

**HABITAT USE OF BIRDS OF NORTH MALABAR
COAST WITH SPECIAL REFERENCE TO THE WHITE
BELLIED SEA EAGLE, *HALIAEETUS LEUCOGASTER***

*Thesis submitted to the University of Calicut
for the Degree of
Doctor of Philosophy
in Zoology*

By

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MAY 2000.

DECLARATION

I hereby declare that the thesis entitled, "Habitat use of birds of North Malabar Coast with special reference to the Whitebellied Sea Eagle, *Haliaeetus leucogaster*" submitted to the University of Calicut for the award of the degree of Doctor of Philosophy in Zoology is a bonafide work done by me and that it has not been submitted earlier in part or in full to any other University for award of any degree or diploma.



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CERTIFICATE

This is to certify that this thesis is an authentic record of the bonafide research work carried out by Shri. Muhamed Jafer. P, under my supervision and guidance and that neither this nor any part of it has previously formed the basis for the award of any degree or diploma.



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INTRODUCTION AND REVIEW OF LITERATURE

Muhamed Jafer.P “Habitat use of birds of north malabar coast with special reference to the white bellied sea eagle, *haliaeetus leucogaster*” Thesis.
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CHAPTER 1

INTRODUCTION AND REVIEW OF LITERATURE

Birds constitute the most abundant, larger forms of wildlife that occur on the sea coast. Based on the nature of the substrate, coastal habitats could be divided into rocky shores, sandy shores and tidal mudflats. Many species of birds use different coastal habitats, mostly tidal mudflats during at least some time of the year. Sea Eagles use them for perching and nesting. India's 5734 Km long coastline comprises a network of wetlands, estuaries, backwaters, lagoons and tidal marshes. These habitats favour the growth of mangrove vegetation and support a large number of fishes, birds and other invertebrates. The unique geographical setting and varying climatic factors favour the development of distinct types of wetlands in the coast of Kerala. The 580 Km long irregular coastline on the west, and the 41 west flowing rivers have created various forms of wetlands in the coastal areas of Kerala. The coastal wetlands of Kerala cover an area of 3313 Sq.Km with its unique system of backwaters, lagoons, estuaries, islands and a wide continental shelf.

The current status of wetlands in north Malabar is not fully known and hence nothing is known about their conservation problems. Therefore a study on the status of wetlands and tidal mudflats with their avifauna in north Malabar is taken up. The study deals with the population dynamics and species diversity of

different bird species in four distinct natural wetland habitats and a man-made wetland habitat (Paddy field) in the northern most districts of Kerala- Kannur and Kasaragod districts. The estuarine habitat at Madackara, the backwater-swamp of Chemballickundu, River banks of Payangadi, Inland wetland of Kuniyan and a paddy field at Edattummal are taken up for the study. Besides this, a detailed study on the ecology of the endangered Whitebellied Sea Eagle, *Haliaeetus leucogaster*, which occur in the coastal north Kerala is also carried out; with a view to formulating its conservation strategies.

The biology and ecology of different species of fish eating eagles have been studied by various workers in many countries. Studies on Southern bald Eagle, *Haliaeetus leucocephalus* by Dunstan and Harper,(1975); Sherrod et al, (1976); Haywood and Ohmart, (1986); Gerrard et al (1992); Hunt et al; (1992) and Jenkins and Jackman (1994). African Fishing Eagle, *Haliaeetus vocifer* by Mayr and Rand (1937); Stowell,(1958),Brown (1960), Green (1964), and Kruger (1997), the Whitetailed Sea Eagle, *Haliaeetus albicilla* by Meyburg ,(1974);Dukes et al,(1975); Struwe,(1996) and Sulkara et al,(1997) and the Pallas' Fishing Eagle, *Haliaeetus leucoryphus* by Magrath,(1913); Muir,(1916); Munns,(1928) are worth mentioning.

Publications dealing with the Whitebellied Sea Eagle, *Haliaeetus leucogaster* are scanty, but a few of them appeared as early as 1839 and most of them were brief notes of casual observation concerning the distribution of nests, and food habits of the species. Many aspects of the life history and ecology of Whitebellied

Sea Eagle is poorly understood. There has been no single, comprehensive study of the biology and ecology of the species. Legge (1880) and Henry (1955), Chandola and Van Grusen (1983) reported the population of this eagle from Srilanka. Loke(1952) Photographed its nesting sequence from Singapore. In India, Jerdon (1862-64) reported its sightings from Chilika and Calicut and also mentioned about a breeding colony at Pigeon Islands. Hume, (1874) sighted a pair of eagles from Lakshadweep. However, Betts (1938) and Kurup (1991) did not come across the species with their survey. Keswal (1886) noted the Whitebellied Sea Eagles very common in western India. Barnes (1897) reported them not uncommon on the sea coast of India and recorded its breeding colony on Pigeon Islands. Law (1924) recorded two pairs of the species from Visakhapatnam, subsequently Whistler and Kinnear (1934) have also recorded this species from Narasapatnam and Vizhianagaram of Andhra Pradesh coast. Ali (1936) quoted the statement of Baker(1934) that it breeds in Travancore but could not meet with, during his survey. Acharya(1935) observed Whitebellied Sea Eagle in north Gujarat. Baker and Inglis (1930) writes "Bulkely took an egg on the Malabar coast in August, possibly a second laying". Major E.G.Pythian Adams reported nesting of a pair in October 1921 in the fort at Cannanore, and he took the eggs. According to him the nest was a huge mass of sticks and at least 4 feet across. It was blown down in the severe monsoon of 1924 but the birds built new (and smaller) nest on an adjacent tree. Ali and Abdulali (1936) and Futehally (1995) observed breeding pairs of this eagle in Kihim near Bombay. Biddulph (1938)

(1938) recorded it common on the Rameswaram islands and nesting was reported at Cuddalore. McCann (1941) recorded breeding pair of the species in North Karwar a Kurmagad. Dharmakumarsinghji and Lavkumar Kachar (1956) narrated nesting sequences of the eagle in Karwar coast. Abdulali (1964) and Tikader (1984) recorded it common on the Islands of Andaman and Nicobar Islands. Murthy and Rama Rao (1988) noted the snake eating habits of the eagle. A recent survey by Prakash (1994) came across a good population of this species between Bombay and Goa.

Extensive studies on wetland and water birds have been done in Europe and North America . Of these Gross-Custrard (1969), Gross-Custard and Yates(1992), Burger et al(1977), Kushlan (1979&1992) Hancock (1984); Hancock and Kushlan (1984), Powell (1987), David (1994),Kirby (1995)Colwell and Dodd, (1995) are worth mentioning. Very few attempts have been made to study the population and ecology of the wetland birds in Kerala, though some studies on wetland ecosystem and its bird fauna have been carried out in some other parts of the country. Notable among them are those of the Bombay Natural History Society at Point Calimere, (Ali,1963; Ali and Hussain,1981 & 1982; Sugathan,1982; Natarajan, 1992) and at Keoladeo Ghana National Park, Bharatpur by Ali and Vijayan (1986), Vijayan.(1987& 1991) , Sridharan (1989) , Bhupathy (1991) , Ramachandran (1998) Bhupathy, Vijayan and Mathur (1998) etc., Mukherjee (1969-75) has summarised the food habits of water birds at Sunderbans, while Dharmakumarsinghji (1973) has reported details of migratory and resident

waterfowls at Bhavnagar. Parasharya and Naik (1990) has given a detailed account on the breeding of Ciconiformes in Gujarath., In Andhra Pradesh Krishnaraju (1983), Nagulu and RamanaRao (1983), Rajendra Madhav (1988), Anjaneyulu (1992), Johnson (1992) and Mallareddy (1996) studied the major wetland habitat and their waterfowls. Hussain et al (1984) has prepared an avian profile of Chilika Lake. Singh and Roy (1990) has studied the ecology of birds of Kavar Lake in Bihar. Battacharjee et al (1988) has carried out some studies on the wetlands and waterfowls of Assam. Sampath (1990); Sampath and Krishnamurthy (1993) have studied the food habits and ecology of wetland birds in coastal Tamilnadu. Recently Perennou (1989) and Perennou and Santharam (1990) listed some interesting distributional records of migratory waterfowls in south India, while Kurup and Zacharias (1994) has given a detailed account of the bird fauna of Lakshadweep Islands.

A preliminary list of birds along the coastal wetlands of Kerala has been documented by Ali(1967). Logan (1887) and Baker & Inglis (1930) have listed the bird fauna of Malabar coast. Neelakantan (1956-1992) has published a series of notes on wetland birds. Subsequently many short notes on the wetland birds were published in the last one decade. (Namassivaam et al 1989; Uthaman *et al*,1989;1990; Uthaman and Namassivayam,1992; Sashikumar,1990; Sashikumar *et al*,1991; Nameer,1992,93; Ravindran,1993; Jafer *et al*, 1997). Kurup (1991) has carried out detailed studies on the bird fauna of Malabar coast in Kozhikode

and Malappuram districts, while, Babukutty (1997) studied wetland birds in the Vembanadu lake area of the Aleppey district.

In India, studies on birds in the agro-ecosystem were restricted to the pest status of birds.. Lister(1952), Ali and Ripley (1983); Agarwal and Bhatnagar(1982) and Dhindsa and Saini (1994) listed birds associated with cultivated lands, Mathew et al, (1980) studied the feeding habits of birds in agricultural system. Further, Francisnathan and Rajendran (1982) has listed avifauna of the rice ecosystem of Pondicherry. Majumdar and Brahmachari (1987) studied the avian predation on insects and rodents in a paddy ecosystem. Rajan (1989) studied the synecology of birds in paddy fields from Kerala. Shyma (1998) has listed birds of agriculture crop in Goa. Thirumurthy (1981) studied the insectivorous birds associated with the rice ecosystem at Madurai. Recently Subramanya and Veeresh (1998) has presented the avifaunal pattern in a rice ecosystem of Bangalore. There were many studies dealt in detail on the damage of birds on agricultural ecosystem (Hamid Ali etal.1971;Dhindsa and Toor 1980; Saini et al,1992). Despite being one of the major man-made habitat, the avian utilization of paddy fields has been little studied

The present study has been undertaken with the following main objectives

1. To collect information on the status, biology and ecological requirements of the Whitebellied Sea Eagle *Haliaeetus leucogaster* in north Malabar .
2. Recommend the measures for conservation and management of the species and birds in wetland habitats in north Malabar..

- 3 To estimate the spatial and temporal variability of wetland birds and get an idea about the habitat preferences of the wetland bird assemblages in five different coastal wetland habitats in north Malabar.

STUDY AREA

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CHAPTER 2

STUDY AREA

2.1 Introduction

The north Malabar is situated on the south-west coast of India. It comprises two northern most district of Kerala state viz., Kannur and Kasaragod, lying between latitude $11^{\circ} 40'$ to $12^{\circ} 48' N$ and longitude $74^{\circ} 52'$ to $76^{\circ} 07'$. The area is bounded on the north and the east by the south Kanara and Coorg districts of Karnataka state, on the south by the Kozhikode district and on the west by the Arabian sea. The total coastal area studied is about 153 Km. extending from Mahe River in the south to Manjeswaram River in the north. Five different wetland bird habitats were selected for the study of wetland birds along the coastal line (Fig 2.1).

2.2 Topography

Physiographically the area is mainly divided into three natural regions. They are the lowland bordering the sea (coastal area), the midland consisting of the undulating laterite hills having a height of 8 to 80m above MSL and the highland consisting of Western Ghat mountains, with an average height of 100m above sea level. Ezhimala on the sea-coast, is a small historic hill having a height of 285m, which has always been a well known land mark for the sailors in the past.

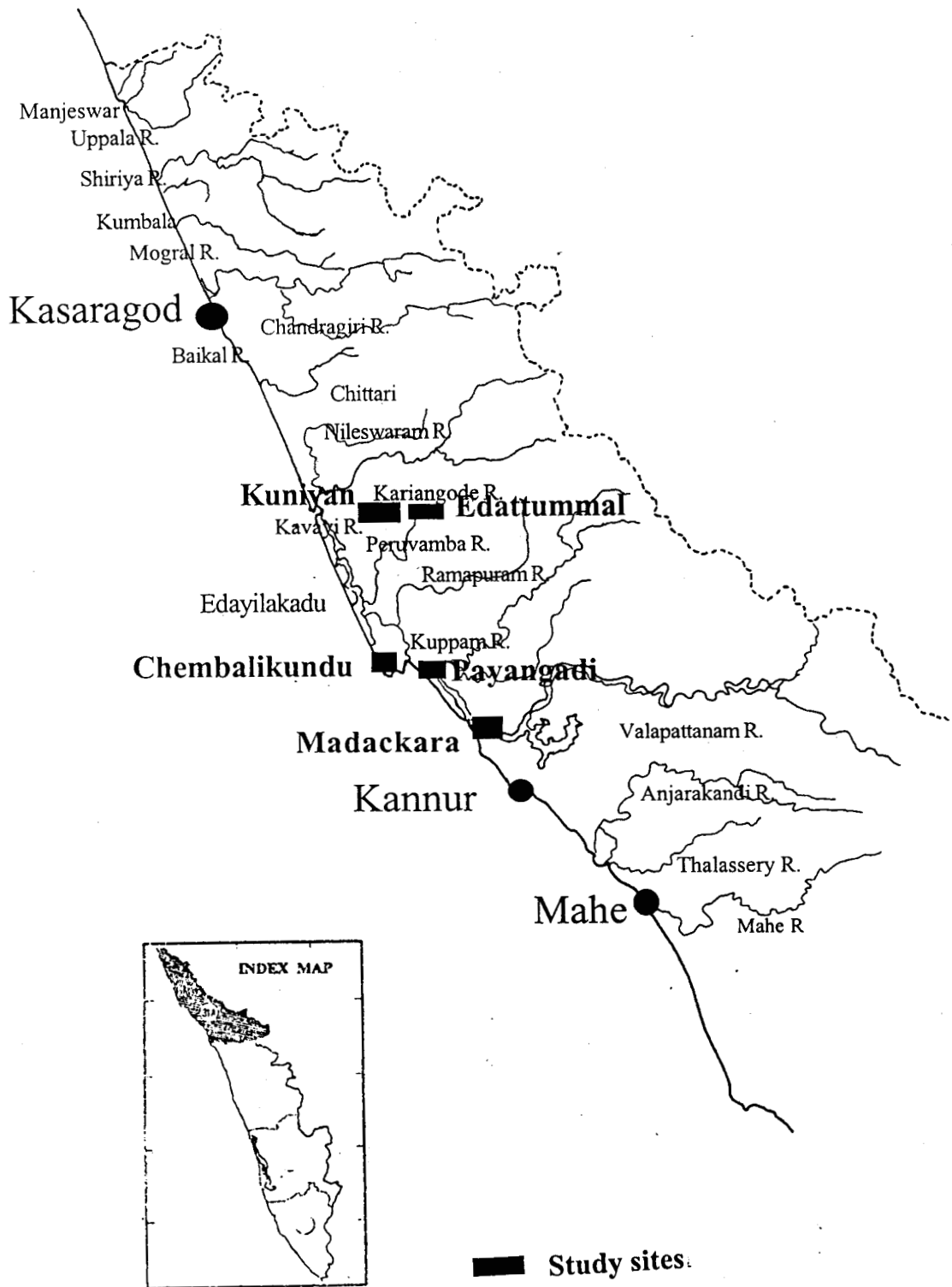


Fig.2.1. Map of north Malabar showing location of the weland study sites.

2.3 Sea coast

North Malabar districts have extensive sea coast of about 153 Km. long and narrow through out. Its width varies from 32 Km. in the north to 80 Km. in the south.. The major part of North Malabar coastline is characterized by a narrow longitudinal strip of coastal zone formed of alluvial deposits between Arabian sea and a chain of backwater and estuaries with connection to the sea at numerous points. These wetlands provide good habitat for water birds and migratory shorebirds.

2.4 Backwaters

The important backwaters of north Malabar are, Kumbala, Kalanad, Bekkal, Chittari and Kavvayi. The Kavvayi backwaters is the largest and most important one in the area. It extends parallel to the coast for a distance of about 21 Km with outlets at Chandira and Olakkal Azhi near Palakode. It is connected to the Kuppam river through the Sultan's Canal, built in 1764 by Arackal Beevi of Kannur. The Kavvayi backwaters is enriched with the discharge of Peruvamba, kavvayi and Ramapuram rivers. There are a number of islands and mangrove areas within the backwaters. The Edayilakkadu is one of the major island and is a known nesting site of Whitebellied Sea Eagle.

2.5 River System and Water resources:

The North Malabar coast is transversed by 19 rivers (Basak,1995). This creates extensive areas of mudflats, creeks, bays and lagoons and mangrove

vegetation forming feeding grounds for the waterfowls shorebirds and the Whitebellied Sea Eagle. The following are the 19 rivers.

1. Manjeswaram River: This is a small stream flowing through the town of Manjeswaram having a length of about 16 Km. and originating from Balepani of Western Ghats about 60m high.

2.Uppala River: Another smaller river extending about 50 Km. and originating from Virakamba Hills at about 150m height. This becomes dry in the summer.

3. Shiriya river: The river is formed by the confluence of Adkastala Hole, and Palleadka Hole at Angadimogaru in Kasaragod district. The river enters the Kumbala backwaters from north east and flows south before it joins the sea with a total length of about 67 Km.

4. Kumbala River : One of the smallest stream, has a total length of about 10 Km from the source to the sea. It is a major tributary of the river Shiriya.

5. Mogral River : It is flowing parallel to the Shiriya river in Kasaragod district with a total length of about 34 Km. After the railway bridge, the river abruptly turn south, forming a long stretch of backwaters of about 5 Km in length. The river originates from the Kanathur hills.

6. Chandragiri River: One of the largest river in Kerala. There are two main tributaries for the river, of which one is Payaswani and other is Chandragiri. The river originate from Pattighat of the Coorg district at an elevation of 1350m. and is about 105 Km long from its source.

7. Kalanadu River: It is a small river of 8Km from its source to the sea mouth near Kasaragod.

8. Bekkal River : It is flowing parallel to the Kalanadu river. The river is small and has a length of about 10 Km from the source.

9. Chittari River : Originating from the hills of Chettiamchal is mainly an accumulation of backwaters along the coast, near Chittari many small streams from all direction discharge into the backwaters. The total length of the river is about 25 Km.

10. Nileswar River: Originates from Kinnanur of Hosdurg taluk (140m). Its total length is about 46Km, and the lower 12 Km are tidal, resulting in a vast stretch of water providing facility for navigation.

11. Kariangote River: One of the major river originating from Padinalkad (1520m) of Coorg mountains. The 64Km long river enters the sea at Thiruthi. The common estuaries of Kariangode and Nileswar extends along the coast forming a long stretch of backwaters where Kavvayi and Peruvamba rivers also discharge their waters.

12. Kavvayi River : This river has its origin in Cheemeni village(385m) on the banks of Kariangode river. The 31Km long river enters Padanna backwaters which extends from Cheruvathur in the north to Ramanthali in the south.

13. Peruvamba River : Originate from the dense forest and hill slopes of Western Ghats near Peckunnu (325m) . The 51Km long river enters in to the sea at

Palackode and forms long stretch of backwater swamps at Chemballickundu and Kunhimangalam.

14. Ramapuram River: It is a small river with a length of 19Km ,originating from a laterite hill near Iringal and enters the sea at palackode along with Peruvamba river.

15. Kuppam River : The river originates from Pudinalkad (1630m) of Coorg mountains. Its three tributaries; Adukit tod, Pakkattu Poya and Kuttikkol joins the river. The river enter the sea at Azhikkal, along with Valapattanam river, after flowing a length of 82 Km, it forms extensive mudflats at Madackara estuary.

16. Valapattanam River : The three tributaries, Srikandapuram River, Valizhapuzha or Barapole and Aralam Puzha enriches the river . It originates at the Brahmagiri Hills (1350m) and joins the sea at Azhikkal with a length of 110Km.

17. Anjarakandy River: It originates from Kannavam forest (600m). After a course of about 48Km, it divides into two branches, and form the Dharmadam island at its junction with the Arabian sea.

18. Tellicherry River : The river originates from Kannavam reserve forest. It is 28 Km long and empties itself into the Arabian sea at Dharmadam about 2 Km north of Tellicherry.

19. Mahe River: It originates at Waynad hills (910m). The 50Km long river joins the Arabian sea at Mahe.

2.6 Geology

In the coastal areas the terrain is undulating and characterised by laterite capped hills developed along the coastal areas of the districts. The laterite being primary and form flat topped ridges of about 8-10m depth . The area is famous for the deposits of China Clay and Bauxite. The well known heavy mineral deposits like Ilmenite, Monozite, Zircon, Thoriamite, etc. occur in the coastal sands. (Sreedharamenon,1957).

2.7 Climate

The area has humid tropical climate. The hot season from March to May is followed by the southwest monsoon from June to September, north east monsoon occurs from October to November. The annual rainfall in the region is more than 3000 mm, which is more than the state average. The period from about March to the last week of May is the summer season. December to February are cooler months. The climate of the Malabar coast has been described by Zacharias and Gaston: (1983).

2.7.1 Temperature

A maximum temperature of 33.4⁰C. is experienced in April and a minimum of 18.7⁰C.in December. The monthly variation in maximum and minimum temperature recorded in the study area is given in the Table -2.1.

2.7.2 Humidity

Table: 2.1. Climatic Parameters of the study Locality

MONTH	Rainfall	Mean Temperature		Relative Humidity	
		Maximum	Minimum	Maximum	Minimum
May '94	106.2	31.9	25.6	86	69.1
June	1445.5	28.1	23.8	98.6	90
July	1069.7	27.6	23.2	95.5	89.2
August	793.2	28.7	23.6	97.4	79.9
September	139.9	29.1	23.3	94.9	73.2
October	469.7	30.2	23.8	95.9	79.3
November	73.6	31.6	22.5	94.9	62.8
December	0	31.8	19.6	93.3	50.2
January'95	0	31.6	19.8	92	54.9
February	0	32	22	92.3	66.6
march	0	32.5	23.4	88.3	61.1
April	32.2	33.4	25.6	81.6	60
May	150	32.8	25.4	87.5	67.9
June	907.2	30.1	26.9	94.5	94.4
July	1172.8	27.8	23.5	99.2	94.4
August	543.9	28.9	24.8	98.5	85.3
September	202.1	29.5	24.5	97.1	78.6
October	174.8	30.7	23.8	97.9	70.2
November	68.7	31	22.8	93.3	71
December	0	31.3	18.7	91.7	41.7
January'96	0	31.4	19.1	93	56.3
February	0	31.9	21.2	92.5	58
march	0	32.5	23.5	89.2	62.6
April	37.8	33.1	24.6	86.7	62.9
May	98.5	33.1	25.3	87.2	66.8

Source : Regional Agriculture Centre, Peelikode, Kasaragod

The area is characterised by high humidity nearly all the year round. Humidity is maximum in July (99%) and minimum in December (49%).Details are given in the Table -2.1..

2.7.3 Rainfall

The area receives rain both from the southwest and the northeast monsoon. The peak period of rainfall is in July. The average number of rainy days in a month is maximum in July and minimum or nil during December to April.(Table-2.1)

2.7.4 The Waves and Tides

The nature of waves along the coast is evidently controlled by climatical conditions in the sea. The highest wave activity along the coast coincides with occurrence of the monsoonal winds from May to October; the roughest period being June to July. A significant reduction in wave height is noticed in the north Malabar, when compared to the sea coasts of southern districts of Kerala. The tides in the estuaries are semi-diurnal, on an average varying from 90cm to 1.8m in northern Kerala (Moni,1980). Two high and two low water marks occur each day and differ in height which reduce gradually towards the upper reaches of the estuaries. Flooding owing to storm tides, is a characteristic phenomenon along the coastal areas of Kerala, especially during the south west monsoon period.

2.8 Flora

Due to the edaphic and climatic factors, the area has a rich flora .In general, the vegetation on these areas can be distinguished in to (1) Inland wetland flora (2)

Sandy beach flora and (3) Estuarine and backwater flora.(Mudaliar and Kamath,1954; Rao and Sastry,1974). The list of the coastal vegetation of north Malabar is given in the Appendix no. II..

The inland wetland vegetation mainly comprises of aquatic plants like *Nymphae nauchali*, *Nymphoides indicus*, *Hygrophila schulli*, *Fimbristylis spp*, *Ludwigia spp*, *Mariscus javanicus*, etc. The sandy coastal land flora comprises only very few plants. Most of the plants are prostrate and small, adapted to the condition of soil and wind. The plant representatives are *Ipomoea biloba*, *I. pres-carpae*, *Euphorbia spp*, *Spinifex mousthachiae*, etc. The third and most important vegetation type is the mangrove formation around the estuaries, backwaters and riverine areas. The Kerala state once supported a rich mangrove vegetation of 700 Sq.Km. which has declined to a mere 50 Sq.Km.(Chandbasha,1991). The present estimate has shown a total of 400 ha of mangroves in Kannur and Kasaragod districts (Mohan,1997). The dominant species of this ecosystem are *Avicennia officianalis*, *Avicennia marina*, *Bruguiera cylindrica*, *Rhizophora mucronata*, *Sonneratia caseolaris*, *Acanthus ilicifolius*, *Achrostichum aureum* *Derris trifoliata*, *Excoecaria agallocha*, *Aegiceras corniculatum*, *Clerodendrum inerme*, etc. The coastal waters of Dharmadam puzha and Anjarakandipuzha near Thalasserry and Dharmadam have rich growth of mangroves. Other major mangrove areas include those on Kuppam and Valapatanam river banks especially at Irinavu, Madackara, Theckumbadu islands, Pallickara, Muttill, Payangadi, Ezhome, pattuvam and Thavam. The Ezhimala region, at the confluence of Ramapuram,

Peruvamba, and Kavvayi river system support a rich growth of mangroves. These areas are infact recommended as a potential site for Mangrove Genetic Resource Centre in the state (Mohanam,1997). Mangroves grow further north in the Kavvayipuzha, Kariangote river, Chittari and Nileswar river at several locations. The estuarine areas of river Chandragiri, Manjeswaram, Mogral Puthur and the banks and lower beaches of river Shiriya and Kumbala also support remnants of mangrove vegetation.

