predictor	Coef	SE Coef	T	P
Constant	5.519	1.258	4.39	0.000
AHB hori	0.8388	0.2618	3.20	0.004

S = 3.455 R-Sq = 28.3% R-Sq(adj) = 25.5%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	122.56	122.56	10.27	0.004
Residual Error	26	310.40	11.94		
Total	27	432.96			

Appendix-V

Crested Drongo change their perching behaviour base on presence of other Birds

Overall result Orange –billed Babbler (OBB)

Perched height Drongo, Horizontal OBB

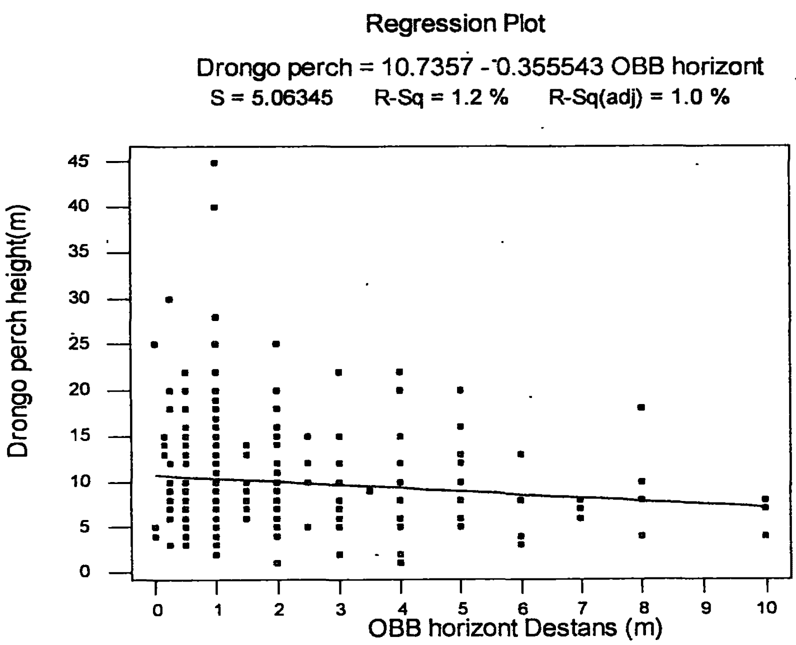
```
The regression equation is
Drongo perch height(m) = 10.7 - 0.356 OBB horizontal destens(m)

Predictor        Coef     SE Coef         T        P
Constant      10.7357      0.3593     29.88    0.000
OBB hori      -0.3555      0.1529     -2.32    0.021

S = 5.063        R-Sq = 1.2%       R-Sq(adj) = 1.0%

Analysis of Variance

Source            DF          SS          MS         F        P
Regression         1      138.56      138.56      5.40    0.021
Residual Error   441    11306.57       25.64
Total            442    11445.13
```



Deniya to Heendola result (OBB)

Perched height Drongo(m), Horizontal OBB(m)

The regression equation is
Drongo perch height(m) = 13.4 - 0.917 OBB horizontal destens(m)

Predictor	Coef	SE Coef	T	P
Constant	13.3615	0.9745	13.71	0.000
OBB hori	-0.9170	0.4685	-1.96	0.054

S = 5.301 R-Sq = 4.5% R-Sq(adj) = 3.3%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	107.65	107.65	3.83	0.054
Residual Error	81	2275.99	28.10		
Total	82	2383.64			

Camp to West main result (OBB)

Perched height Drongo(m), Horizontal OBB(m)

The regression equation is
DRONGO perch height(m) = 11.1 - 0.310 OBB horizontal destans(m)

Predictor	Coef	SE Coef	T	P
Constant	11.0774	0.6322	17.52	0.000
OBB hori	-0.3104	0.2503	-1.24	0.218

S = 4.424 R-Sq = 1.5% R-Sq(adj) = 0.5%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	30.10	30.10	1.54	0.218
Residual Error	103	2016.15	19.57		

Wathurawa result (OBB)

Perched height Drongo(m), Horizontal OBB(m)

The regression equation is
D.P.H(m) = 9.17 - 0.356 OBB horizontal destance(m)

Predictor	Coef	SE Coef	T	P
Constant	9.1740	0.6258	14.66	0.000
OBB hori	-0.3563	0.2296	-1.55	0.125

S = 3.627 R-Sq = 3.5% R-Sq(adj) = 2.0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	31.69	31.69	2.41	0.125
Residual Error	67	881.53	13.16		
Total	68	913.22			