Anthropogenic activities such as aquaculture, land reclamation for construction of buildings, agriculture, and various developmental activities have resulted in massive destruction of mangrove ecosystems.

2.9 Fauna

Apart from the rich bird fauna and fishery resources, the coastal wetlands of north Malabar harbour a number of animal species. The thick growth of mangroves is a good hideout for Jackals, *Canis aureus*. Large packs were seen in Madackara and Theckumbadu. The rare and endangered Fishing Cat, *Felis viverrina*, was sighted at Chemballickundu mangroves during October, 1995. The den of Smooth indian Otter, *Lutra perspicillata* was observed within the mangroves of Theckumbadu and banks of Kuppam river near Ezhome. The Jungle Cat, *Felis chaus* was also reported from the mangrove patches of Valapattanam and Irinavu. The sandy beaches of Azhikkal, Nileswar and Mogral Puthur areas are known breeding grounds of the endangered Olive Ridley Turtle, *Lepidochelys olivacea*. A considerable extent of shore is exposed during low tide and several species of

annelids, polychaetes, crabs, molluscs and echinoderms inhabit the intertidal zone. These form a good prey base for the shore birds, both residents and migrants.

2.10 Land Use Pattern

Mostly there are two distinct paddy cropping season. The rain fed "Pokkali" or "Kaipadu Krishi" are also practiced in some places. Coconut plantation and related industries are the main income for the coastal population. The fishing and collection of mussels, oysters, etc., are the major activities here. Grasses and leaves of some mangrove plants are collected by local people to feed cattle. The screw pine leaves are collected for making mats. Extensive areas at Irinavu, Madackara, Kunhimangalam are used for retting coconut husks. Sand mining operations are frequent in the rivers of Kuppam, Valapattanam, Mogral Puthur, Peruvamba, Nileswar and Chandragiri. Sand mining is a major threat to the ground water table of the area. The recent developments of intensive aquacultural practices along the coastal areas also seem to be detrimental to the stability of coastal environment.

2.11. Population

The total population of Kannur district as per the 1991 Census was 22,51,727, with an area of 2996 Sq.Km, whereas the Kasaragod district was less populated with a population of 10,71,508 people in an area of 1992 Sq. Km. The two districts are densely populated in the coastal areas having an average population

density of more than 2000 per Sq.Km. Which is much higher than the state average of 749. Hence a high pressure on the natural resource is obvious.

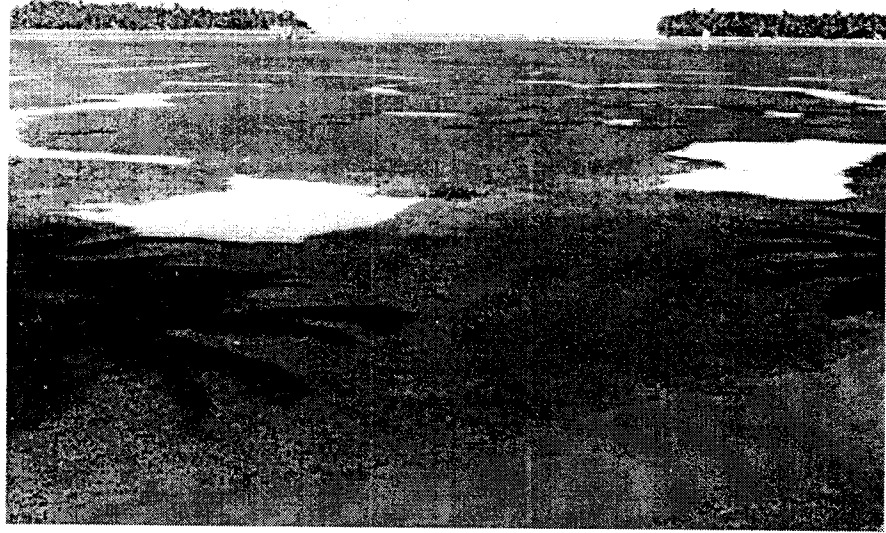
2.12 MADACKARA- ESTUARY

This is one of the most important estuary in the north Malabar. The river Kuppam from the north and the river Valapattanam from southeast meet at Madackara and discharges their water to the sea. The area is lying at a latitude of 11° 57'N and a longitude of 75° 20'E, and 7 Km north of Kannur town (fig 2.2). The extensive mudflats formed by the confluence of Valapattanam and Kuppam river harbour rich mangrove vegetation. The adjacent areas of Irinavu in the river bank of Valapattanam and Theckumbadu island in the Kuppam river also support good mangrove vegetation. The sandy sea-shore of Azhikkal and Mattul in the south and north of the river mouth provide good habitats for resident and migratory birds. The mangroves have shown good regeneration over the years and species like *Acanthus ilicifolius*, *Avicennia officinalis*, *Avicennia marina*, *Rhizophora mucronata*, *Sonneratia caseolaris*, etc. occur; the details of the plant species are given in the Table - 2.2.

2.12.1 Land Use Pattern

The estuary provides good fishery ground for local people. Collection of mussels, prawns and crabs, besides fishing were the major activities here. The leaves of *Avicennia officinalis*, *A. marina*, *Sonneratia caseolaris* are periodically collected by the local people to feed cattle. During September, the nutrient rich mud were collected for manuring the coconut plantation, which also promote the

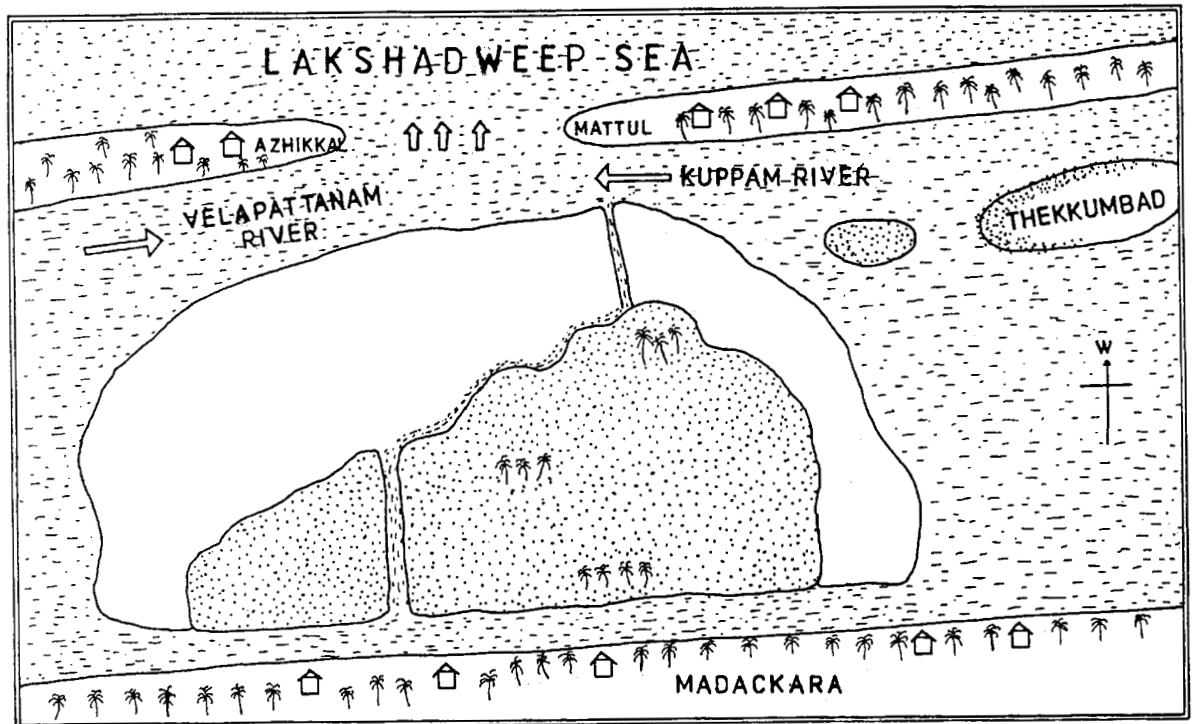
Plate.1



(i) Madakara Estuary during low tide



(ii) Mangrove vegetation at Madakara








- Legends**
-  Residential area
 -  Mudflats
 -  Mangrove area
 -  Coconut plantation
 -  Flooded area

Fig.2.2 Map showing Madakara Estuary

Table 2.2 **A list of plants at Madackara Wetlands**

Plant Species	Family
1 <i>Acanthus ilicifolius</i>	Acanthaceae
2 <i>Acrostichum aureum</i>	Pteridaceae
3 <i>Aegiceras corniculatum</i>	Myrsinaceae
4 <i>Avicennia officinalis</i>	Avicenniaceae
5 <i>Avicennia marina</i>	Avicenniaceae
6 <i>Bruguiera cylindrica</i>	Rhizophoraceae
7 <i>Caesalpinia Nuga</i>	Caesalpinaceae
8 <i>Clerodendrum inerme</i>	Verbenaceae
9 <i>Crinum defixum</i>	Amarillidaceae
10 <i>Crotalaria quinquefolia</i>	Fabaceae
11 <i>Cyanodon dactylon</i>	Poaceae
12 <i>Derris trifoliata</i>	Fabaceae
13 <i>Excoecaria agallocha</i>	Euphorbiaceae
14 <i>Fimbristylis spp.</i>	Cyperaceae
15 <i>Hibiscus tiliaceus</i>	Malvaceae
16 <i>Ipomoea biloba</i>	Convolvulaceae
17 <i>Ipomoea companulata</i>	Convolvulaceae
18 <i>Kandelia candal</i>	Rhizophoraceae
19 <i>Ludwigia sp.</i>	Onagraceae
20 <i>Pongamia pinnata</i>	Fabaceae
21 <i>Premna serratifolia</i>	Verbenaceae
22 <i>Rhizophora apiculata</i>	Rhizophoraceae
23 <i>Rhizophora mucronata</i>	Rhizophoraceae
24 <i>Sonneratia alba</i>	Soneratiaceae
25 <i>Sonneratia caseolaris</i>	Soneratiaceae

economy of the people of Madackara. Extensive areas at Irinavu and limited areas at Madackara and Mattul are used for retting coconut husk for the coir industry.

2.12.2 Disturbances and Threats

1. Hunting of water birds are reported from several areas around the estuary.
2. Unauthorised reclamations of mangrove swamps have been observed near Madackara and Irinavu.
3. Several development projects have been proposed by the Government which include a naphtha based thermal power plant in private sector, upgradation of the Azhikkal Port to a big harbour and a bridge across the Kuppam river connecting Madackara and Mattool. If these projects are implemented, it will have adverse effects on the ecology of the area.

2.13 CHEMBALLIKUNDU- BACKWATER SWAMP

The flood plains parallel to the Ezhimala hills formed by the influence of rivers Ramapuram, Peruvamba and Kavvayi forms this wetland. The area is situated at a latitude of 12° 31' N and a longitude of 75°14'.E The river Peruvamba, after flowing into the marshy water body west of Ezhimala railway station gets bifurcated, one branch enter the Kavvayi Kayal and the other one from the end channel of Ezhimla. One off-shoot of the river extends in the eastern direction near Mulackeel weir and forms the backwater swamp of Chemballikundu and extend up to the railway line to about 1Km. In order to control the salinity

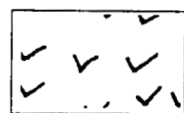
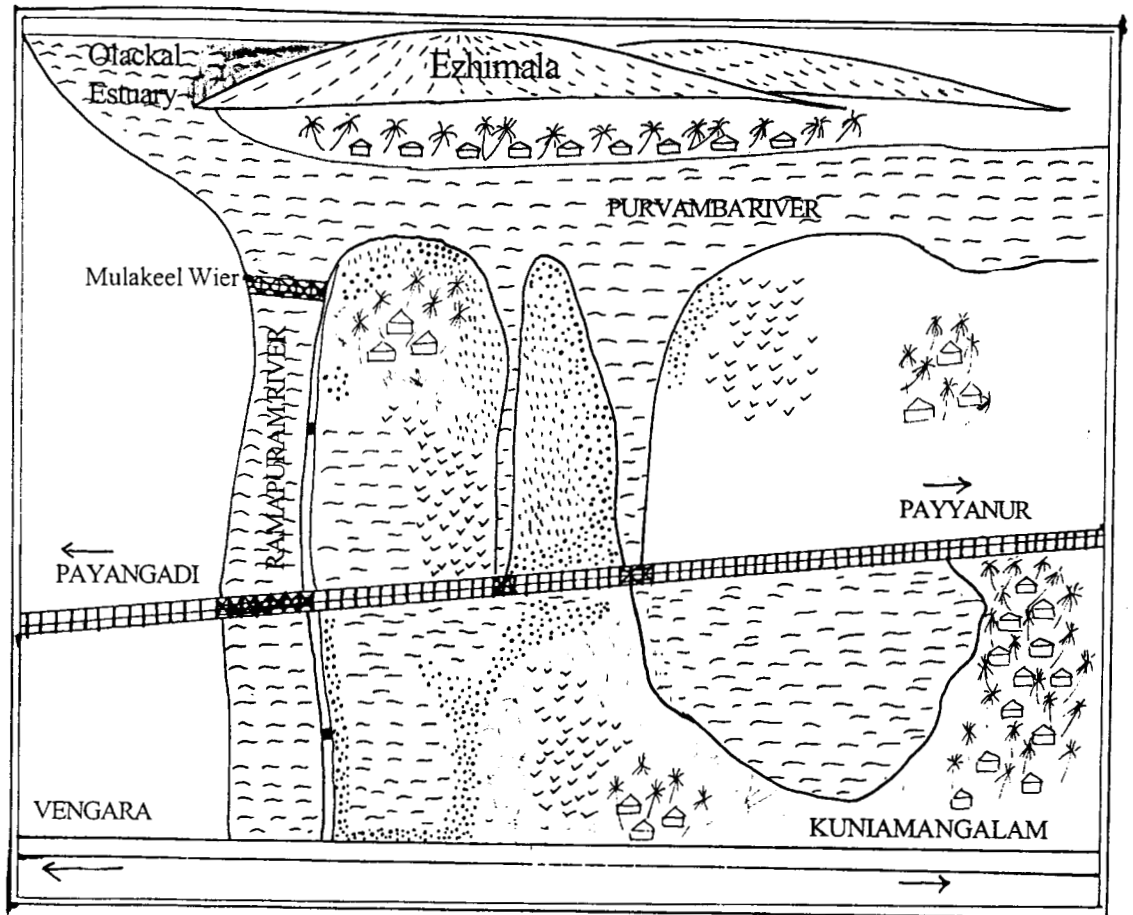
Plate.2



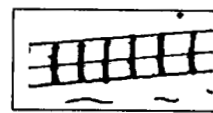
(i) Aquatic vegetation at Chembalikundu



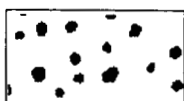
(ii). A View of Congregation of Egrets at Chembalikundu



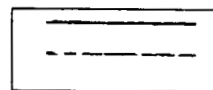
Paddy field



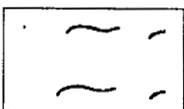
Railway tract



Mangrove forest



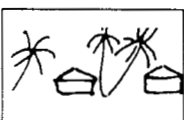
Road



River



Moorlands



Human habitation

Fig.2.3. Locality map of Chemballikundu

Table 2.3 **List of plants of Chemballikundu**

Species	Family
1 <i>Acanthus ilicifolius</i>	Acanthaceae
2 <i>Acrostichum aureum</i>	Pteridaceae
3 <i>Aegiceras corniculatum</i>	Myrsinaceae
4 <i>Ardisia littoralis</i>	Myrsinaceae
5 <i>Avicennia officinalis</i>	Avicenniaceae
6 <i>Avicennia marina</i>	Avicenniaceae
7 <i>Bruguiera cylindrica</i>	Rhizophoraceae
8 <i>Caesalpinia Nuga</i>	Caesalpiaceae
9 <i>Cerbera manghas</i>	Apocynaceae
10 <i>Clerodendrum inerme</i>	Verbenaceae
11 <i>Crinum defixum</i>	Amarillidaceae
12 <i>Crotalaria retusa</i>	Fabaceae
13 <i>Cyperus difformis</i>	Cyperaceae
14 <i>Cyperus haspen</i>	Cyperaceae
15 <i>Cyperus malaccensis</i>	Cyperaceae
16 <i>Cyperus pumilus</i>	Cyperaceae
17 <i>Derris trifoliata</i>	Fabaceae
18 <i>Excoecaria agallocha</i>	Euphorbiaceae
19 <i>Fimbristylis aestivalis</i>	Cyperaceae
20 <i>Fimbristylis miliaceae</i>	Cyperaceae
21 <i>Fimbristylis spp.</i>	Cyperaceae
22 <i>Geissaspis cristata</i>	Fabaceae
23 <i>Hibiscus tiliaceus</i>	Malvaceae
24 <i>Hygrophila angustifolia</i>	Acanthaceae
25 <i>Hygrophila schulli</i>	Acanthaceae
26 <i>Ipomoea biloba</i>	Convolvulaceae
27 <i>Ipomoea companulata</i>	Convolvulaceae
28 <i>Kandelia candal</i>	Rhizophoraceae
29 <i>Limnophila heterophylla</i>	Scrophulariaceae
30 <i>Ludwigia sp.</i>	Onagraceae
31 <i>Mariscus javanicus</i>	Cyperaceae
32 <i>Marsilia quadrifolia</i>	Marsiliaceae
33 <i>Melastoma malabathricum</i>	Melastomaceae
34 <i>Morinda citrifolia</i>	Rubiaceae
35 <i>Nymphaea nouchali</i>	Nymphaeaceae
36 <i>Nymphoides indica</i>	Nymphaeaceae
37 <i>Pandanus tectorius</i>	Pandanaceae
38 <i>Pongamia pinnata</i>	Fabaceae

39 *Premna serratifolia*
40 *Rhizophora apiculata*
41 *Rhizophora mucronata*
42 *Rotala* spp
43 *Sessamum indicum*
44 *Sphaenoclea zeylanica*
45 *Syzigium calophyllifolia*

Verbenaceae
Rhizophoraceae
Rhizophoraceae
Lythraceae
Amarillidaceae
Companulaceae
Myrtaceae

intrusion from tidal river a weir was constructed at Mulackeel across the river Ramapuram, near the Chemballikundu. (Fig.2.3)

Due to the variation in salinity across the seasons, the vegetation of the area is diverse.. The aquatic vegetation comprises species such as *Nymphae nauchali*, *Nymphoides indicus*, *Limnophylla heterophylla* and mangrove species like *Acanthus ilicifolius*, *Avicennia marina* , *Aegiceras corniculatum*, *Excoecaria agallocha*, etc., and the diverse moorlands comprises of species like *Cyperus* ,*Fimbristylis* etc. These form microhabitats for many birds and animals. A detailed list of plants is given in Table-2.3.

2.13.1 Land Use Pattern

According to the old farmers, the area was once known for its good harvest of paddy. Now the major portion of the paddy fields were left fallow as paddy cultivation is said to be economically non-viable. The traditional prawn culture practiced by the local fishermen however fetches good income. In the recent past, a spurt of shrimp farms have replaced many of the wetland and mangrove areas . The construction of Mulackeel weir to control the salinity intrusion was a total failure. The project established in 1961 failed due to the negligence of the government departments, and the people living in the upstream areas struggle to protect their paddy cultivation from salinity problems. The reeds and grasses are collected by local villagers for cattle . The screwpine leaves were collected for making mat. The mussel collection is one of the major income of the local people . In summer months of March, April and May the water level was lowered by

closing the weir and other sluices connecting river. During this period the number of waterfowls were found to increase.

2.13.2 Disturbances and Threats

1. The doubling of railway track by the southern Railway is a main threat to the mangrove vegetation in the area.
2. The semi and intensive prawn farming has badly affected the mangrove swamps and breeding grounds of the natural population of prawns and fishes.
3. The malfunction of the Mulackeel weir has adversely affected the agriculture and fishery production.
4. Indiscriminate poaching by the locals of the roosting population of egrets, herons, cormorants and storks is a major problem.

2.14 PAYANGADI-RIVER BANK WETLANDS

The river Kuppam originating from the Western Ghats flows through Chapparapadavu, Kuveri, Pattuvam, Ezhome and Muttukandy almost in an east to west direction. But immediately near Payangadi Railway bridge it turn south and run parallel to the Arabian sea, form extensive marsh areas on the banks. The study area extends from Payangadi to Muttukandy having a distance of about 1KM, located in a latitude of 12°1'N and a longitude of 75°16'E.

The two sluices on a small bund road connecting the Muttukandy from Payangadi controlled the tidal water inflow into the marshes. The wider marshy areas and swamps were once covered with rich growth of mangrove vegetation

Plate.3



(i). Riverine wetland of Payangadi



(ii). Riverine mangrove vegetation at Payangadi

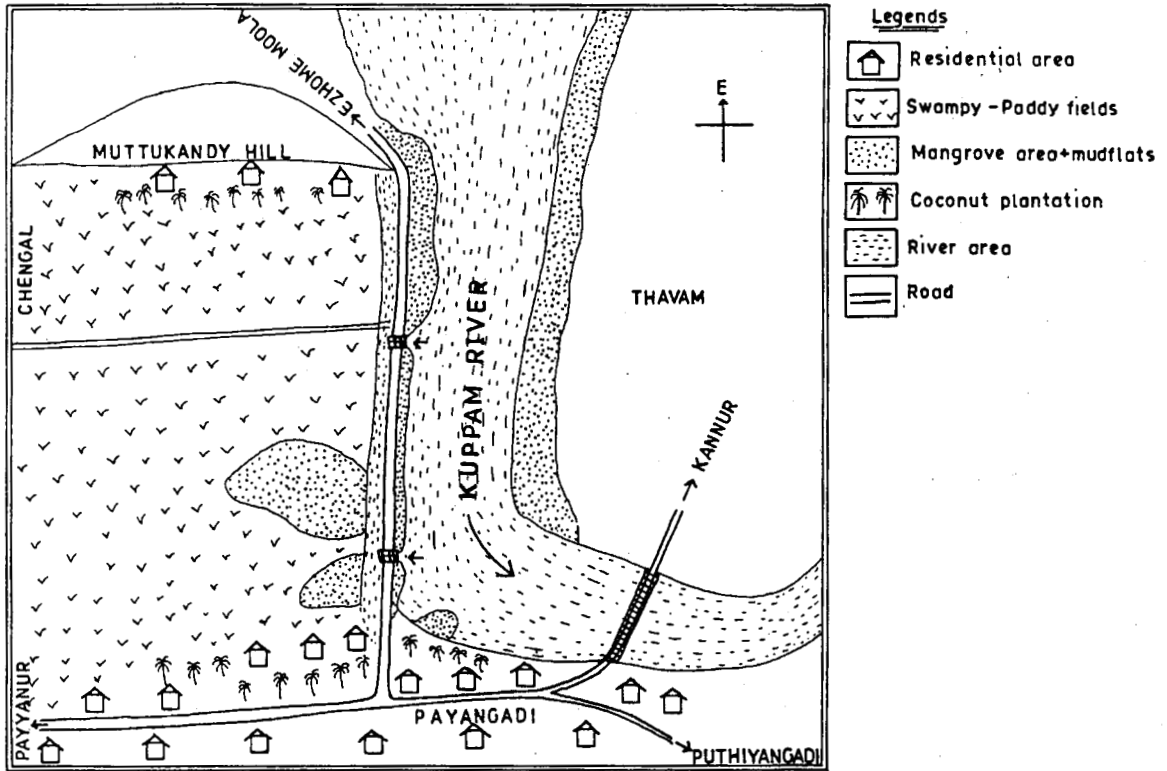


Fig.2.4.-Map showing Payangadi riverine wetlands

Table 2.4 **Plants of Payangadi**

1	<i>Acanthus ilicifolius</i>	Acanthaceae
2	<i>Achyranthus aspera</i>	Amaranthaceae
3	<i>Acrostichum aureum</i>	Pteridaceae
4	<i>Aegiceras corniculatum</i>	Myrsinaceae
5	<i>Avicennia officinalis</i>	Avicenniaceae
6	<i>Avicennia marina</i>	Avicenniaceae
7	<i>Bruguiera cylindrica</i>	Rhizophoraceae
8	<i>Caesalpinia Nuga</i>	Caesalpinaceae
9	<i>Crotalaria quinquifolia</i>	Fabaceae
10	<i>Crotalaria retusa</i>	Fabaceae
11	<i>Cyperus difformis</i>	Cyperaceae
12	<i>Cyperus haspen</i>	Cyperaceae
13	<i>Cyperus malaccensis</i>	Cyperaceae
14	<i>Excoecaria agallocha</i>	Euphorbiaceae
15	<i>Fimbristylis aestivalis</i>	Cyperaceae
16	<i>Fimbristylis spp.</i>	Cyperaceae
17	<i>Hibiscus tiliaceus</i>	Malvaceae
18	<i>Hygrophila schulli</i>	Acanthaceae
19	<i>Ipomoea biloba</i>	Convolvulaceae
20	<i>Ipomoea companulata</i>	Convolvulaceae
21	<i>Kandelia candal</i>	Rhizophoraceae
22	<i>Mariscus javanicus</i>	Cyperaceae
23	<i>Pongamia pinnata</i>	Fabaceae
24	<i>Premna serratifolia</i>	Verbenaceae
25	<i>Rhizophora mucronata</i>	Rhizophoraceae
26	<i>Sphaeranthus indicus</i>	Asteraceae

(Fig.2.4). Now only relicts of the past vegetation was noted. The dominance of species such as *Rhizophora mucronata*, *Avicennia officinalis*, *Clerdendrum inerme* was recorded. A good regeneration of mangrove plants was observed in the study area besides the *Rhizophora* seedling all along the bundline planted by a dedicated fisherman, Shri Kallen Pockudan, whose activities had attracted public attention .

2.14.1 Land Use pattern

The two sluices owned by the Ezhome Panchayath fetch lakhs of rupees annually through auctions.. The local women were seen collecting prawns by hands under the roots of mangrove vegetation here. The " Kaipadu cultivation" of paddy also practised during the rainy season. Reeds are collected for making small basket called "Kuriya", which are used for collecting prawns. The grasses, reeds, and leaves of some mangrove plants are collected by local people to feed cattle .

2.14.2 Disturbances and Threats

- 1.The road proposed by the Fisheries Department from Payangadi to Ezhome moola pass through wetlands and the mangrove vegetation. It would destroy the mangrove patches and the mudflats.
2. Most of the wetlands and mangroves are occupied by the private owners. The construction of new Bus stand by reclaiming the wetlands fastened development process.

3. Poaching was reported at the Vengara kole, mainly on roosting population of egrets and herons.

2.15 KUNIYAN- INLAND WETLAND

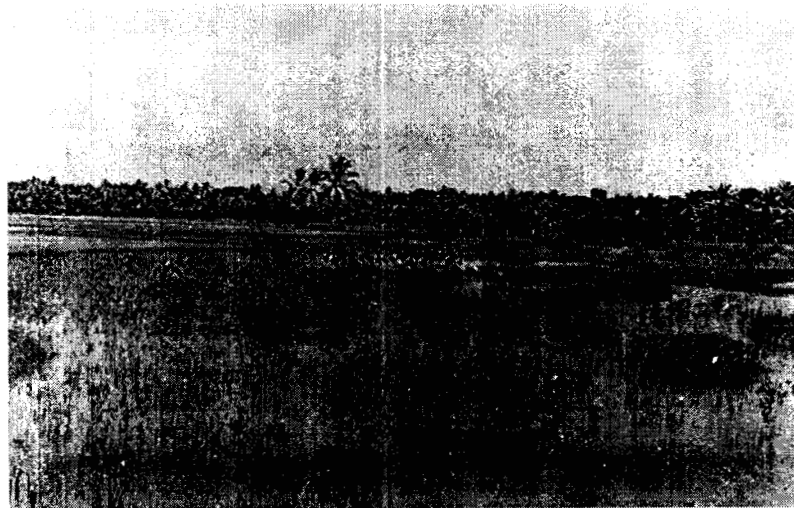
The Kuniyan wetland is formed by the confluence of two small tributaries of the river Kavvayi such as Kuniyan and Vellur. The area is characterised by jheels and moorlands, This wetland is situated near Trikarippur town bordering Kannur and Kasaragod district, at a latitude of 12° 9'nN and a longitude of 75° 12' E. (fig.2.5). Due to its high fertility and the availability of water, three crops are raised in a year. Coconut plantations grow in the adjacent areas. The diverse wetland habitats provide different types of vegetation in the area, The mangrove vegetation here is dominated by species like *Achrostichum aureum*, *Aegiceras corniculatum*, *Excoecaria agallocha*, *Clerodendrum inerme*, etc., and the associated species like *Nymphae nauchali*, *Nymphoides indicus*, *Fimbristylis milliaceae*, *Mariscus javanicus*, etc., (See-Table 2.5). The fringes of the river banks are lined with *Pandanus tectorius*, *Acrostichum aureum* which provide good hideout for Crakes and Bitterns.

2.15.1 Land Use pattern

Plate.4



(i) 'Manga kuthir' located in the centre of the paddy field at Edattunna



(ii) Whitenecked storks are the regular visitor to Kuniyan wetlands

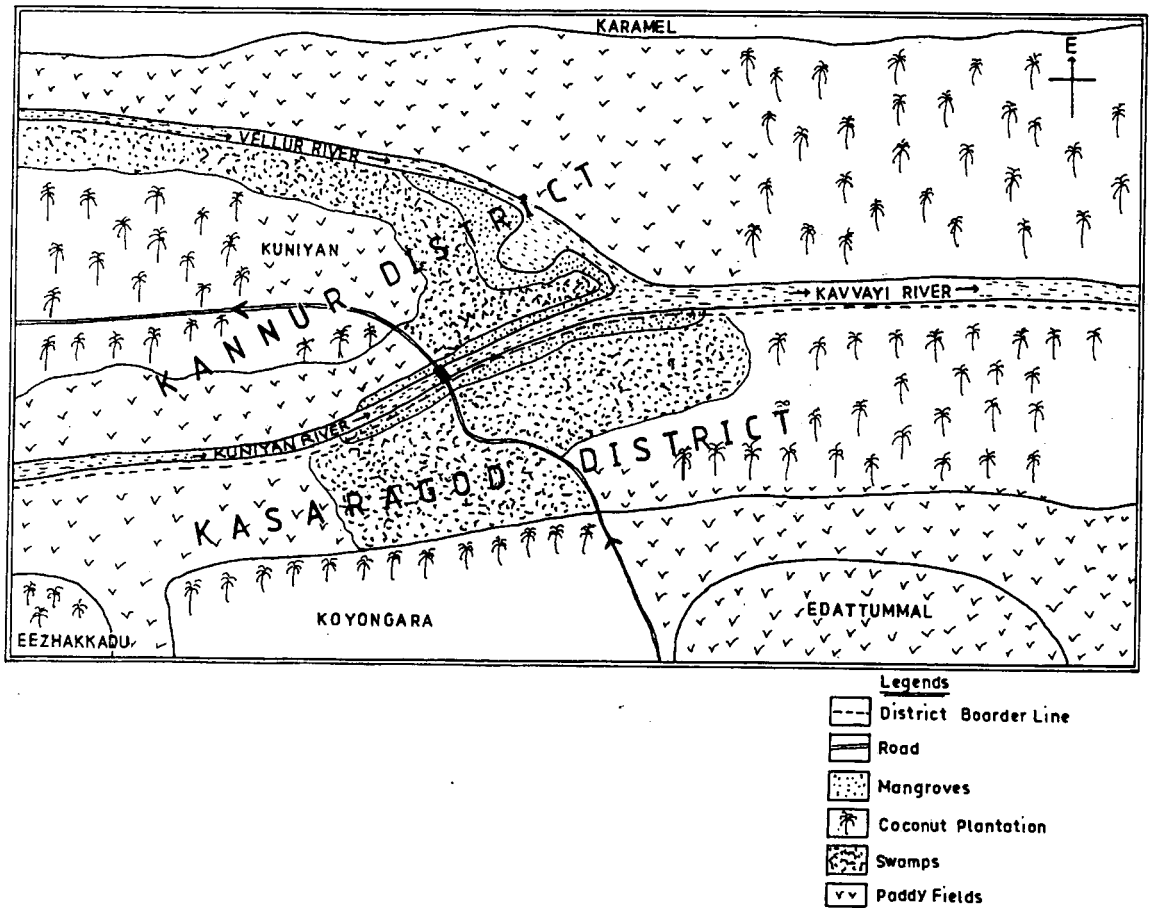


Fig.2.5. Map showing Kuniyan inland wetlands

Table 2.5 **Plants of Kuniyan**

1 <i>Acanthus ilicifolius</i>	Acanthaceae
2 <i>Acrostichum aureum</i>	Pteridaceae
3 <i>Aegiceras corniculatum</i>	Myrsilanaceae
4 <i>Avicennia officinalis</i>	Avicenniaceae
5 <i>Bacopa moneiri</i>	Scrophulariaceae
6 <i>Caesalpinia Nuga</i>	Caesalpiniaceae
7 <i>Calophyllum inophyllum</i>	Clusiaceae
8 <i>Carallia brachiata</i>	Rhizophoraceae
9 <i>Careya arborea</i>	Lecythidaceae
10 <i>Cerbera manghas</i>	Apocynaceae
11 <i>Clerodendrum inerme</i>	Verbenaceae
12 <i>Crinum defixum</i>	Amarillidaceae
13 <i>Crotalaria pallida</i>	Fabaceae
14 <i>Crotalaria striata</i>	Fabaceae
15 <i>Cynodon dactylon</i>	Poaceae
16 <i>Cyperus difformis</i>	Cyperaceae
17 <i>Cyperus haspen</i>	Cyperaceae
18 <i>Cyperus malaccensis</i>	Cyperaceae
19 <i>Cyperus pumilus</i>	Cyperaceae
20 <i>Derris trifoliata</i>	Fabaceae
21 <i>Drosera sp.</i>	Droseraceae
22 <i>Elaeocharis sp.</i>	Cyperaceae
23 <i>Epaltes sp.</i>	Asteraceae
24 <i>Excoecaria agallocha</i>	Euphorbiaceae
25 <i>Fimbristylis aestivalis</i>	Cyperaceae
26 <i>Fimbristylis ferruginea</i>	Cyperaceae
27 <i>Fimbristylis miliaceae</i>	Cyperaceae
28 <i>Fimbristylis ovatus</i>	Cyperaceae
29 <i>Fimbristylis spp.</i>	Cyperaceae
30 <i>Hibiscus tiliaceus</i>	Malvaceae
31 <i>Hygrophila angustifolia</i>	Acanthaceae
32 <i>Hygrophila schulli</i>	Acanthaceae
33 <i>Ipomoea biloba</i>	Convolvulaceae
34 <i>Ipomoea companulata</i>	Convolvulaceae
35 <i>Ipomoea sepiaria</i>	Convolvulaceae
36 <i>Ludwigia sp.</i>	Onagraceae
37 <i>Mariscus javanicus</i>	Cyperaceae
38 <i>Melastoma malabathricum</i>	Melastomaceae

39 Memecylon sp.	Melastomaceae
40 Mimosa pudica	Mimosae
41 Monochoria vaginalis	Pontederiaceae
42 Morinda citrifolia	Rubiaceae
43 Nymphaea nouchali	Nymphaeaceae
44 Nymphoides indica	Nymphaeaceae
45 Pandanus tectorius	Pandanaceae
46 Panicum sp.	Poaceae
47 Premna serratifolia	Verbenaceae
48 Pycneus polystachyon	Cyperaceae
49 Sacciolepis sp.	Poaceae
50 Utricularia sp.	Lentibulariaceae
51 Vitex trifoliata	Verbenaceae

Up to 1976, the area was fully covered with mangrove vegetation. Since then it has been converted into paddy fields and coconut plantations. The remnants of mangrove vegetation and the backwaters provide good fishery potential to the area. The traditional method is used for catching fishes and prawns. Most of the land is private owned. The recent conversion of mangrove swamps and jheels into aquaculture farms and coconut plantations form the main threat to the wetlands of Kuniyan. The collection of grasses and reeds for feeding cattle, collection of screw-pine leaf for making mat and *Excoecaria agallocha* plant root for making cork were the major human dependence on these wetland resources.

2.15.2 Disturbances and threats

1. Conversion of moorlands and mangrove areas into Aquaculture is a major threat to this inland wetland.
2. Most of the wetland areas here are private owned, the reclamation of wetlands for the raising of coconut palm is a common practice.
3. Poaching is rampant, many larger wading birds are killed indiscriminately.

2.16 EDATTUMMAL- PADDY FIELD WETLAND

The Paddy field is situated in the southern border of Kasargod district within the Trikaripur Panchayath. The area is highly fertile due to the proximity of Kuniyan wetlands and the small rivers of Kuniyan and Vellur. Approximately three acres of the paddy field are considered for the study. Three crops are raised during the year. The paddy field is bordered with coconut groves intermingled

with mango trees. Except the monsoon season, the paddy field is flooded with water. In the centre of the paddy field there is a protected 'island of vegetation' or small grove called "Manga Kuthir", which provide nesting place for many paddy field birds. The major vegetation of the "Kuthir" are *Mangifera indica*, *Cinnamomum verum*, *Bridelia retusa*, *Careya arborea*, *Mymecelon* sp., *Strichnos nux-formica*, *Ixora coccinoides* and coconut palms. Weeds like *Grangea maderspatna*, *Ipomoea seiparia*, *Amischopecelus axillaris*, *Cyanotis axillaris*, *Phyllanthus urinaria*, *Eclipta prostrata*, *Fuierena umbellata*, *Lindernia pucilla*, *Sporobolus* spp, *Monocoria vaginalis*, *Utricularia* spp., etc.were collected from the paddy fields.

Animals like the Common Mongoose. *Herpestes edwardsii*, the Bandicoot, *Bandicota benghalensis*, Field Rat, *Mus* spp.; Snakes like Indian Cobra, *Naja naja* Rat Snake, *Ptyas mucosa*, Checkered Keelback, *Xenophis piscator*; Frogs like Green Frog, *Rana hexadactyla*, Indian Bull Frog, *Rana tigerina*, Fungoid Frog *Rana malabarica*, Skipper Frog, *Rana cyanophlyctis*, Paddyfield Frog, *Rana limnocharis* and Molluscs such as *Pila virens*, *Indoplanorbis exustus* and *Lymnaea luteola* were recorded in the paddy fields.

METHODOLOGY

Muhammed Jafer.P “Habitat use of birds of north malabar coast with special reference to the white bellied sea eagle, *haliaeetus leucogaster*” Thesis.
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CHAPTER 3 METHODOLOGY

3.1 Introduction:

A preliminary study was conducted on the major wetlands of the Kannur and Kasargod districts for about three months in 1993. After being fully acquainted with the distribution of water birds, five sites were selected for intensive study to understand the general distribution of birds in different seasons. The habitat features and distribution of different vegetational components were recorded at every visit.

3.2 Methods of data collection

3.2.1. Population study of Whitebellied Sea Eagle

In the study of Whitebellied Sea Eagle, which is comparatively less abundant, and resident, nest search method was employed (Fuller and Molher, 1986).. The survey for nesting sites was carried out in the crowded places of the coastal towns, estuaries, mangrove swamps, backwater areas and on sacred groves in the coasts by foot and vehicle. About 150 km. along the coast line in the North Malabar region were searched bringing a total of about 300 Sq. Km. area under the survey. This survey was conducted between 1992 to 1998.

3.2.2. Food habits of Whitebellied Sea Eagle

Studying raptor diets can provide valuable information on prey species distribution, abundance, behaviour, and vulnerability. The most accurate and complete method to know the prey species is the direct observation method (Marti,

1986). In the present study both direct observation method and prey remain analysis by collecting food remains from underneath the nesting tree or perching tree are collected in each nest sites are incorporated. On several occasions, the fallen prey or partly-eaten prey or even live prey slipped from the talons of eagle are helped in the identification of the prey. .

3.2.3 . The Biology of the Whitebellied Sea Eagle

The species of the nesting tree, its girth at breast height (GBH), height of the nest and the distance of the nest from the main trunk were recorded for each nest. The direction of nest on the tree was noted by using magnetic compass. The distance between nesting tree and nearest water body was also estimated.

One nest site was selected (Ettickulam) for intensive study. Observations were made with 10 X 50 Minolta binoculars from a vantage point at a distance of about 100 m to avoid disturbances. A total of 61.10 hours were spent for observation on incubation and nestling stage. The observations were carried out between 10.12.1994 to 5.3.1995. The activities of the both the birds such as courtship behaviour, copulation, nest building ,defense of the nests, egg laying, incubation, hatching, care of chicks, feeding of young ones and resting are noted.

3.2.4. Line transect:

To estimate the population trends of birds in different study areas, line transect method (Gaston 1975, Rberhardt 1978) was employed. In this method the observer walked on a predetermined transect and recorded all the birds met with. The length of the transect is one km., which was completed in two hours

time. All the transect counts were conducted between 7.00 and 9.00 in the mornings. In the coastal area, the transects were conducted during the low tides and birds which are using the exposed mudflats are recorded. Two counts were taken at every month with an interval of 2 weeks for two years from May 1994 to may 1996. The data were entered in the standard data sheets.

Details of terrestrial and aquatic vegetation and other animal species in the study area are recorded. Human activities which affect the quality of the wetlands like cultivation, encroachment, reclamation fishing, hunting and trapping of birds were also noted.

3.2.5 Total count

Total count of all the wetland associated birds were made in the paddy fields of the Edattummal. The observations were conducted during the period February 1995 to May 1996 and covered three crops. The counts were made daily between 7.00 and 10.00 am. during each crop season. The first crop season was between 5th February 1995 to 3rd May 1995, the second crop season was between 12th may 1995 and 10th October 1995 and the third between 11th October 1995 and 11th February 1996. One more premonsoon crop 12th February 1996 to 11th May 1996 was taken for comparison between the years..

3.3 Methods of data analysis

The result of the transects are used to give information about the relative frequency of different species of birds and the relative frequency of same species

in the different habitats. Based on the field data at different sites, bird species were categorized into families and further grouped into resident (R), local migrant (LM) and migrants (M) with respect to their residential status (Ali and Ripley, 1983). The various guild patterns are also identified on the basis of their foraging techniques and substratum., Viz., the Open Water Birds (OWB), Low Wading Birds (LWB), Raptors (RAP), Shore Birds (SB), Surface Water Feeders (SWF) and Others (OTH).

3.3.1 Alpha diversity

The richness and evenness are the two basic components of diversity of species of any locality (alpha diversity). A number of indices have been proposed for characterizing species richness and evenness. There are many indices that attempt to combine both these components. In this study, an attempt has been made to analyse the collected data using some of these most accepted indices.

Richness Indices

Since 'S' (species richness) depends on sample size, a number of indices have been proposed to measure species richness that are independent of sample size. In this study species richness is calculated by two well known richness indices as follows.

1. Margalef (1958) index

$$R_1 = \frac{S-1}{\ln(n)}$$

2. Menhinick (1964) index

$$R_2 = \frac{S}{\sqrt{n}}$$

Where 'S' is the number of species encountered and 'n' the total number individuals.

Diversity indices

As it is a combined value the diversity indices have a major limitation. By giving just the value of a diversity index it is impossible to say the relative importance of species richness and evenness. Therefore as Ludwig and Reynolds (1989) suggests the series of diversity numbers presented by Hill (1973 b) are probably the easiest way to assess the community ecologically.

Hill's family of diversity numbers are derived from the following formula.

$$NA = \sum_{i=1}^S (P_i)^{\frac{1}{1-A}}$$

Where P_i is the proportion of individuals belonging to the i th species. Hill shows that the 0th, 1st and 2nd order of these diversity numbers [ie $A = 0, 1, \& 2$ of the above equation] coincide with three of the most important measures of diversity.

Hill's diversity numbers are

$$N_0 = S \quad \text{where 'S' is the total number of species}$$

$$N_1 = e^{H'} \quad \text{where } H' \text{ is the Shannon's index}$$

$$N_2 = \frac{1}{\lambda}$$

where 'lambda' is the Simpson's index

N_0 is the number of all species in the sample, N_1 measure the number of abundant species in the sample and N_2 is a measure of very abundant species.

The simplest and widely used two indices are the Simpson's index, and Shannon's index'. They are computed as follows

1. Simpson's index (1949)'

$$\lambda = \sum_{i=1}^S (P_i)^2$$

Where P_i is the proportional abundance of the i th species, given by $P_i = n_i/N, i=1,2,3,\dots,S$

2. Shannon index

This is the most widely used index of community ecology. This equation used natural logarithm.

$$H' = -\sum_{i=1}^S (P_i \ln P_i)$$

Where H is the average uncertainty per species in an infinite community made up of 'S' species with a non proportional abundance P1, P2, P3,.....,Ps.

Evenness indices

A number of indices have been used to quantify evenness component of diversity. A series of five indices are used here. They are all expressed as a ratio of Hill's numbers (Alatalo 1981).

1. Evenness index I (Pielou 1975,1977)

$$E_1 = \frac{H'}{\ln(s)} = \frac{\ln(N_1)}{\ln(N_0)}$$

2. Evenness index II (Shelden 1969)

$$E_2 = \frac{e^{H'}}{S} = \frac{N_1}{N_0}$$

3. Evenness index III (Heip 1974)

$$E_3 = \frac{e^{H'} - 1}{S - 1} = \frac{N_1 - 1}{N_0 - 1}$$

4. Evenness index IV (Hill 1973)

$$E_4 = \frac{\frac{1}{\lambda}}{e^{H'}} = \frac{N_2}{N_1}$$

5. Evenness index V (Alatalo, 1981)

$$E_4 = \frac{\frac{1}{\lambda} - 1}{e^{H'} - 1} = \frac{N_2 - 1}{N_1 - 1}$$

3.3.2 Beta diversity:

3.3.2 Beta diversity:

In the method used to estimate beta diversity two similarity indices are employed. First is the Jaccard Index (Cj) (qualitative information which takes in to consideration the presence and absence of birds in a site) and the second is the Morisita -Horn Index (C_{MH}) (for quantitative data which considers the abundance estimate also.

They are calculated as follows

$$C_j = j / (a+b-j)$$

Where j is the number of species common to both sites

a= the number of species in site A ; c= the number of species in site B

$$C_{MH} = \frac{2 \sum (a_n_i x b_n_i)}{(d_a + d_b) aN x bN}$$

where aN = the number of individuals in site A

bN = the number of individuals in site B

aN_i = the number individuals in the i th species in site A

bN_i = the number individuals in the i th species in site B

$$d_a = \frac{\sum a_n_i^2}{aN^2} \quad \& \quad d_b = \frac{\sum b_n_i^2}{bN^2}$$

BIOLOGY AND ECOLOGY OF WHITEBELLIED SEA EAGLE, *Haliaeetus* *leucogaster* (Gmelin).

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CHAPTER 4

BIOLOGY AND ECOLOGY OF WHITEBELLIED SEA EAGLE, *Haliaeetus leucogaster* (Gmelin).

4.1 Introduction

The Whitebellied Sea Eagle *Haliaeetus leucogaster* is a coastal bird, its life being woven between land and water. It is a good indicator of the health of a coastal zone. Rarely do the Whitebellied Sea Eagle nest more than a few kilometres away from a river or sea. During the non-breeding season these eagles linger at the water's edge, perching openly or petrolling bays and shorelines for food. The Whitebellied Sea Eagle is one of the three species of fish eating *Haliaeetus* eagles that are found in India. Others are the Whitetailed Sea Eagle (*H. albicilla*) and Palla's Sea Eagle (*H. leucorhynchus*).

The population of raptors in general and the fish eating *Haliaeetus* eagles in particular has been fast dwindling. Hence urgent conservation measures, supported by in depth research are necessary to protect the species and ensure its survival. But very little information is available about the ecological requirements of the species.