Pitakele result (OBB)

Perched height Drongo(m), Horizontal OBB(m)

The regression equation is
D.P.H(m) = 8.61 + 0.871 OBB horizontal destance(m)

Predictor	Coef	SE Coef	T	P
Constant	8.6077	0.8803	9.78	0.000
OBB hori	0.8712	0.5899	1.48	0.148

S = 3.008   R-Sq = 5.3%   R-Sq(adj) = 2.9%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	19.730	19.730	2.18	0.148
Residual Error	39	352.758	9.045		
Total	40	372.488			

Murakele result (OBB)

Perched height Drongo(m), Horizontal OBB(m)

The regression equation is
D.P.H(m) = 7.06 + 0.247 OBB horizontal destance(m)

Predictor	Coef	SE Coef	T	P
Constant	7.0612	0.4622	15.28	0.000
OBB hori	0.2468	0.2020	1.22	0.226

S = 2.593   R-Sq = 2.3%   R-Sq(adj) = 0.8%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	10.042	10.042	1.49	0.226
Residual Error	64	430.398	6.725		
Total	65	440.439			

Sinhagala result (OBB)

Perched height Drongo(m), Horizontal OBB(m)

The regression equation is
Drongo perch height(m) = 14.6 - 0.946 OBB horizontal destans(m)

Predictor	Coef	SE Coef	T	P
Constant	14.628	1.686	8.68	0.000
OBB hori	-0.9458	0.6726	-1.41	0.166

S = 8.439   R-Sq = 3.7%   R-Sq(adj) = 1.8%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	140.83	140.83	1.98	0.166
Residual Error	51	3631.70	71.21		
Total	52	3772.53			

Lankagama result (OBB

Perched height Drongo(m), Horizontal OBB(m)

```
The regression equation is
D.P.H(m) = 9.17 - 0.047 OBB horizontal destance(m)

Predictor          Coef     SE Coef          T        P
Constant         9.1654      0.9044      10.13    0.000
OBB hori        -0.0472      0.3987      -0.12    0.907

S = 2.596       R-Sq = 0.1%       R-Sq(adj) = 0.0%

Analysis of Variance

Source            DF          SS          MS         F        P
Regression         1       0.094       0.094      0.01    0.907
Residual Error    24     161.752       6.740
Total             25     161.846
```

Appendix-VI

Crested Drongo feed more inside flock or outside flock

INSIDE FEEDING RATE

Inside feeding rate total data description

Descriptive Statistics: Sallies/minute, Hovers/minute

Variable	N	Mean	Median	TrMean	StDev	SE Mean
SALLIES/	466	0.3983	0.3300	0.3541	0.4399	0.0204
HOVERS/M	466	0.05777	0.00000	0.02407	0.18284	0.00847

Variable	Minimum	Maximum	Q1	Q3
SALLIES/	0.0000	3.0000	0.0000	0.6225
HOVERS/M	0.00000	1.41000	0.00000	0.00000

Out side feeding rate total data description

Descriptive Statistics: Sallies/minute, Hovers/minute

Variable	N	Mean	Median	TrMean	StDev	SE Mean
Sallies/	58	0.0633	0.0000	0.0238	0.2016	0.0265
Hovers/m	58	0.0202	0.0000	0.0000	0.0893	0.0117

Variable	Minimum	Maximum	Q1	Q3
Sallies/	0.0000	1.0000	0.0000	0.0000
Hovers/m	0.0000	0.5100	0.0000	0.0000

<u>Comparing inside Vs outside Drongo foraging rate side by side</u>

Camp to West Main area

Two-Sample T-Test and CI: Sallies/minute=H, Sallies/minute=H

Two-sample T for Sallies/minute=Hovers/minute vs Sallies/minute=Hovers/minute_1

	N	Mean	StDev	SE Mean
Sallies/	105	0.367	0.453	0.044
Sallies/	12	0.083	0.289	0.083

Difference = mu Sallies/minute=Hovers/minute - mu Sallies/minute=Hovers/minute_1
Estimate for difference: 0.2835
95% CI for difference: (0.0845, 0.4825)
T-Test of difference = 0 (vs not =): T-Value = 3.01 P-Value = 0.008 DF = 17

Deñiya to Hendola area

Descriptive Statistics: Sallies/minute+H, Sallies/minute=H

```
Variable              N       Mean     Median     TrMean      StDev     SE
Mean
Sallies/             83     0.5118     0.3800     0.4675     0.4839
0.0531
Sallies/              1 0.0000E+00 0.0000E+00 0.0000E+00          *
*

Variable        Minimum    Maximum         Q1         Q3
Sallies/         0.0000     2.0000     0.0000     0.7900
Sallies/     0.0000E+00 0.0000E+00          *          *
```