4.2 Description

The Whitebellied Sea Eagle is about 66-71cm in size with a wing span of over two meters. The female is larger than male, though sexes are similar in

World Distribution Map Of Whitebellied Sea Eagle

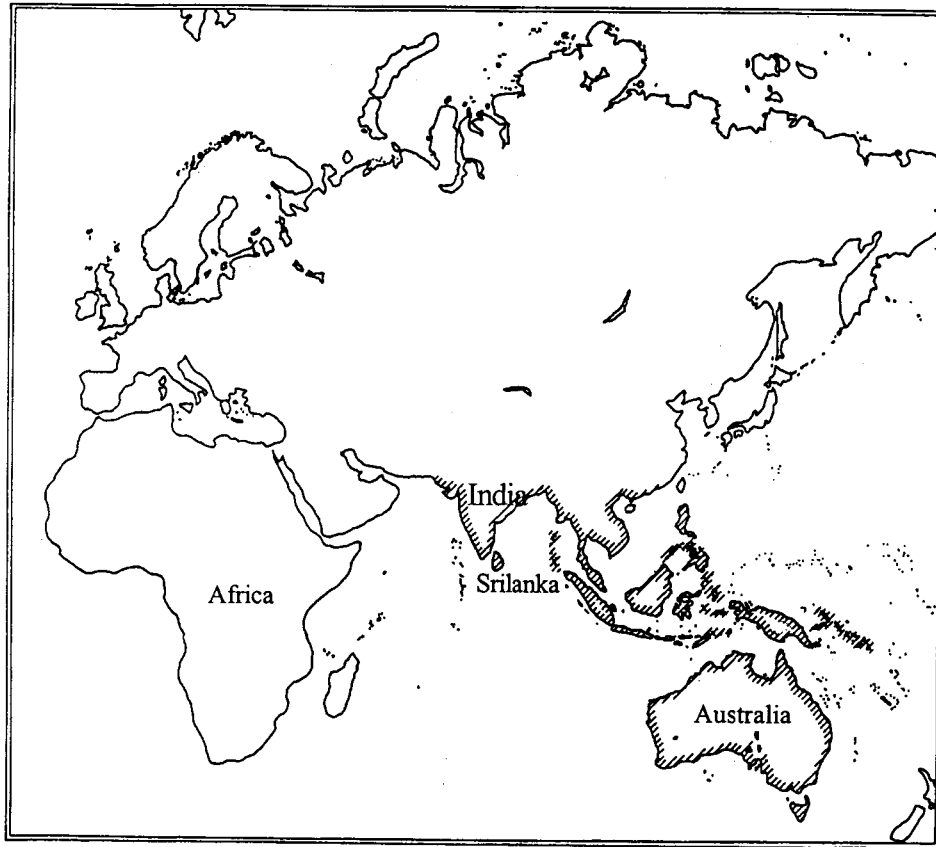


Fig.4.1. World distribution of Whitebellied Sea Eagle (*Haliaeetus leucogaster*)



Whitebellied sea Eagle (*Haliaeetus leucogaster*)- the sentinel of wetlands

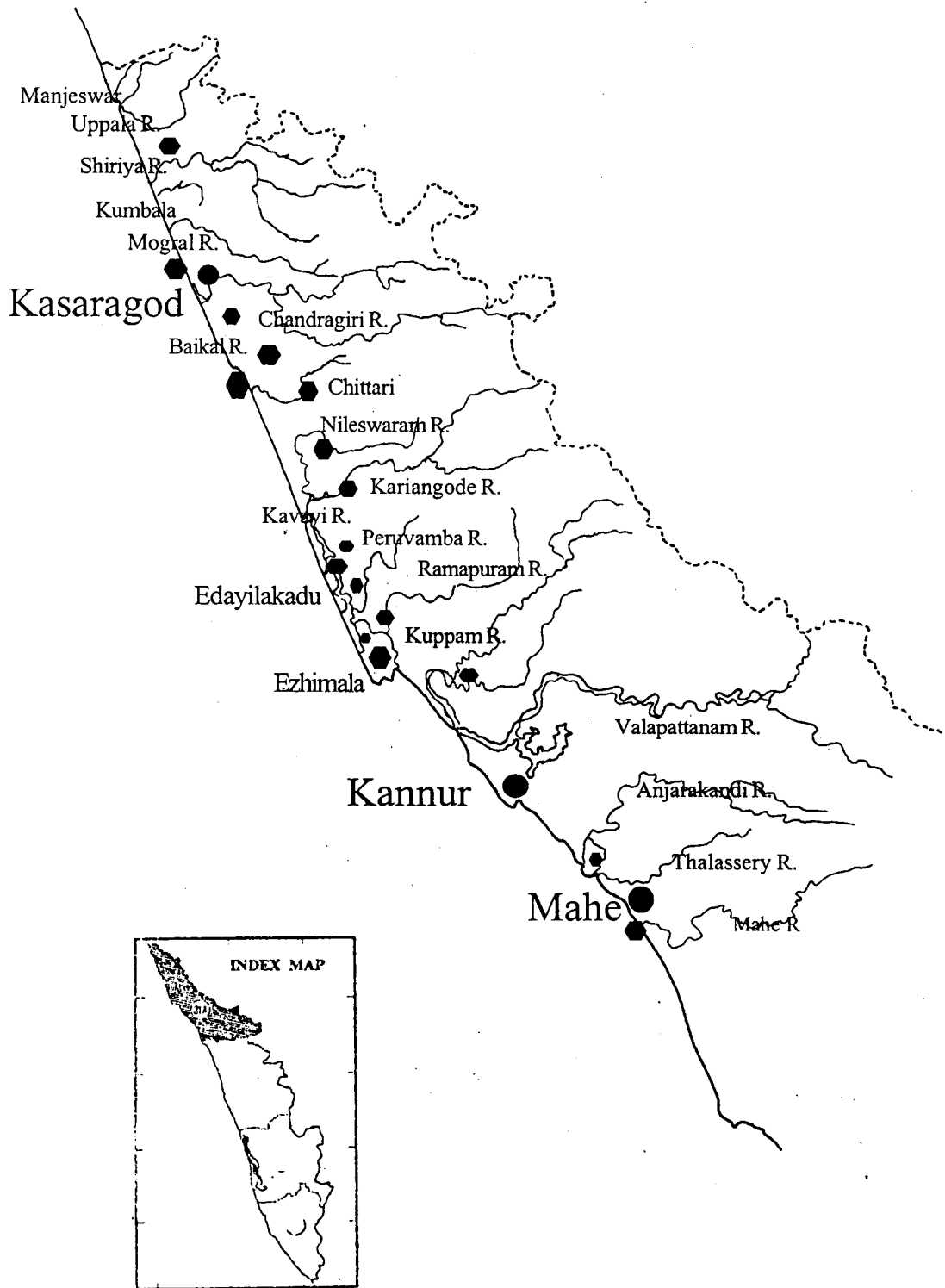


Fig.4.1. Distribution of Whitebellied Sea Eagle (*Haliaeetus leucogaster*) in relation to major river systems of North Kerala.

● Nesting sites

appearance. The adult is ashy brown above with head, neck and underparts pure white; tips of primary feathers blackish; tail wedge shaped, blackish with broad white tips; neck feathers long and pointed; Iris hazel brown; bill dark laden; legs and feet pale yellowish white or greyish white; claws grooved underneath. The immature eagle is dark brown with head and neck tipped with fulvous white; the tail white or whitish, with the terminal portion brown but pale tipped. Chest and upper breast chocolate brown, the lower part edged with fulvous; the breast below this and belly are whitish mixed with brown.

4.3 Distribution

The Whitebellied Sea Eagle has a wide geographical distribution extending from India and Srilanka through south-east Asia in Philippines, Wallacea, New Guinea and Bismark to Australia and Tasmania. In India it is chiefly confined to the sea coast. (Fig.4.1). In the west coast it does not extent commonly beyond Bombay, though recorded rarely in Gujarat coast. (Acharya,1936). In the east coast it extends up to the coast of Pakistan and Bangladesh and common in the islands of Andaman and Nicobar Islands (Ali and Ripley,1983).

4.4 Status and Distribution in Kerala

Jerdon (1863) reported the Whitebellied Sea Eagles from Calicut Coast while Baker (1930) recorded its breeding in Travancore. But Ali did not meet with this species during his Travancore-Cochin survey. (1933-37). Kurup (1991) recorded it from Purathur in the Malappuram district and Robertson Jackson (1992) from Periyar Tiger Reserve from Idukki district. Recent surveys have

shown that the population of Whitebellied Sea Eagle in Kerala today is restricted to two northern most districts, Kannur and Kasaragod, covering a coastal length of about 150 Km, extending from river Mahe in the south to river Manjeswaram in the north.

In the present study 21 active nests were recorded, mostly in the sacred groves in coastal areas on tall trees. A study on the sacred groves of Kerala revealed that a high concentration of sacred groves are distributed along coastal north Malabar. (Ramachandran and Mohanan, 1990; Unnikrishnan,1994), while, very few sacred groves are reported from southern Kerala. Newton (1979) stated that the shortage of nest sites hold raptor breeding densities below the level food would permit or breeding pairs are scarce or absent in areas where nesting sites are scarce or absent. This may be true for the absence of this eagle from southern coast of Kerala.

4.5 Vocalisation

Vocalisation are not just a way to communicate with mates and neighbours, they are also the first line of a Whitebellied Sea Eagle defense. Male and female make characteristic nasal kyank....kyank...metallic call;or louder duck like nasal kaka...ka.. Locally the bird is called 'Kanakan', probably derived from its call. During breeding season the bird is much vocal, but the female's call is low pitched . The nestlings are usually silent and make very low notes during the fledgling stage.

Plate.6



(i) Coastal wetlands of North Malabar- A typical habitat for Whitebellied sea Eagle

4.6 Movements

The Whitebellied Sea Eagle wander a few kilometers inland during the non-breeding season, although it remains close to the sea coast year round.. Baker (1930) recorded the species from Chotta Nagpur, more than 100 KM from the sea . Acharya (1936) has also reported an adult eagle from northern Gujarat, about 80 KM from the sea coast. There are other stray observations of adult eagle away from sea coast during non breeding season .Robertson and Jackson (1992) has reported Whitebellied Sea Eagle from Periyar Tiger Reserve in Western Ghats. It is also observed near Periyapatnam in Mysore , about 60 KM from the sea coast. Wandering of sub adult Bald Eagles was reported in Alaska (Sherrod et al,1984) for better food and to find a new territory for the young ones. But in Whitebellied Sea Eagle all vagrants were adult plumaged birds.

4.7 Population

The population estimate of Whitebellied Sea Eagle was obtained by counting nests along the seacoast and over known areas of this eagle's activity, such as riverine wetlands and reservoirs.

During the study period, paired Whitebellied Sea Eagles occupied 14 nesting territories all along a 150 km long coastal line. The nesting pair remained near their nesting territories throughout the year. The other non-breeding eagles which are noted during the survey were also recorded.

Population estimate of the Whitebellied Sea Eagle has shown that there were a total of 35 birds including 12 pairs of breeding birds ,4 pairs of non-breeding

Table: 4.1. Population of Whitebellied Sea Eagle in Relation to River System.

River system	1994-95			1995-96		
	Breeding	Non breeding	Sub adults	Breeding	Non breeding	Sub adults
Manjeswara	0	2	1	0	2	0
Uppala	0	0	0	0	0	0
Shiriya	0	0	0	2	0	0
Kumbala	0	2	0	0	0	0
Mogral	0	0	0	0	0	0
Chandragiri	2	2	0	2	2	0
Kalanadu	0	0	0	2	0	0
Bekkal	4	0	0	4	2	0
Chittari	0	0	0	0	0	0
Nileshwar	2	0	0	2	0	0
Kariangode	4	0	0	4	0	0
Kavayi	4	0	0	4	0	1
Peruvamba	2	0	0	2	0	0
Ramapuram	0	0	1	0	0	0
Kuppam	2	0	0	2	0	0
Valapattana	2	2	0	2	2	1
Anjarakandi	2	0	0	2	0	0
Tellicheri	0	0	0	0	0	0
Mahi	0	1	0	0	1	0
Total	24	9	2	28	9	2

adults, a solitary adult bird and two immature birds, probably first years with brownish plumage in the study area, during 1994-95. During 1995-96 season a total number of 39 birds were recorded, comprising 14 pairs of breeding birds, 9 non-breeding birds and 2 sub adults. Of these, 4 non-breeding pairs did not make any attempt to breed.. Broley (1947) and Brown (1960) have reported pairs of African Fish Eagle which were not breeding for several years. Figure.4.2 shown that a remarkable concentration of 12 pairs of nesting Whitebellied Sea Eagle were observed between river Chandragiri and river Kuppam, where 10 rivers and their extensive Kavvayi lagoons form a major foraging area, in the vicinity of the sea. The coastal area of this part had a number of sacred groves with tall trees, which provide ideal breeding sites for the Whitebellied Sea Eagle. (Table-4.1).

When compared to nesting birds, the number of sub adults observed were in low proportion. It was not possible to make accurate counts of the immature eagles; because of their confusing plumage. Only 4 immature fish eagles which were close to the estuarine habitat were positively identified.

Newton (1979) stated that population studies usually entail finding of all the pairs of a species in a given area over several years..A study on the Whitebellied Sea Eagle in Bangladesh part of Sunderbans by Sarker (1985) showed a density of one individual per 53.1 KM of water way. In the westcoast, Prakash (1989) reported around 20 pairs of Whitebellied Sea Eagle in between Goa and Bombay. The present population estimate of Whitebellied Sea Eagle of north Malabar coast is 39 birds, including 14 breeding pairs. In Rhodessia, Gargett (1975) has

recorded 59 pairs of Black eagles in a 620 Sq.Km, an average of one pair per 10.5 Sq.km, where their main prey species is abundant. But in other regions, a single pair of this species had home ranges of about 65,210 or 260 Sq.Km. . It showed that the breeding density was broadly related to food supply.

When compared to the average human population density of Kerala of about 700 per Sq.Km, the coastal area of north Malabar had a high density of more than 2000 peoples per Sq. Km.The high population density did not seem to affect the population of the Whitebellied Sea Eagle in the coastal north Malabar.

4.8 Hunting

Whitebellied Sea Eagles eat fishes and sea snakes, which they catch both in clear river water or in turbulent sea water. This eagle does not usually plunge into the water, but quietly sails along high above the water, with outstretched wings often motionless; scanning over the water. Suddenly they parachute down from a height and snatch the wriggling prey with its feet and extended talons, and carry it off to a favourite perch. In Ezhimala coast , the birds were seen hunting over the sea water for sea snakes. The bird does not go very far into the sea. The most of the hunting is done near the littoral zone, within an area of about 1-2 Km.

4.9 Food habits

Studying raptor diets can provide valuable information on prey species distribution, abundance, behaviour, and vulnerability. The prey species of the Whitebellied Sea Eagle was accurately identified in most cases. In the present

observation and analysis of prey remains collected and identified from underneath the nesting tree or perching tree has shown that this bird took a variety of fishes and sea snakes. On several occasions, the fallen prey or partly eaten live prey slipped from the talons of the eagle are helped in identification of the prey. .

Diet and foraging behaviour of Whitebellied Sea Eagle are not well documented. Ali and Ripley (1987) listed fishes, sea snakes, crabs in their diet. Later Murthy and Rama Rao (1988) reported snake species such as *Achrochordus granulatus*, *Cereberus rhynchops* and *Hydrophis obscurus* as food of Whitebellied Sea Eagle from Chilika Lagoon, Orissa.

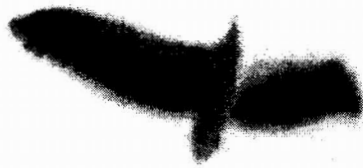
Altogether 98 prey items were recorded during this study . During 1994-95 season , 50 prey items were identified from 12 nesting sites and in 1995-96 season 48 prey items were identified from 14 nesting sites .A detailed list of prey items in the two year study has been summarised in Table -4.2.

A total of 20 fish prey items were recorded in 1994-95 season and 14 in 195-96 season , consisted of 13 species. Marine species such as *Pampus argentius*, *Scoliodon* spp., *Anchoviella* spp., etc were identified. Estuarine species like *Thysariophrys* spp., and *Etroplus suratensis* were also represented in good numbers. Most of the fishes are brought to the perch or nest site and eaten. Only flesh parts were eaten and the bones and skeletal remains are left out. Smaller fishes are eaten completely and no remains were left.

Table:4.2 Diet of Whitebellied Sea Eagle, *Haliaeetus leucogaster* from 1994-96 Season

Prey Species	1994-95	1995-96
ARTHROPODA		
<i>Scylla serrata</i>	6	4
<i>Portunus pelagicus</i>	3	1
Total Arthropods	9(18%)	5(10,4%)
FISHES		
<i>Pampus argentius</i>	1	0
<i>Scoliodon spp.</i>	3	2
<i>Anchoviella spp.</i>	1	0
<i>Thysariophrys spp.</i>	4	2
<i>Anguilla bengalensis</i>	0	2
<i>Scatophagus argus</i>	1	0
<i>Mugil cephalus</i>	1	2
<i>Liza persia</i>	0	1
<i>Etroplus suratensis</i>	3	2
<i>Tilapia mossambica</i>	2	0
Unidentified species	4	3
Total Fishes	20(40%)	14(29%)
AMPHIBIANS		
<i>Rana spp.</i>	2(4%)	1(2,8%)
REPTILES		
<i>Enhydrina schistosa</i>	18	26
<i>Lapemis curtus</i>	0	1
Total Reptiles	18(36%)	27(56,2%)
MAMMALS		
<i>Tatera indica</i>	1(2%)	0
OTHERS		
Poultry wastes	0	1(2,8%)

Plate.7



(i) Soaring flight of Whitebellied Sea Eagle

(ii) Foraging flight of Whitebellied Sea Eagle



(iii) Hook nosed sea sanke (*Enhydrina schistosa*).
A major prey of Whitebellied sea eagle.

Sea snakes dominated the diet of the Whitebellied Sea Eagle with 18 numbers of *Enhydrina schistosa* in 1994-95 season and 26 numbers of *E.schistosa* with a single specimen of *Lapemis curtus* in 1995-96. The Hook-nosed Sea Snake, *Enhydrina schistosa* is infact the most common sea snake reported from north Malabar coast (Whitaker, 1982). Immediately after the south west monsoon these snakes are very active and frequently caught in the fishing nets, the species is locally called "Valakadiyan." In all the nesting sites of eagles the skeletal remains of sea snakes were observed. Once at Ramanthali nest site an entire live specimen of *Lapemis curtus* (Malabar Sea Snake) slipped from the talons of a Sea Eagle. It was noticed that the fallen preys were never taken again by the eagles.

Frogs also formed a prey species of these eagles. Whitebellied Sea Eagles were observed carrying large frogs (*Rana* spp.) from adjacent paddy fields twice at Edayilakkadu site. Skeletal remains of frogs were seen beneath the nest at Peelickode and Kunhimangalam. During the nesting period large crabs were given to the young ones. Large pincers and other appendages of crabs are found below the nest site. Two species of Crabs were identified. The remains of marine crab, *Portunus pelagicus* were mostly observed at Ettickulam and other sea shore lying nest sites. The Mangrove Mud Crab, *Scylla serrata*. are mainly collected from Edayilakkadu, Kunhimangalam, Thavam where it is abundant in the mangrove vegetation. At Ramanthali nest site, in February a female bird was observed carrying an Indian Gerbille, *Tatera indica* to a nest with nestling from an adjacent

grove. Fish eagles also observed eating some carrion from the river. The eagles were observed taking poultry wastes from the river near the mouth of the sea at Azhikkal; actively scavenging the decayed parts of the chicken along with a large flock of Pariah Kites and Brahminy Kites.

4.10. Effects of Monsoon on Foraging

Weather is known to affect various aspects of the foraging behaviour of birds, including hunting success, rates of energy intake, foraging mode, and microhabitat selection (Grubb, 1977). In the Whitebellied Sea Eagle, hunting activities were restricted to the less turbulent estuarine and riverine areas during the heavy rainfall. At Payangadi, in every monsoon season a pair of Whitebellied Sea Eagle was regularly frequenting the riverine habitat for feeding. According to the local fishermen, sea snakes were rarely caught during the monsoon season, but the snakes reappear immediately after the monsoon. This may be one of the reason the eagles depend river and estuarine habitats for foraging during monsoon season.

4.11 Breeding season

Baker and Inglis (1930) recorded the Whitebellied Sea eagle laying eggs in August on Malabar Coast, While Pythian Adams took its eggs in October 1921. According to Ali. (1969) the species nested from October to January on Malabar coast. The Whitebellied Sea Eagle in the study area nested from October to April

The breeding season of the species differed slightly from year to year. In 1994-95 the nesting activity was initiated on 26th December and ended on 1st April (96 days) at Ettickulam. At Olavara an incubating bird was observed on 24th November, 1995. Fledglings were seen as late as 22nd April at Bekkal. At Peelickode nest site, during September, 1994, an adult bird was seen carrying nesting material to the nesting tree. All the active nests in the present study were between October and April.

4.12 Nest-Site Characteristics

A total of 25 nests of Whitebellied Sea Eagle were recorded during the study period. Out of 25 nests, 10 nests were confined to the sacred groves, three were in revenue lands and the rest in private lands. During the study period six trees which had active nests were cut down.

Six species of trees are used by Whitebellied Sea Eagle for nesting. The largest number of nests were on *Mangifera indica* (14 nests), followed by *Ficus benghalensis* (5 nests), *Alstonia scholaris* (3 nests), and one each on *Ficus callosa*, *Casuarina spp* and *Hopea ponga* are recorded. The average height of the nesting trees was 71.57 feet. The lowest nest was at Ettickulam having a height of 50 feet and the highest nest site at a height of 160 feet at Ramanthali. All nests were located on fully grown trees as evidenced by their average girth at breast height (GBH) of 3.92 m and an average tree height of 76.6ft. A nesting tree having a maximum GBH of 13.5m was noted at Ramanthali on a large *Ficus benghalensis* tree strangled with *Ficus microcarpa*. Nesting tree with a minimum GBH of 1.6m



(i) A large *Ficus bengalensis* tree- a nest site of Whitebellied Sea Eagle.



(ii) A scared grove at Edayilakkad. Showing nesting habitat of Whitebellied Sea Eagle.



(iii) Nesting materials fallen under the tree.



(iv) Partly cut nesting tree of Whitebellied Sea Eagle

Table: 4.3. Nest site characteristics of Whitebellied Sea Eagle, *Haliaeetus leucogaster*

Place	Nest site/ Habitat	Nesting Tree	Tree Ht(ft)	Ht of the Nest (ft)	GBH (cm)	Distance from the Sea (m)	Distance from nearest water body
Shiriya	Compound of a house	<i>Casuarina spp.</i>	50	40	280	500	500
Kasaragod	Compound of a house	<i>Mangifera indica</i>	90	85	220	500	500
Uduma	Railway land	<i>Mangifera indica</i>	60	50	385	600	600
Kappil	Tempe land	<i>Ficus benghalensis</i>	50	48	930	300	300
Chettukundu	Compound of a house	<i>Mangifera indica</i>	50	40	200	300	800
Bekkal	Compound of a house	<i>Mangifera indica</i>	60	50	250	300	300
Madhurakkadu	Compound of a house	<i>Mangifera indica</i>	90	80	335	3500	300
Nagacherry	Compound of a house	<i>Alstonia scholaris</i>	60	50	285	2000	300
Peelickode	Compound of a house	<i>Mangifera indica</i>	75	65	290	3500	1500
Edayilakkadu	Sacred grove	<i>Hopea ponga</i>	60	50	320	800	200
Olavara	Sacred grove	<i>Mangifera indica</i>	80	76	411	3000	1000
Karayil	Sacred grove	<i>Alstonia scholaris</i>	80	75	375	6000	1200
Payyanur	Sacred grove	<i>Mangifera indica</i>	85	68	350	4000	1200
Ramanthali	Sacred grove	<i>Ficus benghalensis</i>	170	160	1350	1000	400
Ettickulam	Sacred grove	<i>Ficus callosa</i>	50	40	160	250	250
Kunhimangalam	Sacred grove	<i>Mangifera indica</i>	95	85	506	5000	400
Thavam	Sacred tree	<i>Mangifera indica</i>	65	60	330	3000	300
Mattul	Sacred tree	<i>Mangifera indica</i>	60	55	210	1000	400
Theckumbadu	Compound of a house	<i>Ficus benghalensis</i>	75	70	864	1000	150
Madackara	Compound of a house	<i>Mangifera indica</i>				800	100
Dharmadam	Compound of a house	<i>Mangifera indica</i>	90	82	258	500	500
Azhikkal	Compound of a house	<i>Mangifera indica</i>				800	800
Mahe	Government land	<i>Ficus benghalensis</i>	60	56	869	300	300
Ilambachi	Sacred grove	<i>Ficus benghalensis</i>				3000	1000
Kuniyan	Compound of a house	<i>Alstonia scholaris</i>				2000	200

Pl. mention

was observed at Ettikulam on *Ficus callosa*. The marked preference to the full grown tall trees provided with high placement of nests, shelter from predators, and also gave a safety base to the nest, as observed in the Common Buzzard by Solonen, (1982).

Whitebellied Sea Eagle nested significantly nearer water bodies. The average distance from nests to the nearest water body was 564m. The longest distance between nest-site and water body was 1300m, observed at Peelikode , and the shortest at Madackara about 100m from the river. Major portion of the food of nesting Whitebellied Sea Eagle consisted of sea snakes. Hence, the proximity to sea is an essential requirement for nest-site selection in this species. An average distance of 1350m was noted between nest sites and the sea. The longest distance from sea to the nest was 6000m; at Karayil. Six nests were located within a limit of 500m from the sea .(See, Table-4.3).

To sum up, the White bellied Sea Eagle selected nesting tree which are located in protected areas, such as sacred groves, on old tall trees and closer to wetlands, which provide good foraging ground for the species..

4.13 Nests

Whitebellied Sea Eagles usually build large, stable nests of sticks, twigs , tiny branches of trees and other materials. Some nests are large which may be due to additions carried out in successive years. During the peak of nest building, prior to incubation , pairs gathered nest material within sight of the nest. Both

sexes took part in building the nest. This eagle is known to use a nest for successive years. This is evidenced by the statement of aged peoples living near the nest site at Ramanthali and Payyanur. In their words a nest has been used for more than 50 years . During the study period the birds never shifted their nest sites, unless there are any changes on the nesting tree or any human interventions. Newton (1979) has stated that the large eagles make huge structures, used by a succession of birds for up to a century or more .

Ali(1969) described the nest of the Whitebellied Sea Eagle as a "huge platform of sticks, lined with green leaves built up on a tall Casuarina or similar tree near the shore and renovated for use year after year."

The materials used in nest construction have been picked up from the mangrove vegetation or from the hillside groves, in the general vicinity of the nest. Nest material found under the nesting tree or information from a fallen nest are also collected for identifying nest material used by the eagle. In March,1995 a nesting mango tree at Payyanur was cut down and the nest had a total of 136 large sticks of more than 50cm size. Large twigs of *Loranthus spp.*(6 pieces), *Adenanthera pavonina* (6 nos), *Artocarpus heterophyllus* (3 nos), and *Mangifera indica* (2 nos) of more than 70cm length were noticed in the nest.. Largest twig was that of *Adenanthera pavonina* of 144cm,length and with aGBHof 10cm. The nest was three feet deep and rim of the nest was lined with mango leaves and empty pods of *Adenanthera*. The inner lining of the nest was made with small twigs mixed with leaves of *Mangifera indica* (160 nos), and empty pods of

Plate.9



(i) A nest site at Bekkal on
Mangifera indica

(ii) A well covered nest at Uduma



(iii) An open nest of White-bellied Sea Eagle at Olavara
on *Mangifera indica*

Adenanthera(120 nos). The dominant material used in the construction of the nest was of *Adenanthera pavonina*, a local tree growing to about 100m from near the nest site.

In most of the nest sites locally available materials were used . At Uduma and Edayilakkadu an entire coconut leaf was used as a nesting material, which is virtually hanging from the nest. At Nagacherry, uprooted plants of *Hyptis salveolens*, *Sida* spp. were added as green nesting material lining the nest. At Kunhimangalam nest, twigs of a mangrove plant, *Avicennia officinalis* are used for lining the nest. Pieces of nylon fishing nets with ropes were found hanging in the nest in Edayilakkadu and Ettickulam. In many nests dried spadix and spathes of coconut palm were used.

Interesting aspect of nesting behavior is the bringing of fresh green leafy sprays to completed nests. Once at Ettickulam , during the nestling period (26 days), the male bird has brought a small piece of *Wattakaka volubilis*, a climber common near the site, to the nest. After circling round the nest the green leafy material was kept on the rim of nest . On another occasion, at Olavara during incubation the female bird was seen bringing green leaves to the nest from a nearby tree .This kind of nest maintenance behaviour is very unusual, though at Edayilakkadu and Uduma nests very long half dried coconut palm leaves were seen hanging down from the nest .Newton (1979) suggested that adding greenery to the nest is a form of sanitation covering rotten meat and excreta or that it

could be another form of advertisement of territory, as the green on a nest immediately signifies recent activity. The observation of large coconut palm leaf at nests may be a kind of advertisement of the nest as major portion of the leaf was hanging out from the nest.

4.14 Nest Defense Behaviour

When a man approach a nest, the bird in the immediate vicinity may sound an alarm call, enabling the mate to leave the nest immediately and the two together make loud calls of protest and circle round the intruder for some time and leave the scene. On many occasions at Ettickulam, adult birds were seen vigorously chasing and attacking Crows and Brahminy Kites coming near the nest. Once at Edayilakkadu nest, Jungle crows were seen robbing food material from the chicks of Whitebellied Sea Eagle. It is known from local tree climbers that the birds make loud calls of protest when they climb on trees near a nest. The bird never attempted to strike human beings.

4.15 Nest spacing

According to Newton (1979) in continuously suitable habitats, the nests of a species are often separated from one another by roughly equal distances. In the Whitebellied Sea Eagle the average distance between neighbouring active nest is about 4.6Km. The nests between Bekkal and Chettukundu are closely spaced with a distance of 1.5 Km, where as the nests between Thavam and Dharmadam had a distance of more than 18Km in between. The other nest sites located were numbered and plotted on a scaled map. (Fig.4.2). The map shows that there is a

close assemblage of nest sites between Uduma and Thavam in a coastal line of about 60Km. The spacing of nest is also found in a uniform manner. The area between Thavam and Mahe, though larger, recorded a very low number of nests. This spacing may be due to the shortage of suitable nest site in the locality

4.16 Courtship and Copulation

Spectacular display flights were observed near Ettickulam nest site .. The birds were calling and circling near the nest for some time, then moved higher and higher towards the sea. Within seconds both the birds locked their claws together and performed a complete loop by somersaulting quickly thrice in the air and slowly landed near the nest. Copulation was never observed near the main study area(Ettickulam),, but once at Bekkal nest site on 12.12.1995. The male bird flew directly to the branch above to the nest, where the female perched and mounted her for a shorter period and moved to the next branch.

4.17 Courtship Feeding

Prior to egg laying, female sea eagles are usually fed by their mates. Many raptors engage in courtship feeding. Lack(1966) explained the importance of courtship feeding as an influence on a female's nutritional reserves, which in turn influence reproductive performance. On 18 December 1994 at Edayilakkadu a male bird was observed bringing a sea snake to the nest site, tearing its flesh and fed the female . During 1995 at Peelickode , a fish was given to an incubating female by the male.

Table; 4.4. Average Clutch Size Assessed by the presence of very young Nestlings for the year 1992-98.

Clutch size	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98
One egg	5	8	6	9	8	3
Two eggs	1	2	3	2	0	0
Total	6	10	9	11	8	3

Table: 4.5. Whitebellied Sea Eagle: Frequency of visits of adult bird with prey

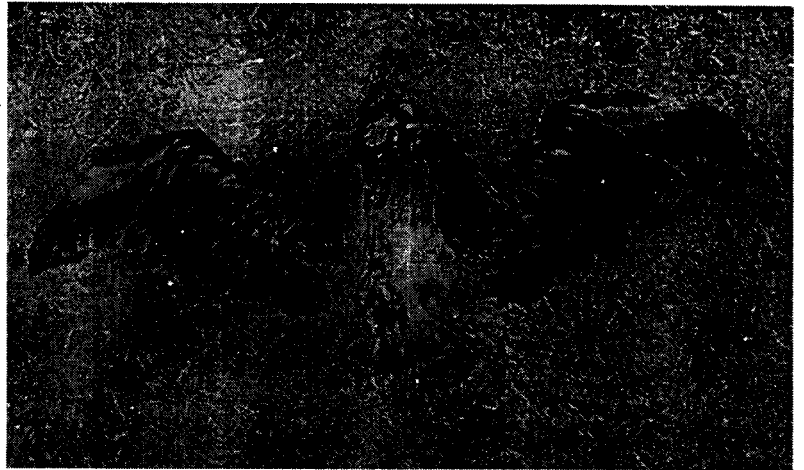
Nestling age in days	Observation period Hours	Time of prey delivery	Total number of delivery
2	13.35-17.15	13.52,16.25	2
3	11.05-14.00	11.40,13.45	2
6	10.20-13.25	10.30,13.05	2
7	14.00-17.30	14.35,16.20	2
9	9.45-14.50	10.50,	1
10	10.45-14.45	10.50,13.45,14.15	3
13	14.20-17.25	15.20,	1
15	15.40-18.00	15.55,	1
20	10.10-14.40	11.05,14.05	2
21	10.35-14.45	10.50,13.25	2
24	14.00-17.30	15.35,	1

4.18 Egg and Incubation Period

Whitebellied Sea Eagles are known to lay 1-2 large eggs, white in colour (Ali and Ripley, 1987). Eggs are usually laid in December in the study area. During 1994-95 season, most of the birds were incubating in December or in January. Clutch size was two in most cases. Average clutch size for 47 nest sites analysed during the year 1992-1998 was 1.2. In the 1994-95 season, out of 9 active nests, 3 nests had two eggs each. In 1995-96 season two out of 11 nests had two eggs. (Table.4.4) No sustained and continuous observations were carried out on the incubation of the sea eagles, but it was found that both the birds incubate. In a 340 minutes observation at Ettickulam the female bird spent about 265 minutes at the nest, whilst the male spent about 64 minutes. Both the birds attended the nest for 11 minutes. In this nest, incubation started on 22 December 1994 and the egg hatched on 1st February 1995. Incubation lasted for 41 days. In the nest site at Edayilakkadu during 1995-96 season, the incubating bird was observed from 20 December 1995, and the egg hatched on 2nd February 1996, covering 43 days. Fish-eating eagles such as Bald Eagle is known to have an incubation period of 34 to 35 days (Nicholson, 1952), Ospreys 39 days (Green, 1976) and 46 days in African Fish Eagle (Brown, 1960). Nothing is known about the disposal of egg shells though some eggshells were found amongst the twigs lining the bottom of a nest, found fallen at Payyanur.

Plate.10

(i) A 26 day old nestling fallen from the Ettikulam nest



(ii) Two month old fledgling

(iii) Three month old fledgling showing aggression posture



Growth stages of Whitebellied Sea Eagle (*Haliaeetus leucogaster*)



(i) Fourteen month old chick



(ii) One year old Whitebellied Sea Eagle



(iii) Three year old Whitebellied Sea Eagle (*Haliaeetus leucogaster*)

4.19 Nestling Period.

A total of 55 hours and 30 minutes were spent for observing the nestlings during 1994-95. The downy white chick seen on 1st February, was attended to by both the parents for brooding and feeding. Male bird shared about 25.73% of the time at the nest and the female 32.96%. Occasionally both the parents were seen at the nest (3.19%), and the nest was seen unattended for a small amount of time (0.48%), when the breeding pairs engaged in protecting the nest from intruders like crows and Brahminy Kites. Growth of the chick was fast. On the 12th day, the down feathers were replaced by small feathers, the first to appear are rusty golden brown feathers on the head and neck. Darker body feathers appeared slightly later, and pins of small dark brown primaries and lighter secondaries emerge about the 21st day of the nestling period. From 21st day onwards the bird started exercising on their wings regularly. Now the flight feathers are almost grown and the birds become slightly heavier in their appearance. On the 34th day the young bird came out of the nest, flapped its wing and leaped from one branch to another. Gradually the fledgling faced the wind and jump repeatedly. During this period of learning the adult bird was not seen around or gave no care. Finally on the 39th day the young bird initiated its first short flight towards the sea. It is able to hunt after 50th days of the hatching. After leaving the nest the young bird was never seen in the vicinity of the nest. The young birds were often chased out of feeding territory by the parents when the former is about four months old.

Table: 4.6. Whitebellied Sea Eagle delivery of prey to the youngones.

Items	Male	Female	Total
Fish	4	6	10(50%)
Snake	6	1	7(35%)
Crab	3	0	3(15%)
Total	13	7	20

Table:4.7. Yearly number of Whitebellied Sea Eagle nests and percentage of nesting success of 1992-97 Season

Nesting success	1992-93	1993-94	1994-95	1995-96	1996-97
Number of Nests	9	11	12	14	12
% of nests with Young	6(66.6%)	10(99.9%)	9(75%)	11(78.5%)	8(66.6%)
% of nests that fledged Y	4(36.6%)	3(27.2%)	6(50%)	4(35.7%)	4(33.3%)

4.20. Food of Nestling.

During the nestling period, the parents were busy in bringing food for the growing chick.. The chicks were fed from the first day of the hatching, with sea snakes. Prey delivery timings are summarised in Table 4.5.. The role of male in delivering prey items during nestling period is vital. Of the 20 food deliveries observed, the male brought 13 prey items (65%) and female 7 (35%) . The maximum number of visits with prey in any time period in a day is three. The shortest time in which the male captured prey was 30 minutes off the nest on, 10th day of the nestling. The adult birds spent much of their time for feeding young ones. The female spent much (5.5%) of her time than male(4%) for feeding the young. Both the parents were seen feeding young ones (3.19%) on many occasions. Till the 21st day, the young was fed by adult birds with pieces of prey items. Of the prey items delivered to the young 20 prey items were identified in the field. These included 10 fishes, represented by species like *Scoliodon* spp., *Scatophagus* spp etc., four fishes are delivered by male bird and six by the female. Of the 7 sea snakes (*Enhydrina schistosa*) brought to the nest, 6 was by the male and one by the female. Three Crabs (*Portunus pelagicus*) were also brought to the nest by the male bird. (See Table-4.6).

4.21 Nesting Success

The nesting success of the Whitebellied Sea Eagle during the 5 year study period (1992-97) has been given in the Table- 4.7. The percentage of eggs hatched in the 1992-93 to 1996-97, covering five breeding season, was 77.3 %. The nesting success was 36.6% in 1992-93 season, 27.2% in 93-94 season; a high percentage of 50% during 94-95 season, 35.47% in 95-96 season and 33.3% in 1996-97 season. For the entire study period, covering 5 breeding season, the average nesting success of Whitebellied Sea Eagle was 36.5%.

It is observed that in nests with two nestlings, only one fledged or survived. During 1992-98 season, 8 nests had two young ones each and in all these nests one chick alone fledged. A greater nestling mortality was observed in nests with more than one nestlings. On many occasions one of the two young ones in the nest become larger and stronger. Sibling aggression could be one of the reason for the nestling mortality. At Ettickulam in 1993-94, a bigger nestling was observed attacking the younger and weaker by pecking on its head and pushing it towards the outer rim of the nest. During this attack or aggression the adult bird did not intervene and major share of the food was given to the larger and dominant young one. After a week the attacked younger nestling was found dead under the tree. O'Connor (1978) explained that, one reason for the mortality in raptors and other predatory birds is the fatal sibling aggression. This may be a kind of natural adjustment to control the population of the animals. Lack (1954) has supported this view as a system by which family size is adjusted to match available level of

essential, parentally provided resources. At other nest sites also fallen chicks were collected, which may also be due to sibling aggression or some other reasons.

4.22 Interspecific Behaviour

During the breeding season, the adult Eagles interact with other species of birds for the defense of their territory. At Ettickulam nest site, a pair of Brahminy Kite was breeding very close to the eagle's nest, about 50 meter away, on a coconut palm. On many occasions the breeding kites enter into the territory of Whitebellied Sea Eagle which resulted in vigorous fighting. The eagles slipped over on the intruder's back and presented its feet for defence. This stoop and defense behaviour continued till the Kite is out of the eagle's territory. In a total observation of 55 hours and 30 minutes in 1994-95, 3.03% time was spent by the eagles for chasing the intruders such as Brahminy Kites, Pariah Kites and crows. The breeding season of Pariah kites and Brahminy Kites coincided with that of Whitebellied Sea Eagle. At Bekkal and Nagacherry nest sites occasional fights were observed with closely nested Brahminy Kites and Pariah kites. At Edayilakkadu on the same nesting tree active nests of Blossomheaded Parakeets were observed. Osprey and Whitebellied Sea Eagle shared the same habitat at Payangadi (Kuppam) river for foraging. But no aggressions were observed in these cases.

4.23 Threats and Conservation

The Whitebellied sea Eagle has become an endangered species due to hunting and habitat destruction. The indiscriminate destruction of sacred groves has been threatening the survival of the species. In the recent past, a number of sacred groves have been completely destroyed in the coastal areas. The bird is extremely choosy about nesting sites and nesting trees. Trees invariably taller than 23 meter, and grow within 200 meter from the water source or coastal wetland ecosystem has been chosen. The findings of the present study clearly indicate the need for conservation of sacred groves as a breeding site and coastal wetlands and marine environments as foraging grounds for the survival of this endangered sea eagle

Shooting of adult birds was also reported from the study area. On three occasions adult birds were shot each at Mahe, Karayil and Payyambalam areas. An attempt for shooting was reported from Ramanthali. The Whitebellied Sea Eagle is listed in the Schedule I of the Indian Wildlife Protection Act (1972) and the importance and conservation value of this eagle has received little attention by the state government and public at large. Larger birds of prey are very susceptible to the effect of DDT on the environment. In India these poisonous compounds are injudiciously used, and the extent of their effects on the ecosystem are not been

known. For the conservation of Whitebellied Sea Eagle following measures are recommended.

1. The coastal area of north Malabar should be well protected
2. Whitebellied Sea Eagles and their nesting trees should be conserved on priority basis, ensure habitat security, perhaps by acquiring land from the present owners.
3. Strict enforcement of the law with regard to the hunting of birds of prey should be implemented..
4. The government should take initiatives to conserve the sacred groves, which is an important ecosystem for many localised population of animals and plants including the Whitebellied Sea Eagle.
5. Local Panchayath should take interest to plant and protect Mango trees and Fig trees in the coastal areas.

COMMUNITY STRUCTURE OF WETLAND BIRDS

Muhammed Jafer.P “Habitat use of birds of north malabar coast with special reference to the white bellied sea eagle, *haliaeetus leucogaster*” Thesis.
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2000

CHAPTER 5

COMMUNITY STRUCTURE OF WETLAND BIRDS

5.1 Introduction

Wetland habitats are vital to large number of aquatic bird species during different phase of their life cycles. Many species depend on coastal wetland habitats during part of the year. Therefore in any type of wetland conservation and management, the focus must be given on habitats, which are not only in the breeding ranges but also the feeding ranges as well during all seasons, along the migration routes and in the wintering areas (Curry-Lindhal, 1978). The study area provides an excellent feeding ground for as many as 32 species of migratory wetland birds

Wetlands have been diminishing at an alarming rate, posing a threat to its avifauna. Ali and Ripley (1983) has recorded 2170 forms of birds belonging to 1230 species and 400 genera within Indian subcontinent. Of these 318 species belonging to 146 genera are found in the Indian Wetlands (Vijayan, 1986). The management of wetland bird habitats must be based on considerations that include an understanding of ecological processes of wetlands and their interactions with other biota including the birds in this system.

Table: 5.1. Alpha diversity of Birds of the different wetland sites

Indices	Chemballikundu	Kuniyan	Madackara	Payangadi
Number of Species	76	52	61	73
Margalef's Index	8.3147	6.0227	6.2614	7.9983
Menhick's index	0.8358	0.7537	0.5064	0.8102
Diversity Indices				
Simpson's Index	0.9358	0.9495	0.8289	0.915
Shannon's Index	3.2927	3.295	2.5059	3.1814
Hill's ratio 1	26.9153	26.9778	12.255	24.0798
Hill's ratio 2	15.5665	19.7974	5.8442	11.7589
Evenness Indices				
E1	0.7603	0.8339	0.6096	0.7415
E2	0.3541	0.5188	0.2009	0.3299
E3	0.3455	0.5094	0.1876	0.3206
E4	0.5784	0.7338	0.4769	0.4883
E5	0.5621	0.7236	0.4304	0.4662

Table: 5.2. Beta diversity of birds between the four sites

Between	Jaccard	Morisita-Horn
Chemballikundu & K	0.44	0.44
Chemballikundu & P	0.54	0.14
Chemballidundu & P	0.75	0.46
Kuniyan & Madacka	0.36	0.05
Kuniyan & Payanga	0.47	0.28
Madackara & Payan	0.63	0.09

The present study involves the temporal and spatial variation of populations of wetland birds in four different kind of wetland habitats along coastal north Malabar over a period of two years from May 1994 to May, 1996 covering two migratory seasons.

5.2 Species Diversity

The diversity of the birds in the four different habitats was computed using 13 different indices of diversity parameters (Chapter 3). The results are summarized in Table 5.1. This results show that birds utilize the four different habitat in different ways and that is expressed by the difference in their diversity patterns and variations in the species composition..

Though species richness is much high in Chembalikundu (Backwawter habitat with mudflats) all the diversity indices do not show any significant differences with the relatively species poor site Kuniyan (Inland wetland without mudflats). This may be due to the much better evenness of abundance at Kuniyan. Madackara shows an average species richness, but diversity indices give the lowest value. This may be due to the occurrence of large migrating flocks, which reduce the evenness of abundance between the species. Migratory birds constitute 58 percent of the bird community at Madackara and the fluctuations of bird population is very high here. The unevenness of the abundance causes the low diversity index values. Payangadi show moderate values in all richness, diversity and evenness indices.

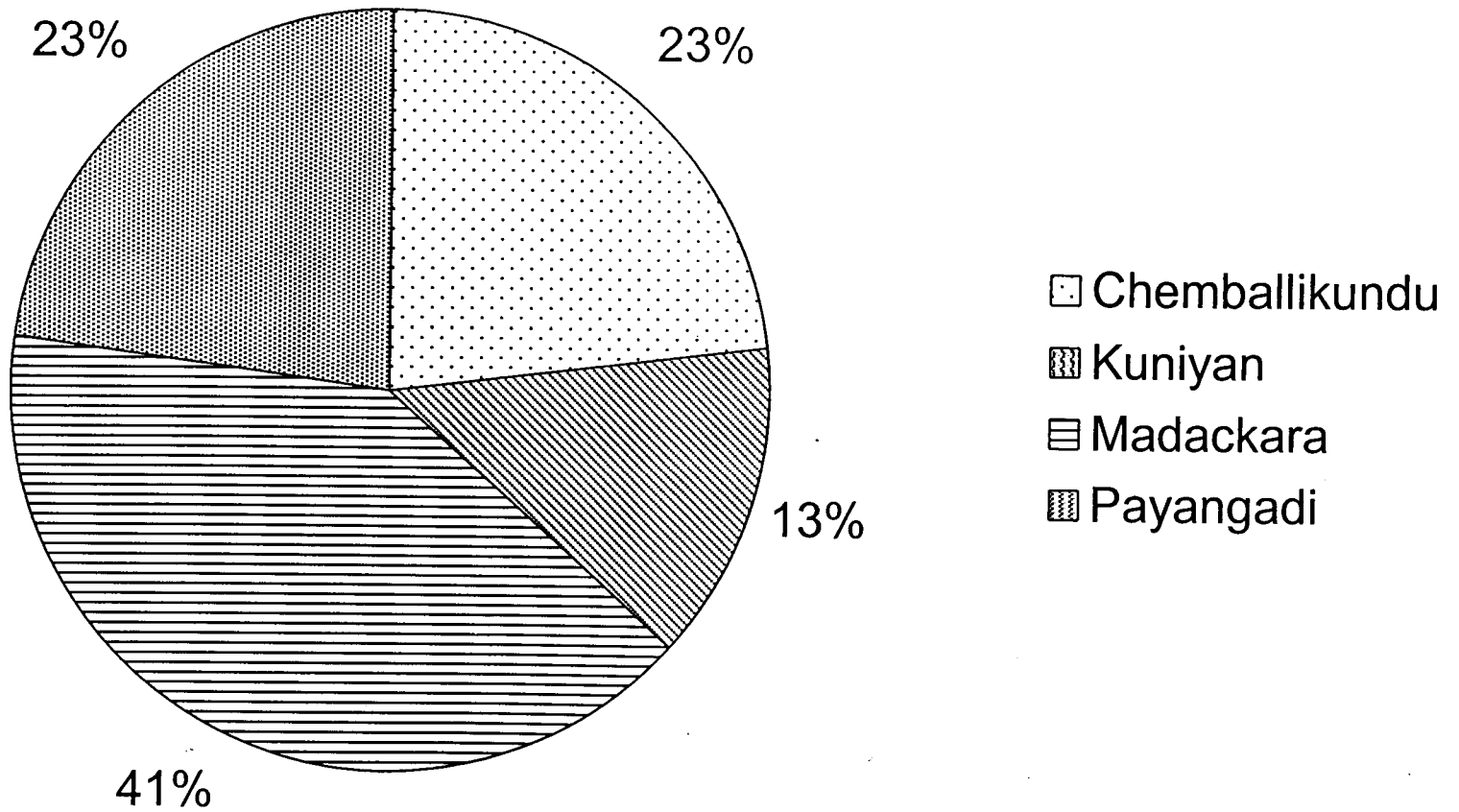


Fig.5.1. The percentage division of the total birds observed in the four wetland habitats

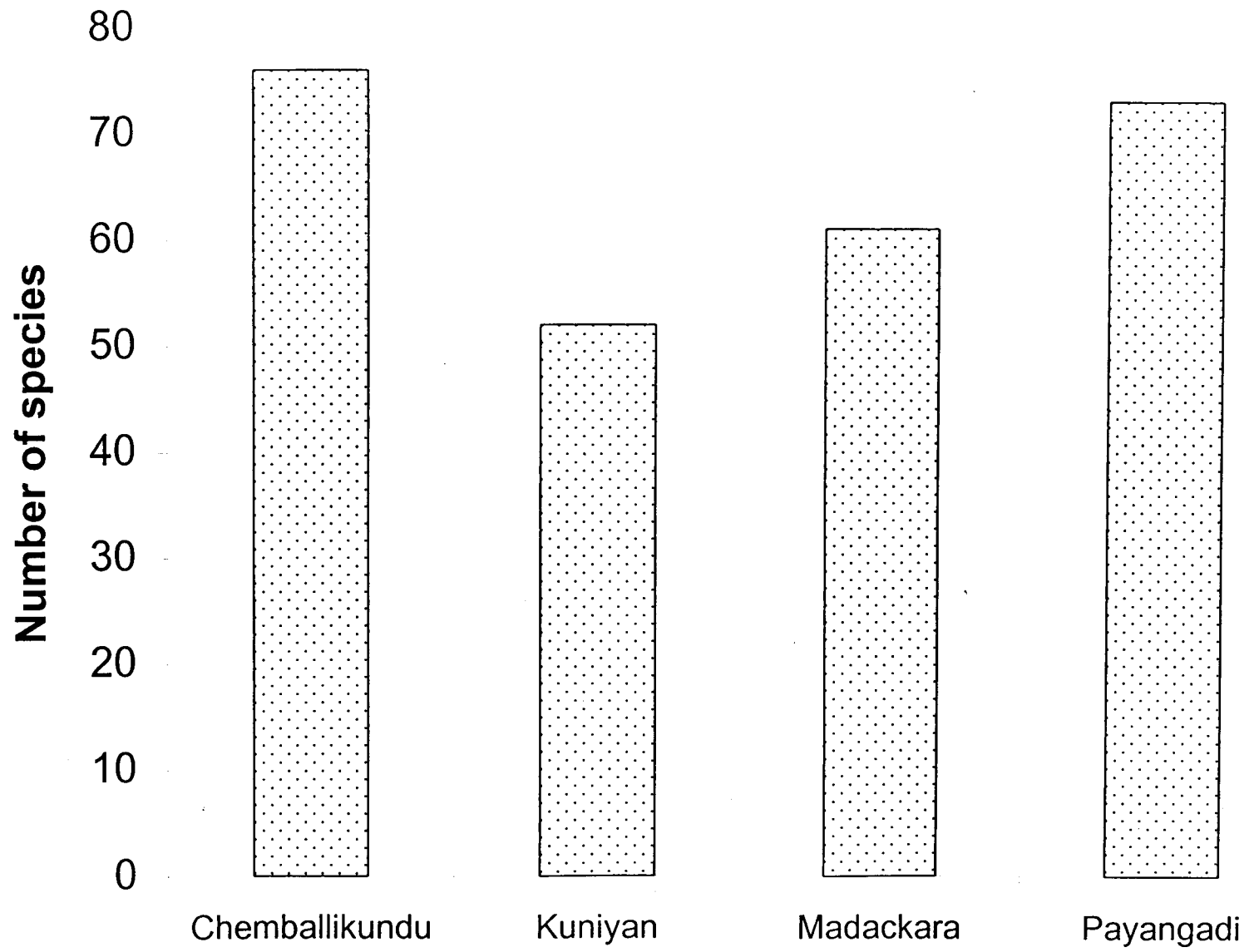


Fig.5.2. The Species Richness in the four wetland habitats.