Lankagama area

Descriptive Statistics: Sallies/minute+H, Sallies/minute+H

```
Variable              N       Mean     Median     TrMean      StDev     SE
Mean
Sallies/             26     0.4419     0.3350     0.3904     0.4620
0.0906
Sallies/              8    0.00000    0.00000    0.00000    0.00000
0.00000

Variable        Minimum    Maximum         Q1         Q3
Sallies/         0.0000     2.1200     0.1350     0.6675
Sallies/        0.00000    0.00000    0.00000    0.00000
```

Murakele area

Descriptive Statistics: Sallies/minute+H, Sallies/minute+H

```
Variable              N       Mean     Median     TrMean      StDev     SE
Mean
Sallies/             66     0.3680     0.3550     0.3235     0.4365
0.0537
Sallies/              5    0.00000    0.00000    0.00000    0.00000
0.00000

Variable        Minimum    Maximum         Q1         Q3
Sallies/         0.0000     2.5000     0.0000     0.6475
Sallies/        0.00000    0.00000    0.00000    0.00000
```

Pitakele area

Two-Sample T-Test and CI: Sallies/minute+H, Sallies/minute+H

```
Two-sample T for Sallies/minute+Hovers/minute vs
Sallies/minute+Hovers/minute_1

           N      Mean     StDev   SE Mean
Sallies/  42     0.684     0.522     0.081
Sallies/   6     0.217     0.168     0.069
```

Difference = mu Sallies/minute+Hovers/minute - mu Sallies/minute+Hovers/minute_1
Estimate for difference: 0.467
95% CI for difference: (0.248, 0.687)
T-Test of difference = 0 (vs not =): T-Value = 4.42 P-Value = 0.000 DF = 22

Sinhagala area

Two-Sample T-Test and CI: Sallies/minute+H, Sallies/minute+H

Two-sample T for Sallies/minute+Hovers/minute_1 vs Sallies/minute+Hovers/minute

	N	Mean	StDev	SE Mean
Sallies/	57	0.500	0.626	0.083
Sallies/	4	0.240	0.278	0.14

Difference = mu Sallies/minute+Hovers/minute_1 - mu Sallies/minute+Hovers/minute
Estimate for difference: 0.260
95% CI for difference: (-0.157, 0.676)
T-Test of difference = 0 (vs not =): T-Value = 1.60 P-Value = 0.170 DF = 5

Wathurawa area

Two-Sample T-Test and CI: Sallies/minute=H, Sallies/minute=H

Two-sample T for Sallies/minute=Hovers/minute vs Sallies/minute=Hovers/minute_1

	N	Mean	StDev	SE Mean
Sallies/	87	0.442	0.456	0.049
Sallies/	22	0.072	0.221	0.047

Difference = mu Sallies/minute=Hovers/minute - mu Sallies/minute=Hovers/minute_1
Estimate for difference: 0.3706
95% CI for difference: (0.2352, 0.5060)
T-Test of difference = 0 (vs not =): T-Value = 5.46 P-Value = 0.000 DF = 70

Overall inside out side test

Two-Sample T-Test and CI: Sallies/minute+H, Sallies/minute+H

Two-sample T for Sallies/minute+Hovers/minute vs Sallies/minute+Hovers/minute_1

	N	Mean	StDev	SE Mean
Sallies/	466	0.456	0.493	0.023
Sallies/	58	0.083	0.214	0.028

Difference = mu Sallies/minute+Hovers/minute - mu Sallies/minute+Hovers/minute_1
Estimate for difference: 0.3725
95% CI for difference: (0.3008, 0.4442)
T-Test of difference = 0 (vs not =): T-Value = 10.27 P-Value = 0.000 DF = 148