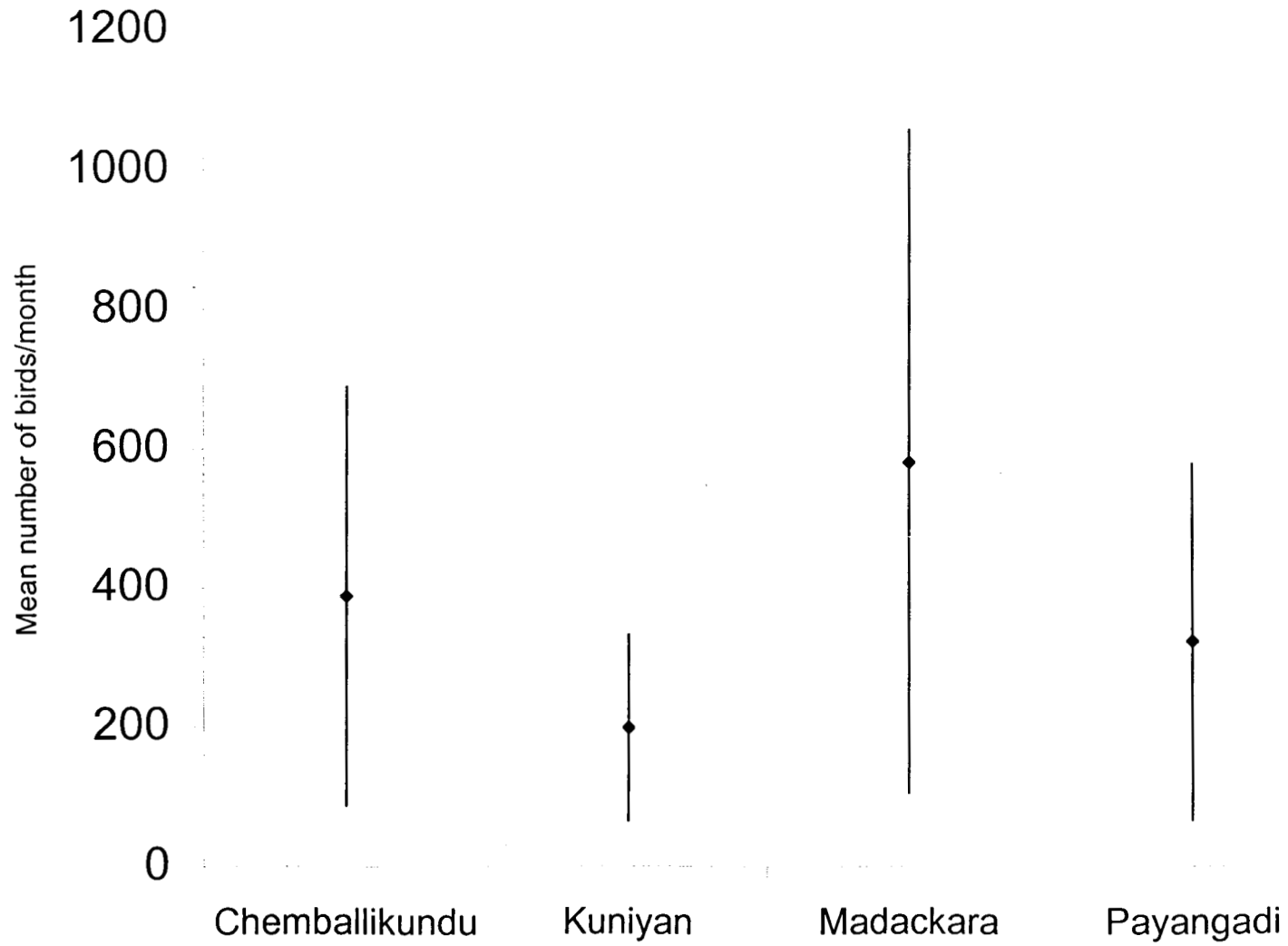


Fig.5.3. Mean number of birds with standard deviation observed per month for the study areas.

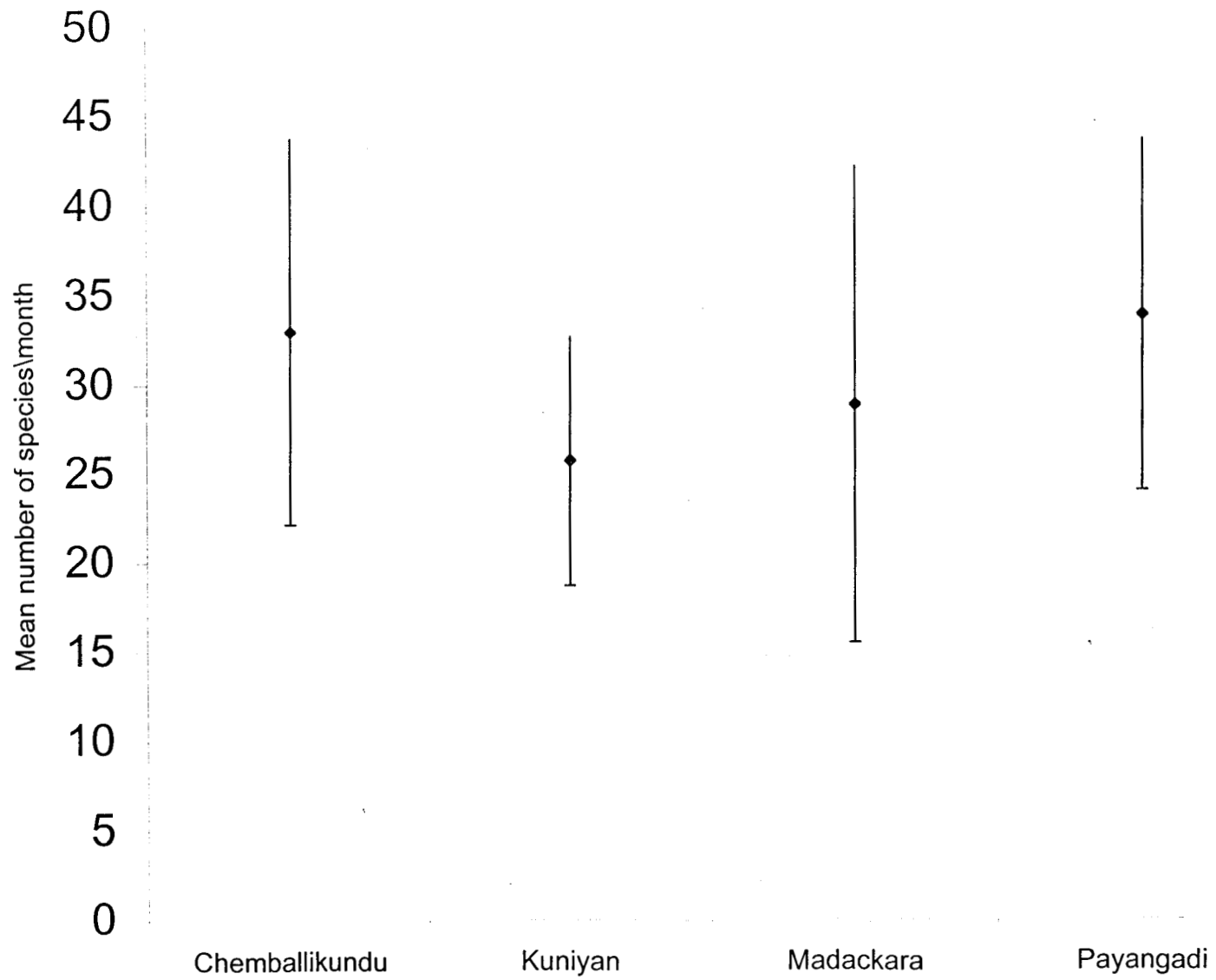


Fig.5.4. Mean number of species of birds with standard deviation observed per month for the study area.

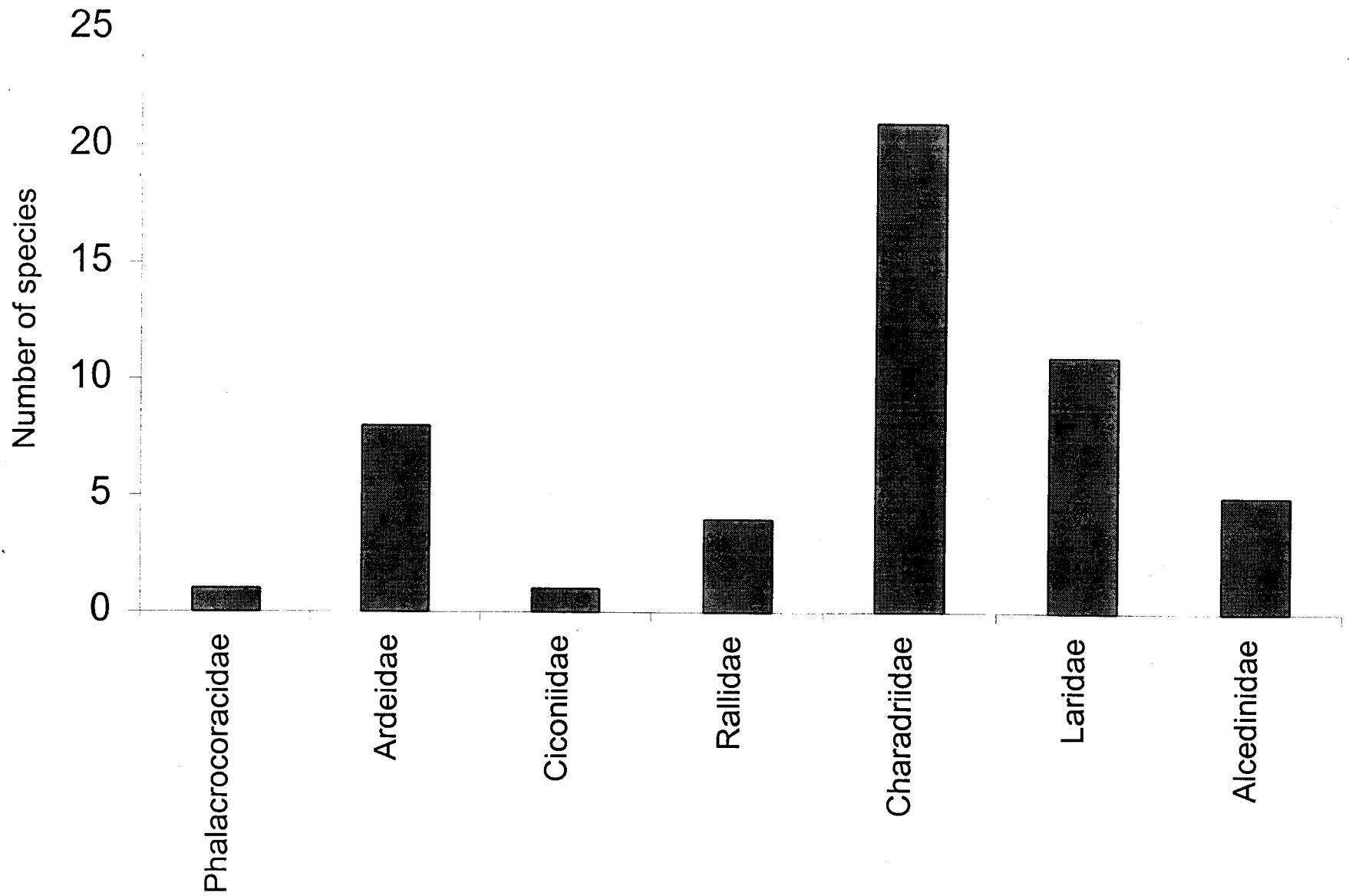


Fig.5.5. Family-wise species richness in the estuarine habitat of Madackara.

Same amount of effort has been employed in the observation of birds in these four different habitats. Of the total of 101 birds observed from all these habitats 41 percent was from Madackara (Fig 5.1). Kuniyan with 13 percent, had the lowest number of species recorded (Fig. 5.2). The lesser number of species at Kuniyan may be due to the absence of mudflats that do not entertain larger flocks of migratory birds here. This makes it a species poor habitat, though it has its own specific species composition.

Figures 5.3 and 5.4 gives the mean number of birds and species of birds per month in each site with the standard deviation. Here also Kuniyan shows the lowest diversity. Madackara, the preferred habitat of large migratory flocks of birds, as expected shows a high value in the mean number of birds but not in species. Chemballickundu is fairly high in both mean species richness and population density.

5.3. Species composition and abundance

5.3.1 Madackara Estuary

Fiftysix species of wetland associated birds included in 7 families were recorded from the estuarine habitat of Madackara. These birds fall into three categories, resident throughout the year, seasonal migrants and local migrants. The migrants comprise 36 species, dominated by family Charadriidae with 21 species followed by Laridae with 10 species (Fig. 5.5). The resident raptor Whitebellied Sea Eagle (*Haliaeetus leucogaster*) and the migratory Osprey (*Pandion haliaetus*) occur here. (Table 5.2)

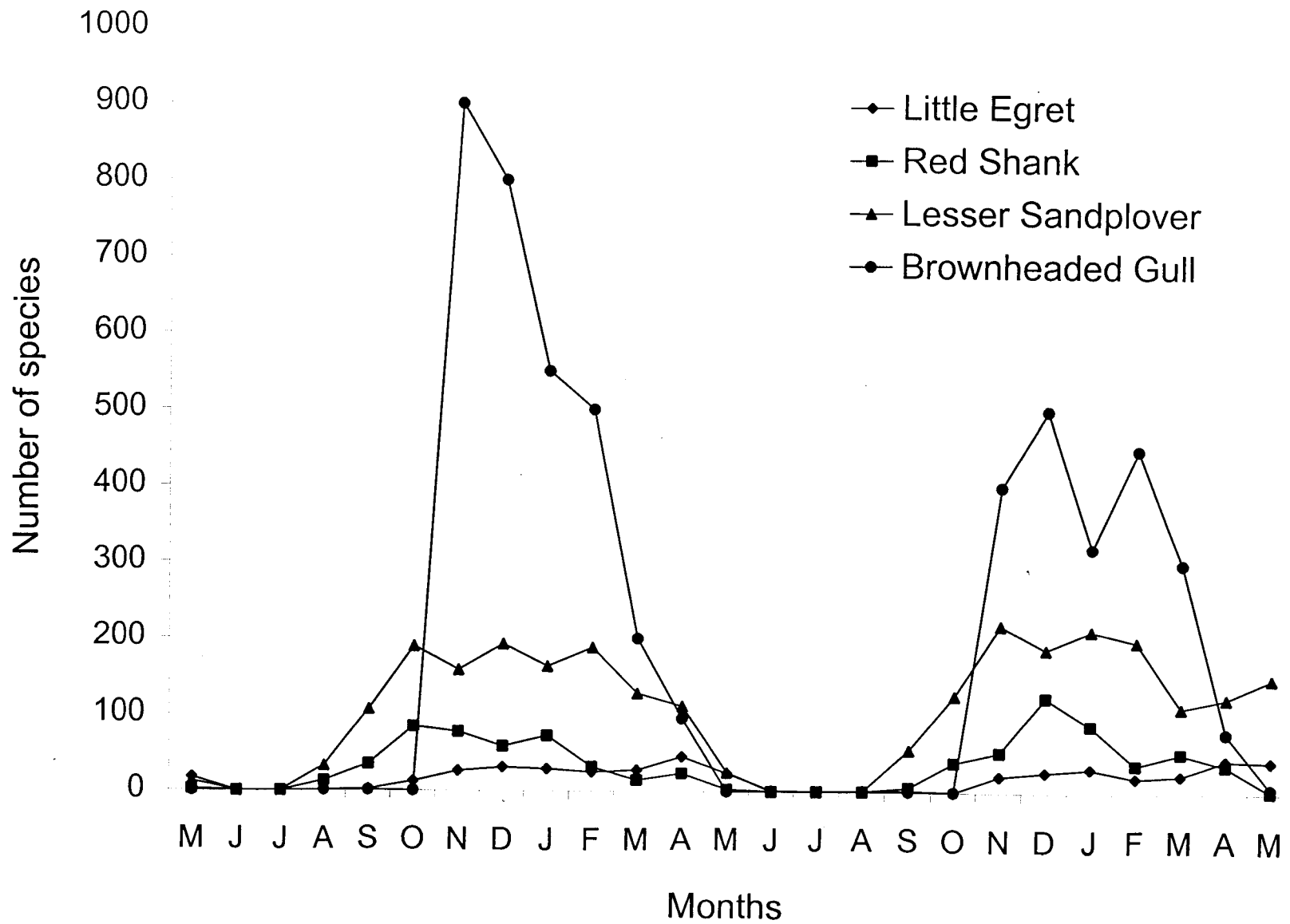


Fig.5.6. The Population fluctuation of four most common species observed at Madackara.

Table :5.3 Flock size parameters of Wetland birds of Madackara

Species	Mean Number	SD	Frequency	Minimum	Maximum
<i>Phalacrocorax niger</i>	1.27	0.45	11	1	2
<i>Ardea cinerea</i>	1.33	0.47	6	1	2
<i>Ardea alba</i>	1.75	0.43	4	1	2
<i>Ardeola striatus</i>	1.85	0.91	20	1	4
<i>Ardeola grayii</i>	23.88	17.31	25	2	63
<i>Bubulcus ibis</i>	2.80	1.51	15	1	7
<i>Egretta intermedia</i>	2.12	1.18	17	1	5
<i>Egretta garzetta</i>	22.45	13.40	20	1	46
<i>Egretta gularis</i>	5.06	4.84	16	1	16
<i>Ciconia episcopus</i>	1.25	0.43	4	1	2
<i>Haliastur indus</i>	12.24	6.58	25	3	28
<i>Haliaeetus leucogaster</i>	1.72	0.65	18	1	3
<i>Pandion haliaetus</i>	1.00	0.00	9	1	1
<i>Rallus striatus</i>	1.59	0.60	17	1	3
<i>Porzana fusca</i>	1.64	0.61	14	1	3
<i>Rallina eurizonoides</i>	1.00	0.00	1	1	1
<i>Amaurornis phoenicurus</i>	1.60	0.86	20	1	4
<i>Vanellus indicus</i>	1.40	0.49	10	1	2
<i>Pluvialis squatarola</i>	2.00	0.82	3	1	3
<i>Pluvialis dominica</i>	6.53	4.79	15	1	15
<i>Charadrius alexandrinus</i>	2.14	1.12	7	1	4
<i>Charadrius mongolus</i>	134.25	61.87	20	12	218
<i>Numenius phaeopus</i>	1.21	0.41	14	1	2
<i>Tringa totanus</i>	42.35	32.76	20	2	124
<i>Tringa stagnatilis</i>	1.18	0.39	11	1	2
<i>Tringa nebularia</i>	4.63	5.34	16	1	24
<i>Tringa glareosa</i>	5.29	3.69	7	1	12
<i>Tringa terek</i>	11.13	8.58	8	2	27

<i>Tringa hypoleucos</i>	19.15	22.31	20	2	105
<i>Calidris alba</i>	9.00	5.29	8	2	18
<i>Calidris minuta</i>	2.50	0.87	4	2	4
<i>Calidris alpina</i>	1.67	0.47	3	1	2
<i>Calidris testacea</i>	2.91	1.50	11	1	6
<i>Limicola falcinellus</i>	3.20	1.08	10	2	5
<i>Larus argentatus</i>	10.00	15.15	9	2	52
<i>Larus fuscus</i>	21.64	6.34	11	12	32
<i>Larus icthyaetus</i>	4.33	0.94	3	3	5
<i>Larus brunnicephalus</i>	392.31	257.50	13	6	900
<i>Larus ridibundus</i>	9.36	7.09	11	2	24
<i>Chlidonias hybrida</i>	25.39	30.00	18	1	114
<i>Geochelidon nilotica</i>	2.67	0.94	3	2	4
<i>Sterna hirundo</i>	7.43	6.99	7	2	21
<i>Sterna bergii</i>	8.75	8.24	8	2	28
<i>Sterna bengalensis</i>	16.28	23.06	18	2	90
<i>Sterna sandvicenis</i>	22.57	12.58	7	11	50
<i>Ceryle rudis</i>	1.75	0.62	20	1	3
<i>Pelargopsis capensis</i>	1.09	0.29	11	1	2
<i>Alcedo atthis</i>	1.43	0.49	21	1	2
<i>Halcyon pileata</i>	1.00	0.00	5	1	1
<i>Halcyon smyrnensis</i>	1.42	0.49	19	1	2

Figure 5.6 gives the population fluctuation of the four most common birds. This shows a clear and distinctive pattern of seasonal bird migration to this area and shows the similar trends over the years. The two most abundant species are Brownheaded Gull and Lesser Sand Plover.

The Lesser Sand Plover had a mean flock size of 134.25 (SD 61.87). Next in order of abundance was the Red shank (Mean 42.3 SD 32.76), Common Sandpiper (Mean 19.15 SD 22.30), Terek Sandpiper (Mean 11.12 SD 8.57) and Large Sandplover (Mean 10.70 SD 9.25). Gulls and terns are the most abundant members of the family Laridae. Brownheaded Gulls are found abundant in early winter (in November) and reduced to a low population in May, before the return migration. Large flocks of Brownheaded Gull (Mean 392.30 SD 257.49), Lesser Blackbacked Gull (Mean 21.63 SD 6.34) with flocks of Whiskered Tern (Mean 25.38 SD 30.0) Lesser Crested Tern (Mean 16.27 SD 23.06) and Sandwich Tern (Mean 22.57 SD 12.57) were observed. The Sandwich Tern is an interesting record in North Malabar. Earlier Kurup (1992) has reported this species from Kadalundi estuary.

The Terek Sandpiper which prefers muddy estuarine habitats is poorly represented in the study, though its number showed an increase in the month of April, before fall migration, possibly a passage migrant. Most of the migratory shorebirds arrived in August or September and left by April or May (see table 5.3.). Sanderlings were observed late in January, while Spotted Sandpiper was observed in good numbers towards the middle March and stayed upto May.

Table: 5.4. Status of Wetland Birds of Madackara estuary during 1994-96

Family	Number of species			
	Migrants	Resident	Local Migr	Total
Phalacrocoracidae	0	1	0	1
Ardeidae	0	4	5	9
Ciconiidae	0	0	1	1
Acciptridae	1	2	0	3
Rallidae	1	1	2	4
Charadriidae	21	1	0	22
Laridae	10	0	1	11
Alcedinidae	0	4	1	5
Total	33	13	10	56

Table. 5.5. Migration data of Major waterfowls at Madackara during 1994-95 season

Species	Date of arrival	Date of departure
<i>Pluvialis dominica</i>	7.9.94	12.4.95
<i>Charadrius leschenaultii</i>	9.9.94	4.5.95
<i>Charadrius dubius</i>	7.9.94	4.5.95
<i>Charadrius alexandrinus</i>	9.9.94	12.4.95
<i>Numenius phaeopus</i>	7.9.94	12.4.95
<i>Limosa lapponica</i>	7.9.95	12.4.95
<i>Tringa totanus</i>	7.9.96	22.5.95
<i>Tringa nebularia</i>	9.9.94	22.5.95
<i>Tringa glareola</i>	15.3.94	15.5.95
<i>Tringa terek</i>	9.9.94	19.4.95
<i>Tringa hypoleucos</i>	7.8.94	15.5.95
<i>Calidris alba</i>	12.1.94	12.4.95
<i>Calidris testacea</i>	9.9.94	22.5.95
<i>Limicola falcinellus</i>	9.9.94	15.5.95

Curlew, Marsh Sandpiper, Eastern Knot, Dunlin and Great Blackheaded Gull were very scarce during the study period. Gulls were late visitors to the estuary, arriving in November and staying upto April or May. Terns also reach very late, in December and leave by May. Once in June 1995 a small population of Lesser Crested Tern was observed over-wintering with the vestiges of their summer plumage, with Whiskered Tern. Foraging associations of Lesser Sand Plover, Large Sand Plover, Broadbilled Sandpiper and Golden Plover were observed many times in the mudflats during low tide.

The number of Pond Herons and Little Egrets increased during the month of January to May in both the seasons. Reef Heron activities were also observed between October and May and a maximum number of 16 birds were recorded in December 1995. The mangrove patches in the creeks and elevated portions of the mudflats provided good habitat for the Rails and Waterhens. Blackcapped King fisher was observed in December to January in 1994-95 season and again in January and May 1996.

5.3.2 Chemballikundu backwater

Sixty three species of wetland associated birds included in 14 families were recorded in the backwater swamp of Chemballikundu. Of these 30 species are migrants dominated by family Charadriidae (22 species) followed by Laridae (4 species), Anatidae (2 species) and Glareolidae (2 species) (Fig.5.7). Thirty species are local migrants and 20 species residents (Table 5.5).

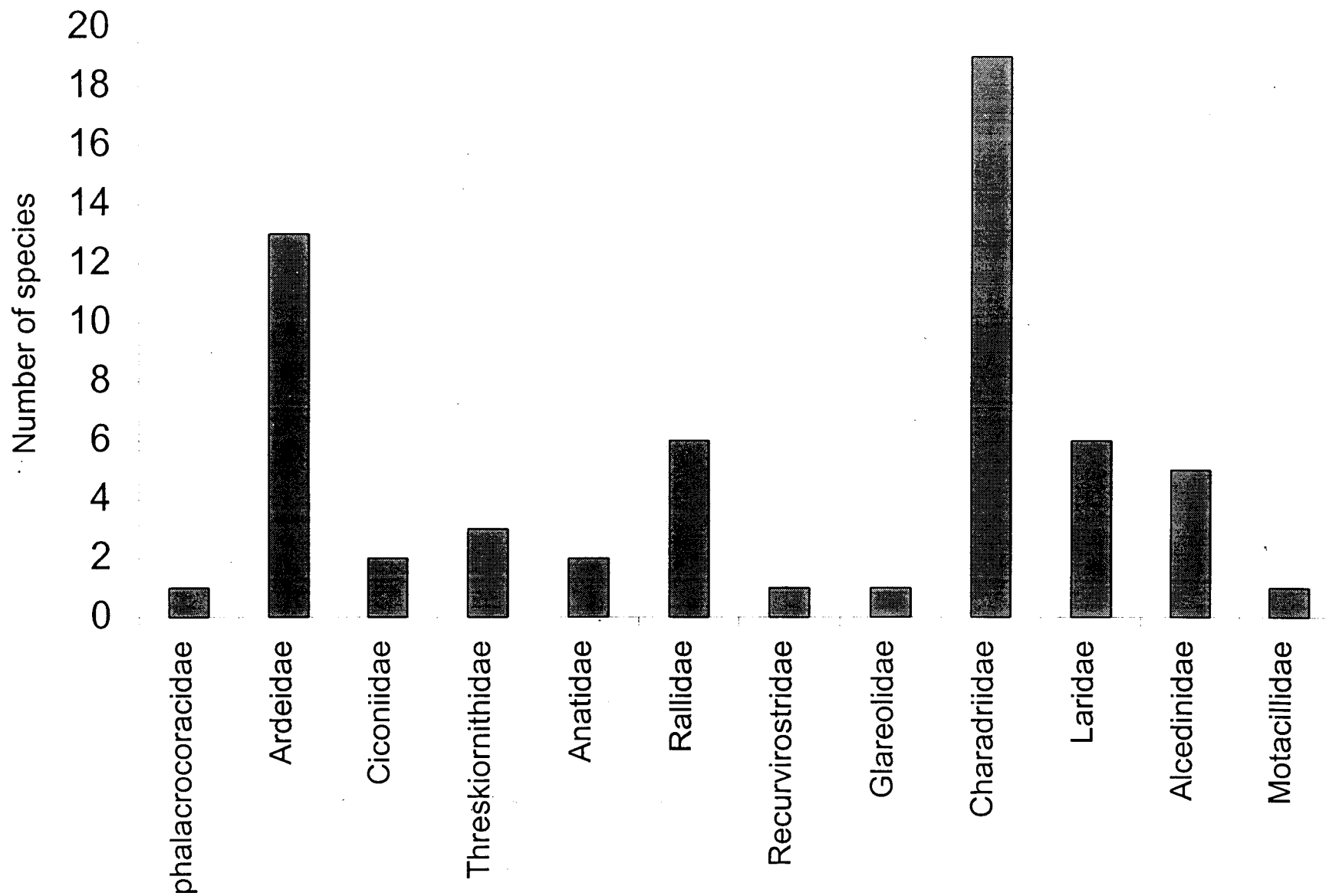


Fig.5.7. Family-wise species richness in the backwater swamp habitat of Chemballikundu.

Table :5.6. Flock size parameters of Wetland birds of Chemballikundu

Species	Mean Number	SD	Frequency	Minimum	maximum
<i>Phalacrocorax niger</i>	56.80	76.43	25	2	315
<i>Ardea cinerea</i>	4.12	3.01	25	1	13
<i>Ardea purpurea</i>	1.74	0.90	23	1	4
<i>Egretta alba</i>	3.83	2.79	23	1	13
<i>Ardeola striatus</i>	3.05	3.68	19	1	18
<i>Ardeola grayii</i>	21.52	15.90	25	4	61
<i>Bubulcus ibis</i>	14.11	7.16	18	7	37
<i>Ardea alba</i>	34.48	22.97	25	5	89
<i>Egretta garzetta</i>	28.50	23.66	24	2	96
<i>Egretta gularis</i>	1.00	0.00	3	1	1
<i>Ixobrychus cinnamomeus</i>	1.20	0.40	5	1	2
<i>Ixobrychus sinensis</i>	1.00	0.00	3	1	1
<i>Ixobrychus flavicollis</i>	1.00	0.00	4	1	1
<i>Mycteria leucocephalus</i>	1.00	0.00	2	1	1
<i>Anastomus oscitans</i>	5.92	3.12	12	1	12
<i>Ciconia episcopus</i>	14.44	8.15	9	4	28
<i>Platalea leucoroidea</i>	6.80	1.17	5	6	9
<i>Dendrocygna javanica</i>	3.25	1.30	4	2	5
<i>Anas acuta</i>	13.20	5.04	5	4	18
<i>Anas querquedula</i>	31.29	15.13	7	19	65
<i>Haliaeetus leucogaster</i>	1.50	0.50	4	1	2
<i>Pandion haliaetus</i>	1.00	0.00	20	1	1
<i>Rallus striatus</i>	1.73	0.96	11	1	4
<i>Amaurornis phoenicurus</i>	1.95	0.71	22	1	4
<i>Gallinula chloropus</i>	1.33	0.47	3	1	2
<i>Porphyrio porphyrio</i>	8.11	4.43	9	2	14
<i>Metopidius indicus</i>	8.14	5.54	7	2	17
<i>Himantopus himantopus</i>	32.77	42.91	13	2	146

<i>Glareola pratincola</i>	3.00	1.00	2	2	4
<i>Glareola lactea</i>	127.82	143.82	11	4	500
<i>Vanellus indicus</i>	5.36	2.61	25	2	11
<i>Vanellus malabaricus</i>	1.50	0.50	2	1	2
<i>Pluvialis squatarola</i>	2.33	1.60	6	1	5
<i>Pluvialis dominica</i>	3.17	1.67	6	2	6
<i>Charadrius leschenaulti</i>	4.00	5.02	5	1	14
<i>Charadrius dubius</i>	40.20	49.32	5	2	135
<i>Charadrius mongolus</i>	1.00	0.00	1	1	1
<i>Numenius phaeopus</i>	2.25	1.09	4	1	4
<i>Numenius arquata</i>	5.00	3.00	2	2	8
<i>Lmosa lapponica</i>	7.20	4.56	10	1	14
<i>Tringa totanus</i>	13.20	29.17	15	1	114
<i>Tringa stagnatilis</i>	6.50	7.76	14	1	29
<i>Tringa nebularia</i>	3.57	4.39	14	1	18
<i>Tringa ochropus</i>	5.08	4.21	12	1	17
<i>Tringa glareola</i>	8.83	5.27	6	3	17
<i>Tringa terek</i>	1.00	0.00	1	1	1
<i>Tringa hypolecos</i>	9.42	7.53	19	1	34
<i>Gallinago spp.</i>	2.50	1.12	14	1	4
<i>Calidris minuta</i>	1.50	0.50	6	1	2
<i>Calidris testacea</i>	2.67	1.49	6	1	5
<i>Limicola falcinellus</i>	1.67	0.47	3	1	2
<i>Larus fuscus</i>	2.29	1.16	7	1	4
<i>Larus brunnicephalus</i>	37.20	29.10	10	5	104
<i>Chlidonias hybrida</i>	21.43	20.35	21	1	63
<i>Geochelidon nilotica</i>	4.50	2.50	2	2	7
<i>Halcyon smyrnensis</i>	2.04	1.11	25	1	5
<i>Motacilla maderaspatens</i>	2.67	0.94	3	2	4

The flock size details of birds in the Chemballikundu wetlands are given in Table 5.6. It showed that flock size was large in Little Pratincole (Mean 127.81 SD. 143.81) followed by Little Cormorant (Mean 56.8 SD 76.42), Little Ringed Plover (Mean 40.2 SD 49.32) Median Egret (Mean 34.48 SD 22,96), Blackwinged Stilt (Mean 32.76 SD 42.90) and Garganey (Mean 31.28 SD 15.13). Among shorebirds, Collared Pratincole (Mean 3 SD 1) and Broadbilled Sandpiper (Mean 1.66 SD 0.47) were rare in this area.

The fluctuations in the population of the four most common birds in this site is given in the Fig. 5.8. There is an increase in the population of Little Pratincole from November to February 1994- 1995 season. Little Cormorants showed an increase in March, April months just before it start breeding.

The arrival of migrant birds coincides with the withdrawal of south west monsoon. The migratory teals arrived in early January and returned by the end of march or April. Little Pratincole is a late visitor arrive in November and leave by the end of April. Red shanks are evenly distributed throughout the migratory season from August to April, over the two years. Over-wintering population of Redshanks were observed in June, 1994. The first Green shanks were sighted in October and they stayed upto May in 1996. Green Sandpiper, Spotted Sandpiper, and Marsh Sandpiper arrived in November and left by early April. Common Sandpipers are regular visitors, arrive by August and stay up to the last week of May. Gulls appeared very late, in December and return by April.

Table:5.7. Status of Wetland birds at Chemballikundu backwater swamp during 1994-96.

Family	Number of species			
	Migrants	Resident	Local Migrant	Total
Phalacrocoracidae	0	1	0	1
Ardeidae	0	2	11	13
Ciconiidae	0	0	3	3
Threskiornithidae	0	0	2	2
Anatidae	2	0	2	4
Acciptridae	1	2	0	3
Rallidae	0	1	5	6
Jacaniidae	0	0	1	1
Recurvirostridae	0	0	1	1
Glareolidae	2	0	0	2
Charadriidae	20	2	0	22
Laridae	4	0	1	5
Alcedinidae	0	4	0	4
Motacillidae	0	1	0	1
Total	29	13	26	68

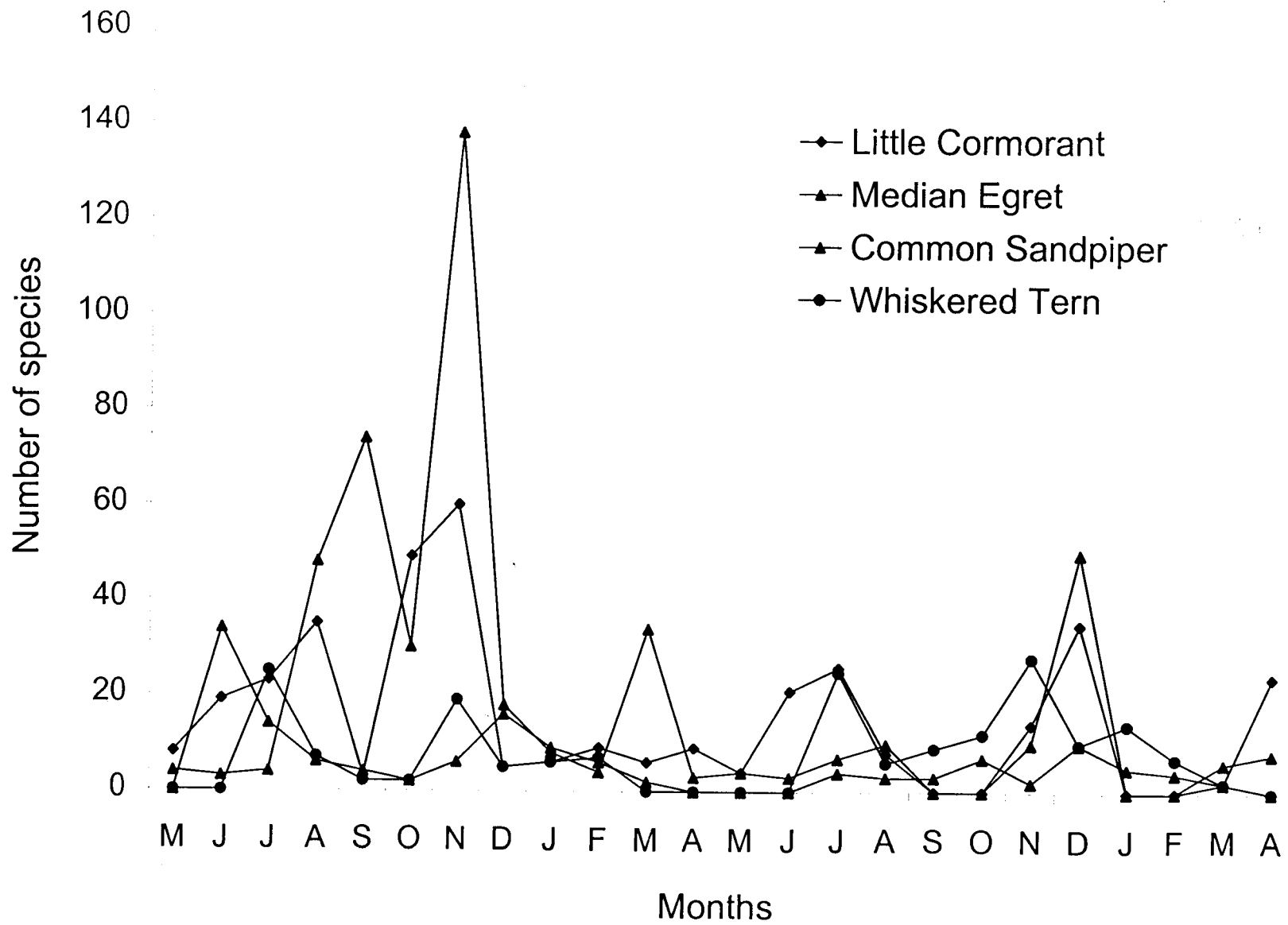


Fig.5.8. The population fluctuation of most common species in Chemballikundu.

Little Cormorant which is the dominant species in the wetlands have colonized the entire north Malabar wetlands in the recent past. Old records have shown that (Neelakantan, 1959) the bird was never abundant in north Kerala. Purple Moorhen was observed (Mean 8.11 SD 4.43) during the months of July to November among the reed beds and the edges of paddyfields. In Chemballikundu both small and large waders were very active during the months of February to April. Their numbers increased to many folds during this period probably due to the influx of return migration. The increased activity of these birds may be also due to the low water level created by prawn farmers during summer.

5.3.3 Payangadi riverine Wet lands

A total of 55 species of wetland birds comprising 13 families was observed in this wetland. The family Charadriidae was represented by a maximum of 18 species followed by Ardeidae (13 species), Alcedinidae (5 species) and Rallidae (4 species)(Fig 5.9). Twentytwo species are recorded as migrants dominated by Charadriidae of 17 species (Table 5.7). The riverine mudflats and adjacent Pokkali fields accommodated these shorebirds. The larger wading birds like egrets and herons use the habitat throughout the study period. Locally moving species such as Ardeidae (9 species), Rallidae (3 species) and one species each from Threskiornithidae and Recurvirostidae, Laridae and Alcedinidae were observed during the study. A single Blackcapped Kingfisher *Halcyon pileata* was observed from October to May during 1995-1996 season. This species is very rare and

observed very sparingly in India (Vidal 1897, Abdulali, 1956; Ali and Ripley, 1983, Robertson & Jackson 1992).

The flock size details of this area are given in Table 4.8. Garganey (Mean 222.55 SD 159.04), Whiskered Tern (Mean 24.42 SD 18.63), Little egret (Mean 22.95 SD 16.90), Median Egret (Mean 17.90 SD 12.86), Little Pratincole (Mean 19.5 SD 14.12), Blackwinged Stilt (Mean 19.2 SD 11.76) and Pintail (Mean 15.87 SD 8.05) were the most common birds in the riverine wetlands of Payangadi. The smaller waders like Little Ringed Plover (Mean 5.06 SD 5.57), Kentish Plover (Mean 3 SD 1) Lesser Sand Plover (Mean 5 SD 4.96), Green Sandpiper (Mean 2.14 SD 0.98), Spotted Sandpiper (Mean 5.33 SD 5.87), Terek Sandpiper (Mean 2 SD 0), Little Stint (Mean 1.66 SD 0.47) and Curlew Sandpiper (Mean 1.57 SD 0.49) were observed comparatively in lesser numbers here.

Glossy Ibis, a rare migrant reported rarely from Kerala wetlands (Sasikumar *et al* 1991, Ravindran, 1993, Praveen and Maneesh Kumar 1996, Zacharias [Pers. Comm.]) was sighted (two birds) in the the paddy fields of Payangadi in November 1995, probably a passage migrant in this area.

The shallow open water habitat of the river is used by migratory waterfowls like Garganey and Pintail in large flocks from December to March in both the years. Whitenecked Stork is a local migrant regularly visiting the area in small flocks (Mean 13.16 SD 9.92) during December to March. Painted Stork was observed only once, in February 1995. Reef Heron (Mean 1.12 SD 0.33) was

Table :5.8 Flock size parameters of Wetland birds of Payangadi

Species	Mean Number	SD	Frequency	Minimum	Maximum
<i>Phalacrocorax niger</i>	6.78	3.59	23	1	15
<i>Ardea cinera</i>	1.59	0.49	17	1	2
<i>Ardea purpurea</i>	1.08	0.28	12	1	2
<i>Ardea alba</i>	1.47	0.50	17	1	2
<i>Ardeola striatus</i>	1.87	0.74	23	1	3
<i>Ardeola grayii</i>	14.96	5.94	24	4	24
<i>Bubulcus ibis</i>	3.89	2.33	18	1	8
<i>Egretta intermedia</i>	17.90	12.86	21	2	45
<i>Egretta garzetta</i>	22.95	16.90	22	4	68
<i>Egretta gularis</i>	1.13	0.33	8	1	2
<i>Ixobrychus cinnamomeus</i>	1.86	0.64	7	1	3
<i>Ixobrychus sinensis</i>	1.00	0.00	3	1	1
<i>Ixobrychus flavicollis</i>	2.00	1.73	4	1	5
<i>Mycteria leucocephala</i>	1.00	0.00	1	1	1
<i>Ciconia episcopus</i>	13.17	9.92	6	2	28
<i>Threskiornis aethiopica</i>	2.00	0.00	1	2	2
<i>plegadis falcinellus</i>	2.00	0.00	1	2	2
<i>Platalea leucordea</i>	5.00	3.00	2	2	8
<i>Anas acuta</i>	15.88	8.05	8	5	30
<i>Anas querquedula</i>	222.56	159.04	9	2	500
<i>Haliastur indus</i>	17.58	10.51	24	5	52
<i>Haliaeetus leucogaster</i>	1.88	0.32	25	1	2
<i>pandion haliatus</i>	1.05	0.22	19	1	2
<i>Rallus striatus</i>	2.00	0.94	16	1	4
<i>Porzana fusca</i>	1.38	0.48	8	1	2
<i>Amaurornis phoenicurus</i>	2.12	0.91	25	1	4
<i>Porphyrio porphyrio</i>	6.83	4.18	6	1	12
<i>Himantopus himantopus</i>	19.20	11.76	10	4	37

<i>Glareola lactea</i>	19.50	14.13	12	1	52
<i>Vanellus indicus</i>	2.25	0.83	24	1	4
<i>Pluvialis squatarola</i>	1.00	0.00	1	1	1
<i>Pluvialis dominica</i>	12.71	10.55	17	2	44
<i>Charadrius dubius</i>	5.06	5.57	16	1	19
<i>Charadrius alexandrinus</i>	3.00	1.00	2	2	4
<i>Charadrius mongolus</i>	5.00	4.97	3	1	12
<i>Numenius phaeopus</i>	1.56	0.86	16	1	4
<i>Numenius arquata</i>	1.25	0.43	4	1	2
<i>Tringa totanus</i>	11.05	5.25	20	2	21
<i>Tringa stagnatilis</i>	1.93	1.12	15	1	4
<i>Tringa nebularia</i>	2.55	1.53	20	1	6
<i>Tringa ochropus</i>	2.14	0.99	7	1	4
<i>Tringa glareola</i>	5.33	5.87	15	1	21
<i>Tringa terek</i>	2.00	0.00	3	2	2
<i>Tringa hypoleucos</i>	12.20	5.89	20	2	21
<i>Gallinago spp.</i>	3.00	1.57	13	1	6
<i>Calidris minuta</i>	1.67	0.47	3	1	2
<i>Calidris testacea</i>	1.57	0.49	7	1	2
<i>Larus brunnicephalus</i>	8.25	4.49	4	5	16
<i>Chlidonias hybrida</i>	24.42	18.64	19	1	61
<i>Ceryle rudis</i>	2.92	0.81	24	2	4
<i>Pelargopsis capensis</i>	1.80	2.40	20	1	12
<i>Alcedo atthis</i>	3.42	1.08	24	2	5
<i>Halcyon pileata</i>	6.00	12.25	7	1	36
<i>Halcyon smyrnensis</i>	2.52	1.90	25	1	11
<i>Motacilla maderaspatensis</i>	1.79	0.41	14	1	2
<i>Nycticorax nycticorax</i>	4.10	2.57	20	1	11

Table: 5.9. Status of Wetland birds at Payangadi riverine wetlands during 1994-96.

Family	Number of species			
	Migrants	Resident	Local Migrant	Total
Phalacrocoracidae	0	1	0	1
Ardeidae	0	3	9	12
Ciconiidae	0	0	2	2
Threskiornithidae	0	0	1	1
Anatidae	2	0	0	2
Acciptridae	1	2	0	3
Rallidae	0	0	3	4
Recurvirostridae	0	0	1	1
Glareolidae	1	0	0	1
Charadriidae	17	1	0	18
Laridae	1	0	1	2
Alcedinidae	0	4	1	5
Motacillidae	0	1	0	1
Total	22	12	18	52

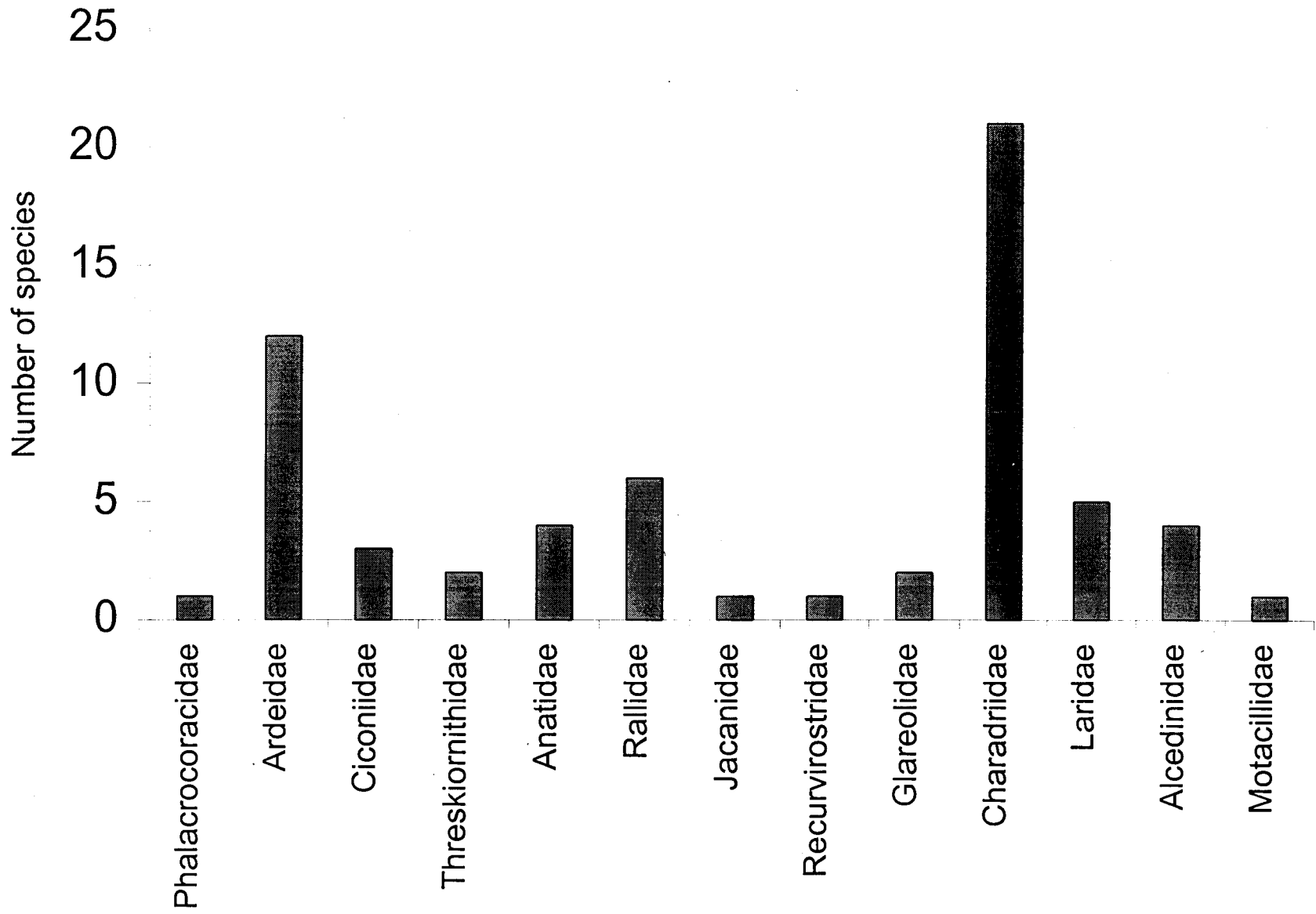


Fig.5.9. Family-wise species richness in the riverine Wetlands of Payangadi.