Appendix-VII

Species[a]	Mean no. individuals/ flock[b]	% flocks in 1980s (n=219)	% flocks in 1990s (n=257)	% flocks in dry season (n=100)	% flocks in wet season (n=376)	Diet[c]	Foraging technique[d]	[e]
ORANGE-BILLED BABBLER* *Turdoides rufescens*	16.2 (n=268)	91	92	99	89	If	LG (n=97)	
GREATER RACKET-TAILED DRONGO *Dicrurus paradiseus*	2.7 (n=316)	89	88	91	88	In	HA/ho (n=53)	
MALABAR TROGON *Harpactes fasciatus*	1.9 (n=222)	53	68	63	61	If	HO,ha (n=43)	
YELLOW-BROWED BULBUL *Iole indica*	2.3 (n=185)	47	58	50	53	IF		
BLACK-NAPED MONARCH *Hypothymis azurea*	1.5 (n=178)	38	57	35	52	I	HA/ho (n=19)	
RED-FACED MALKOHA*~ *Phaenicophaeus pyrrhocephalus*	2.2 (n=173)	42	54	40	51	IF	LG (n=29)	
YELLOW-FRONTED BARBET* *Megalaima flavifrons*	2.0 (n=181)	57	41	51	47	Fa		
SCARLET MINIVET *Pericrocotus flammeus*	2.8 (n=167)	42	53	26	54	I	ho/lg (n=17)	
ASHY-HEADED LAUGHINGTHRUSH*~ *Garrulax cinereifrons*	7.2 (n=147)	33	59	28	52	If	LG s (n=60)	
DARK-FRONTED BABBLER *Rhopocichla atriceps*	3.3 (n=139)	33	54	30	48	I	LG (n=22)	
INDIAN SCIMITAR BABBLER *Pomatorhinus horsfieldii*	1.8 (n=136)	38	50	39	46	In	lg/wg (n=36)	
LESSER YELLOWNAPE *Picus chlorolophus*	1.5 (n=143)	40	42	32	44	I	WT (n=29)	
WHITE-FACED STARLING*~	2.7	41	38	46	38	IFn	LG	
VELVET-FRONTED NUTHATCH *Sitta frontalis*	2.7 (n=106)	26	30	29	25	I	WG (n=18)	81 (n=132)
BLACK-CRESTED BULBUL *Pycnonotus melanicterus*	2.0 (n=89)	19	35	17	31	IF		30 (n=252)
LAYARD'S PARAKEET* *Psittacula calthropae*	5.2 (n=80)	20	32	7	32	FN		36 (n=374)
PALE-BILLED FLOWERPECKER *Dicaeum erythrorynchos*	1.8 (n=90)	15	35	9	30	IFN		28 (n=205)
LEGGE'S FLOWERPECKER* *Dicaeum vincens*	2.0 (n=91)	19	32	14	29	IFN		45 (n=138)
BLACK BULBUL *Hypsipetes leucocephalus*	2.3 (n=73)	21	28	30	24	IFn		37 (n=185)
PALM SQUIRREL *Funambulus* sp.	1.2 (n=92)	22	28	23	26	IF		90 (n=58)
ASIAN PARADISE-FLYCATCHER *Terpsiphone paradisi*	1.3 (n=53)	14	9	38	4	I	HA/ho (n=41)	78 (n=51)

[a] * = endemic to Sri Lanka, ~ = Vulnerable (BirdLife International 2001).

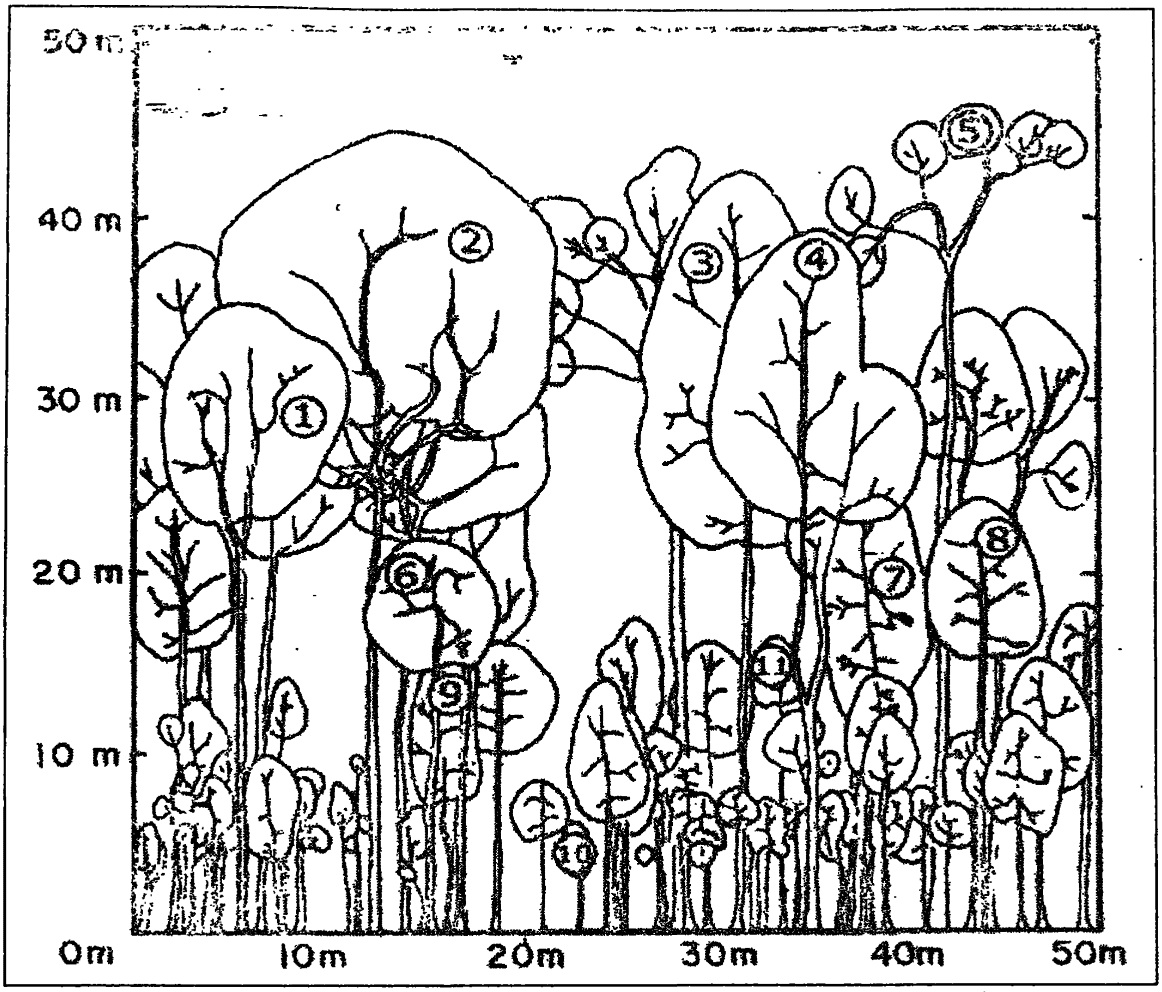
[b] Figures in parentheses represent the number of flocks that had complete information on the number of individuals of the species.

[c] F = frugivorous, I = insectivorous, O = omnivorous. Upper case letters indicate the category is the principal food source, lower case letters indicate that the category is a minor part of the diet.

[d] Foraging technique of insectivorous birds: HA = hawking (no contact with substrate), HO = hovering (contact with bill on substrate), LG = leaf-gleaning, S = scratching on the ground, WG = wood-gleaning (where wood is the combination of trunks, branches and twigs), WT = wood-tapping (repeated probing). Upper case letters indicate that more than 50% of the foraging observations fit the category, lower case letters indicate that between 25% and 50% of the observations fit the category

[e] % individuals seen in flocks out of all observations of species (Thiollay and Jullien 1998). Numbers in parentheses represent the total number of observations of that species, inside or outside of flocks, in the 1990s survey.

(Kotagama and Goodale, 2004).



Vegetation profile of a rain forest close to Sinharaja in Kanneliya (De zoisa andRaheem, 1987)

Appendix-VIII

Location	Elevation (m)	Time Period	Mean Annual Rainfall (MAR) in mm.	Source
Beverly Estate (South-eastern boundary of reserve)	635	1925 - 1935	4054	Baker (1937)
Weddagala (North-western boundary)	275	1948-1970	3691	Maheswaran (1982)
Kudawa (North-western boundary)	340	1980-1981	1614	Maheswaran (1982)
Sinharaja field station (3km within the North-western end of reserve)	380	1981-1984	5006	March of Conservation (1986)

Mean annual rainfall data available for locations in and around Sinharaja

Climate	Elevation	Within or outside forest	Time of day	Relative humidity	Temperature C⁰	Source
Hapugoda Banks of Napala dola	570	within	2400 1400	93 83	21.0a 24.4b	Baker (1937)
Kumburugoda Banks of Napala dola	390	outside	700 1500	95 59	19.4a 31.1b	Merritt & Gunatilleke (1981)
Kudawa	340	outside	-	-	22.5a 34.1b	Gunatillake & Gunatilleke (1981)
Sinharaja	600	within	-	-	20.2a 25.2b	
Sinharaja	600	within	1200	87	24.0	Maheswaran (1982)
Waturawa	510	within	1335	80	25.5	

Temperature and relative humidity data available for Sinharaja

(De zoisa andRaheem, 1987)

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