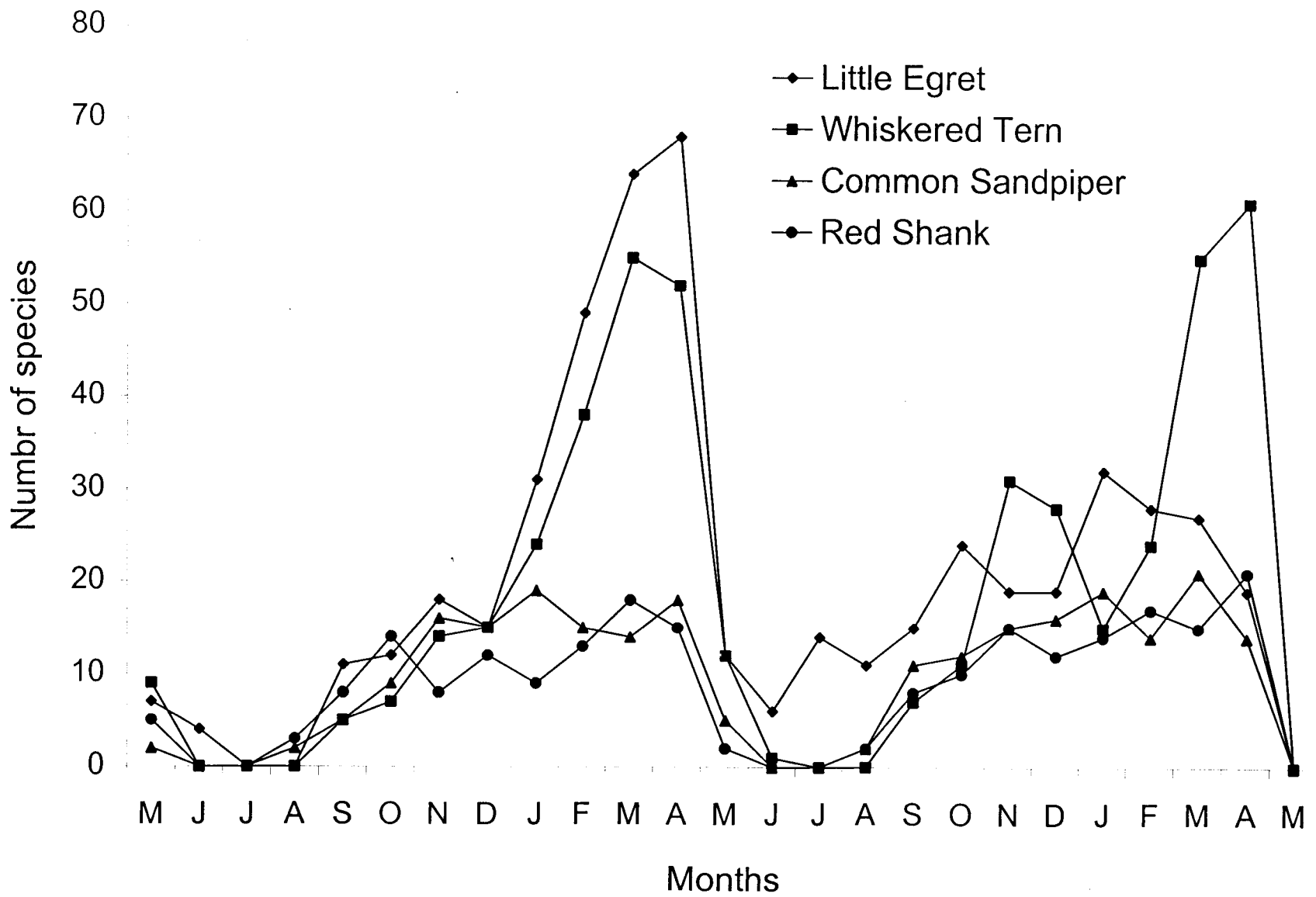


Fig.5.10. The Population Fluctuation of four most common species in Payangadi.

sighted from November to March, 1994-95 season and in January to March in 1995-96.

Whitebellied Sea Eagle (Mean 1.88 SD 0.32) was observed in all the months perching on a pole in the centre of the river. The same pair of eagles was breeding near the wetlands. A migrant raptor, Osprey (Mean 1.05 SD 0.22) shared this habitat with Whitebellied Sea Eagle, as a major predator in this ecosystem. Purple Moorhen (Mean 6.83 SD 4.17) was sighted during July to September in both the season and affect the first crop of paddy in the adjoining fields. Brownheaded Gull (Mean 8.25 SD 4.49) moved upstream of the river during October in 1994 and October to December in 1995, probably an over wintering population or an early migrant.

Figure. 5.10 gives the population fluctuation of four most common species. It shows a clear migratory pattern of seasonal fluctuation in species like Common Sandpiper, Red Shank and Whiskered Tern during September to April..

5.3.4 Kuniyan Inland Wetlands

Altogether 47 species of wetland associated birds were observed in the inland wetland of Kuniyan, a typical jheel and its surrounding areas. Of the 13 families represented, Ardeidae had 13 species followed by Charadriidae (12 species), Alcedinidae (4 species), Motacillidae (4 species), Ciconiidae (3 species) and Rallidae (3 species) (Fig.5.11). Of the total 18 species of migrants, 11 species of the family Charadriidae dominated this study area (Table 5.9). Three

Table :5.10 Flock size parameters of wetland birds of Kuniyan

Species	Mean Number	SD	Frequency	Minimum	Maximum
<i>Egretta garzetta</i>	15.15	20.18	20	2	88
<i>Bubulcus ibis</i>	8.29	6.51	17	1	20
<i>Egretta intermedia</i>	23.30	32.67	20	3	138
<i>Ardea alba</i>	2.08	1.61	12	1	7
<i>Ardea cinerea</i>	1.50	0.50	12	1	2
<i>Phalacrocorax niger</i>	18.30	15.73	20	2	60
<i>Ardeola grayii</i>	22.65	25.81	20	4	124
<i>Ardeola striatus</i>	1.67	1.49	6	1	5
<i>Ixobrychus cinnamomeus</i>	1.25	0.43	4	1	2
<i>Ardea purpurea</i>	1.75	0.72	12	1	3
<i>Anastomus oscistans</i>	5.00	6.68	9	1	23
<i>Threskiornis aethiopica</i>	2.50	0.50	2	2	3
<i>Dendrocygna javanica</i>	11.33	4.75	6	4	17
<i>Haliastur indus</i>	6.42	4.70	24	2	25
<i>Circus melanoleucos</i>	8.07	6.63	14	1	21
<i>Amaurornis phoenicurus</i>	1.67	0.56	21	1	3
<i>Porphyrio porphyrio</i>	5.71	2.19	7	2	8
<i>Rallus striatus</i>	1.00	0.00	1	1	1
<i>Porzana fusca</i>	3.00	0.00	1	3	3
<i>Hydrophasianus chirurgus</i>	3.75	4.21	4	1	11
<i>Charadrius hiaticula</i>	6.00	2.00	2	4	8
<i>Tringa totanus</i>	2.20	1.54	10	1	6
<i>Tringa stanatilis</i>	1.50	0.65	12	1	3
<i>Tringa ochropus</i>	4.61	3.43	18	1	12
<i>Tringa nebularia</i>	1.45	0.50	11	1	2
<i>Gallinago spp.</i>	2.14	0.91	14	1	4
<i>Chlidonias hybrida</i>	10.94	8.18	17	2	28

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<i>Ceryle rudis</i>	3.00	1.73	24	1	8
<i>Alcedo atthis</i>	2.38	0.95	24	1	5
<i>Halcyon smyrensis</i>	2.33	1.25	24	1	7
<i>Pelargopsis capensis</i>	1.38	0.60	16	1	3
<i>Motacilla maderaspatensi</i>	1.50	0.50	2	1	2
<i>Motacilla flava</i>	4.00	0.00	1	4	4
<i>Motacilla cinerea</i>	3.75	2.05	4	2	7
<i>Motacilla flava</i>	2.00	0.00	1	2	2
<i>Nycticorax nycticorax</i>	1.00	0.00	2	1	1
<i>Ixobrychus flavicollis</i>	1.25	0.43	4	1	2
<i>Pulvialis dominica</i>	9.00	4.97	14	2	22
<i>Ciconia episcopus</i>	25.80	12.32	5	17	50
<i>Mycteria leucocephala</i>	1.00	0.00	3	1	1
<i>Egretta gularis</i>	1.00	0.00	4	1	1
<i>Ixobrychus sinensis</i>	1.20	0.40	5	1	2
<i>Himantopus himantopus</i>	7.67	4.42	6	2	14
<i>Charadrius alexandrinus</i>	6.00	4.00	2	2	10

Table:5.11. Status of Wetland birds at Kuniyan inland wetland during 1994-96.

Family	Number of species			
	Migrants	Resident	Local Migrant	Total
Phalacrocoracidae	0	1	0	1
Ardeidae	0	2	11	13
Ciconiidae	0	0	3	3
Threskiornithidae	0	0	1	1
Anatidae	0	0	1	1
Acciptridae	1	1	0	2
Rallidae	1	1	1	3
Jacaniidae	0	0	1	1
Recurvirostridae	0	0	1	1
Charadriidae	11	1	0	12
Laridae	0	0	1	1
Alcedinidae	0	4	0	4
Motacillidae	3	1	0	4
Total	16	11	20	47

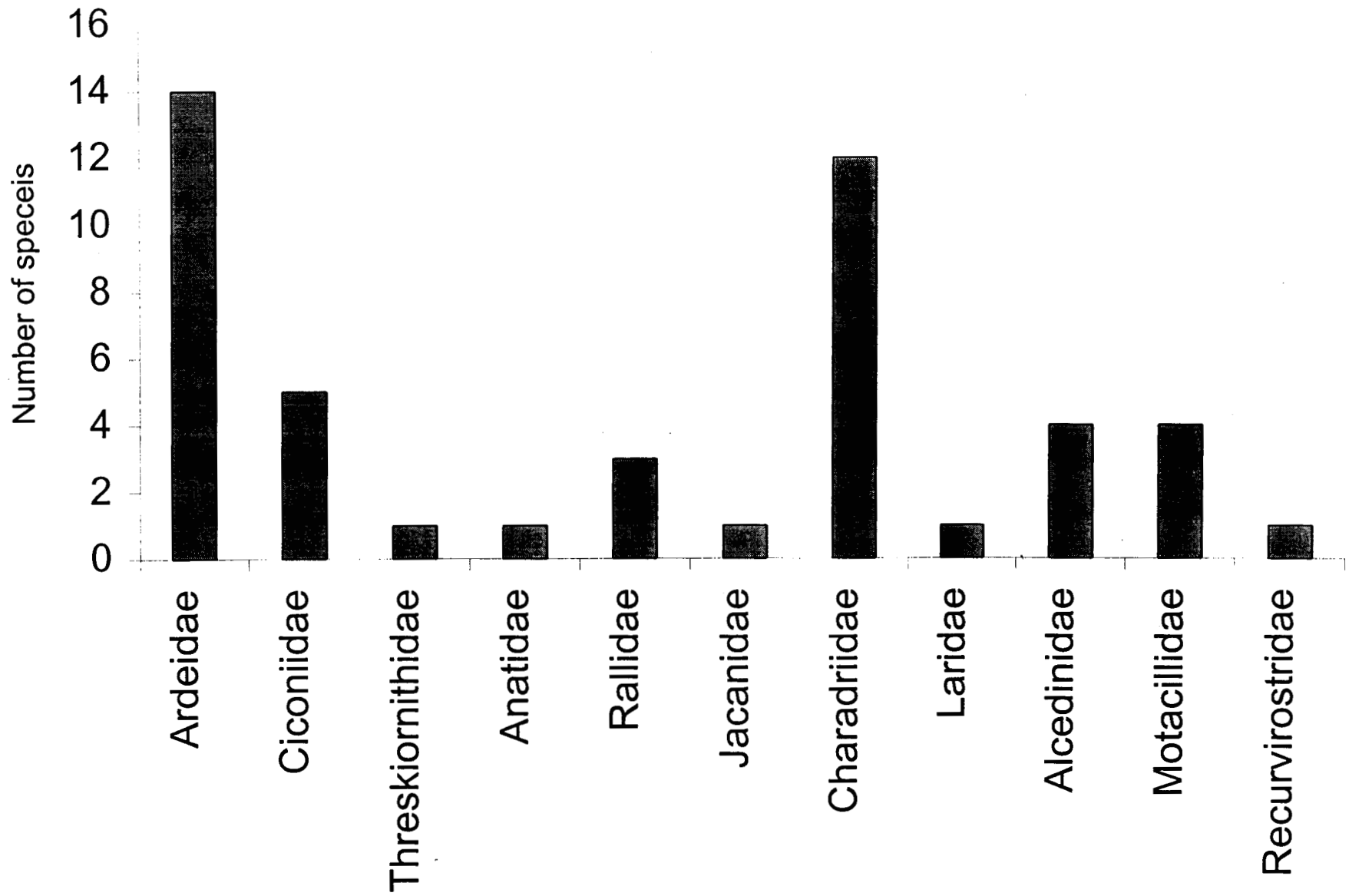


Fig.5.11. Family-wise species richness in the inland wetlands of Kuniyan.

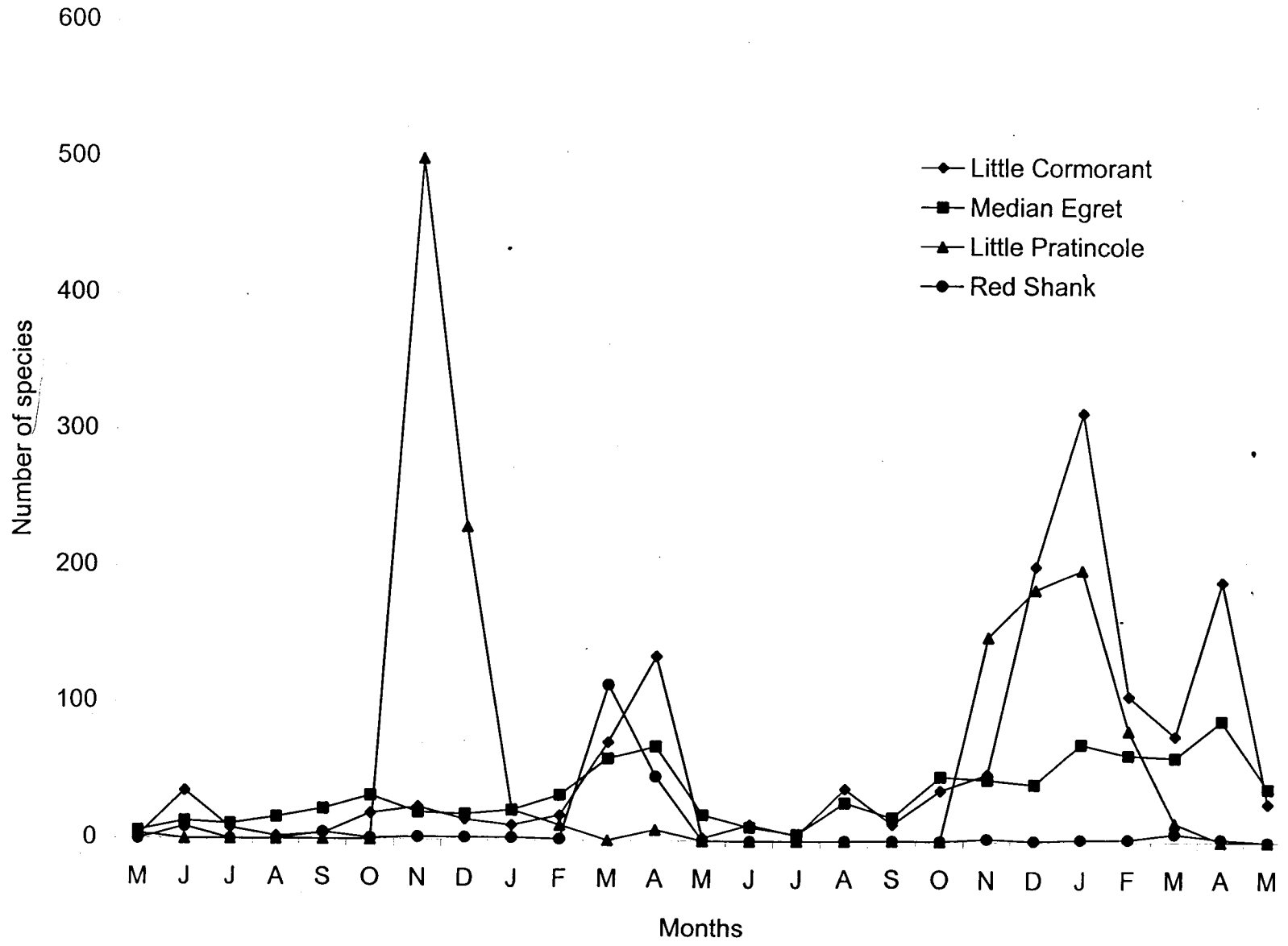


Fig.512 The population fluctuation of four most common species in Kuniyan.

species of migratory wagtails such as Grey Wagtail, White Wagtail and Yellow Wagtail were observed during February 1995. Twenty-one species of local migrants were observed here. The family Ardeidae comprising 11 species of egrets and herons observed in this locality were very less in monsoon months, probably moved out for breeding. However Yellow Bittern, Chestnut Bittern and Black Bittern were frequently sighted during monsoon months.

The species list and flock size parameters of all birds observed in this inland ecosystem are given in the Table 4.10. The Whitenecked Stork had a high mean group size (Mean 25.8 SD 12.31) followed by Median Egret (Mean 23.3 SD 32.6) Little Egret (Mean 15.15 SD 20.18) Pond Heron (Mean 22.65 SD 25.8) Little Ringed Plover (Mean 15.57 SD 15.14) and Whiskered Tern (Mean 10.94 SD 8.17). Large wading birds like Large Egret (Mean 2.08 SD 1.6) Grey Heron (Mean 1.5 SD 0.5) White Ibis (Mean 2.5 SD 0.5) Painted Stork (1) and Reef heron (1) were recorded sparingly from this wetland.

Compared to other sites the number of migratory shore birds observed in this area is less. The Ringed Plover, *Charadrius hiaticula* a rare winter visitor was sighted in this area in March and April, 1995. This bird was previously recorded in Tamil Nadu (Santharam, 1989) and Srilanka (Hoffmann, 1994). One of the locally threatened water bird , Pheasant- tailed Jacana was observed in November - December in both the season; only two birds were sighted. Purple Moorhen was observed in between April and July in lesser numbers (Mean 5.71 SD 2.18). In July 1995, a nesting pair was observed within the reed beds. A good population of

Marsh Harrier(Mean 8.07 SD6.62) was recorded in between October and April. Fig 5.12. shows population fluctuations of four most common birds of this site. Egret: was the most common species here. Unlike the other sites, the graph do not show any specific and significant pattern with respect to the population fluctuation of these common birds.

5.4 Guild Pattern in the different communities

The birds have been classified into six different feeding guild categories on the basis of their mode of feeding; Viz., open water birds, large wading birds, raptors, shorebirds, surface water feeders and the others, which do not fall into any of these five categories. Striking differences were observed between birds of Madackara and Kuniyan. Maximum shorebird species (most of them are migratory) were observed in Chemballikundu. While the least number of shorebird species were observed in Kuniyan. Larger wading birds were observed more in Kuniyan and Payangadi. More number of raptors were observed in Chemballikundu. Payangadi had the maximum open water feeders, whereas Kuniyan had minimum number.(Fig.5.13 to 5.16).

These differences in the habitat preferences can be attributed to the differences in the available microhabitats for foraging of these birds. For example, the absence of mudflats and mangroves in the extensive stretch of reed beds and swampy vegetation is peculiar to Kuniyan. Similarly the absence of reed beds is peculiar to Madackara. On the other hand the vast extent of swampy vegetation and mangroves along with the adjoining aquaculture of shrimps gives different

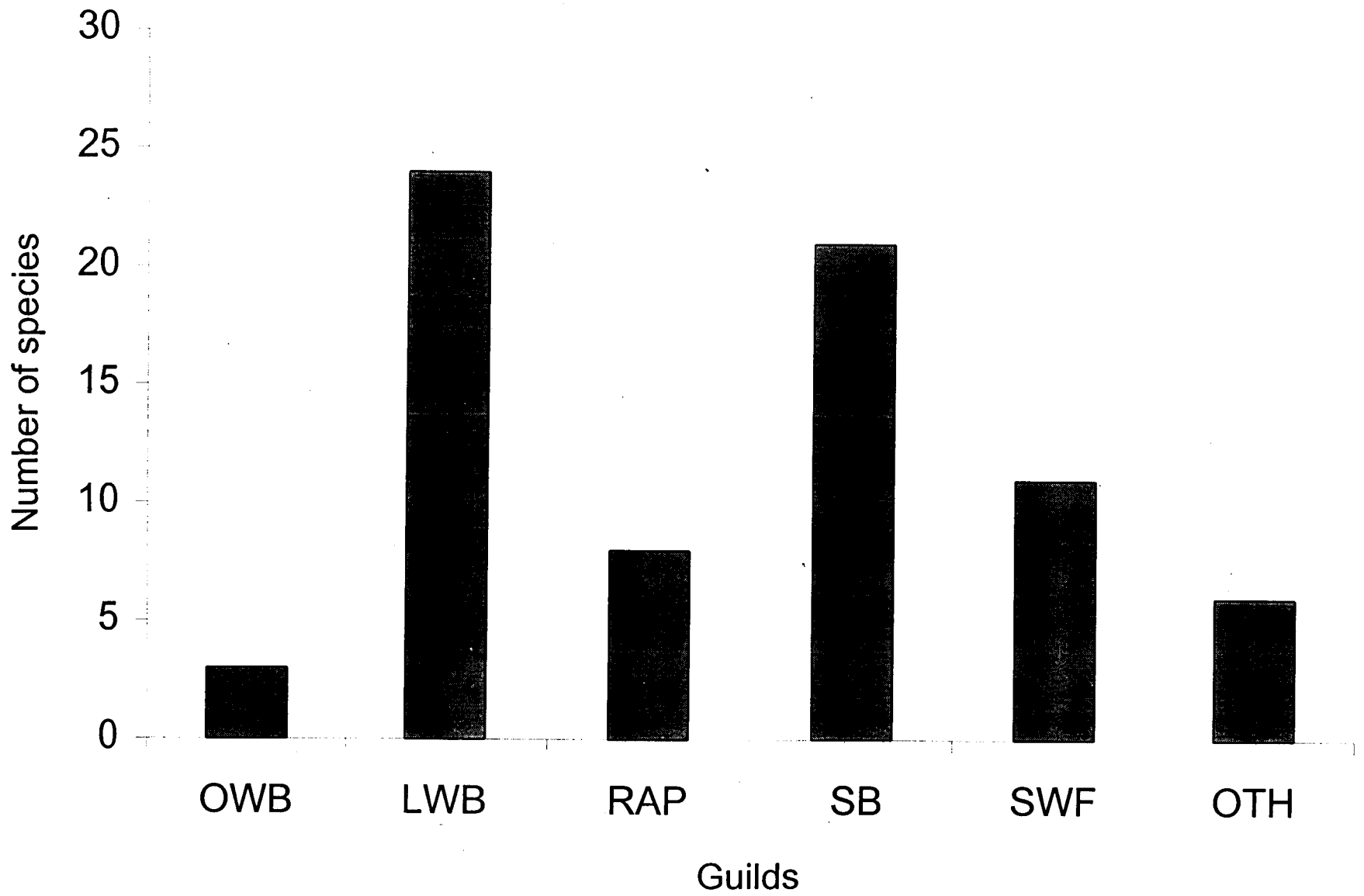


Fig.5.13. The foraging guild composition of Wetland birds of Madackara

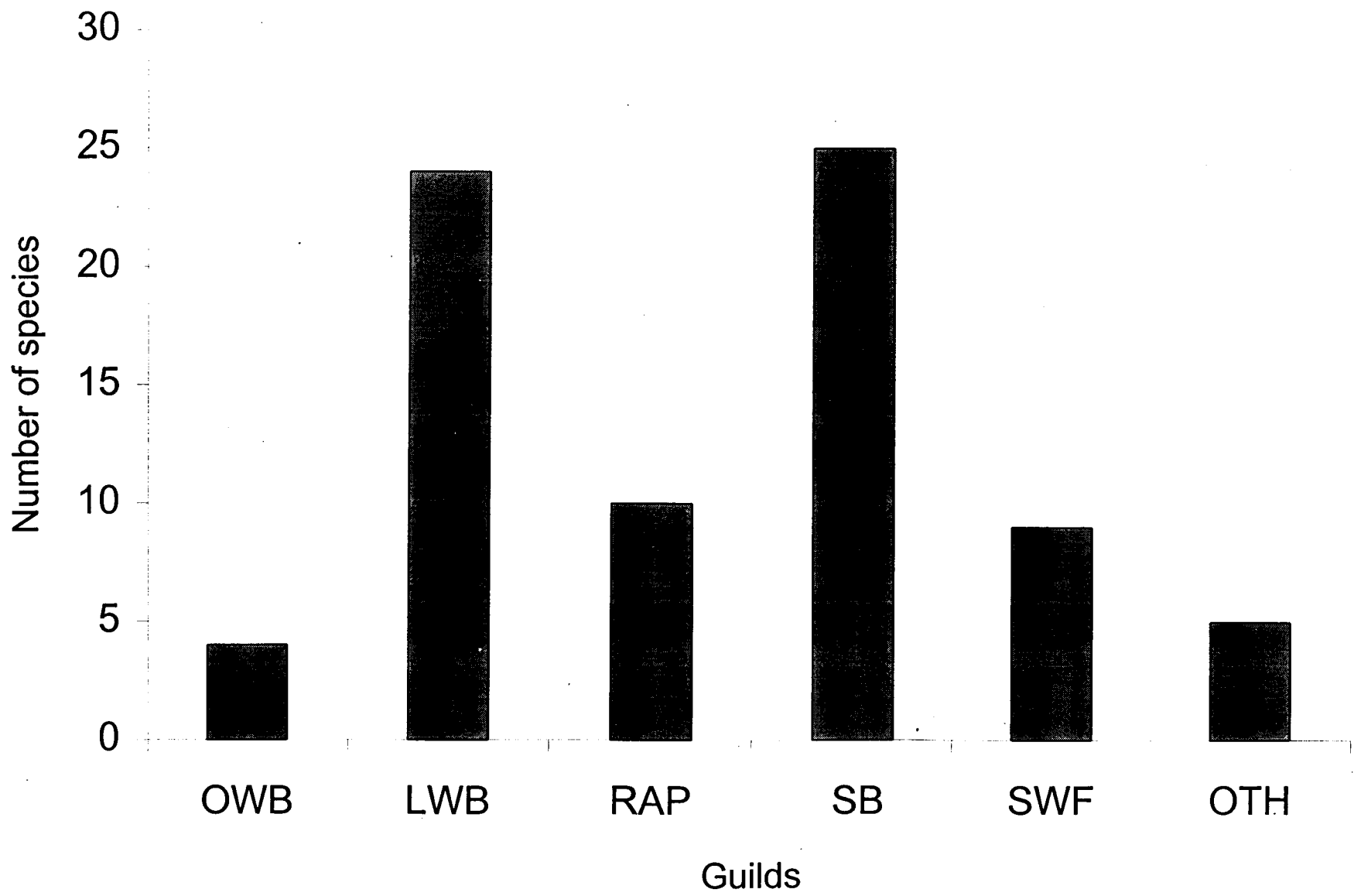


Fig.5.14. The foraging guild composition of Wetland birds of Chembullikundu.

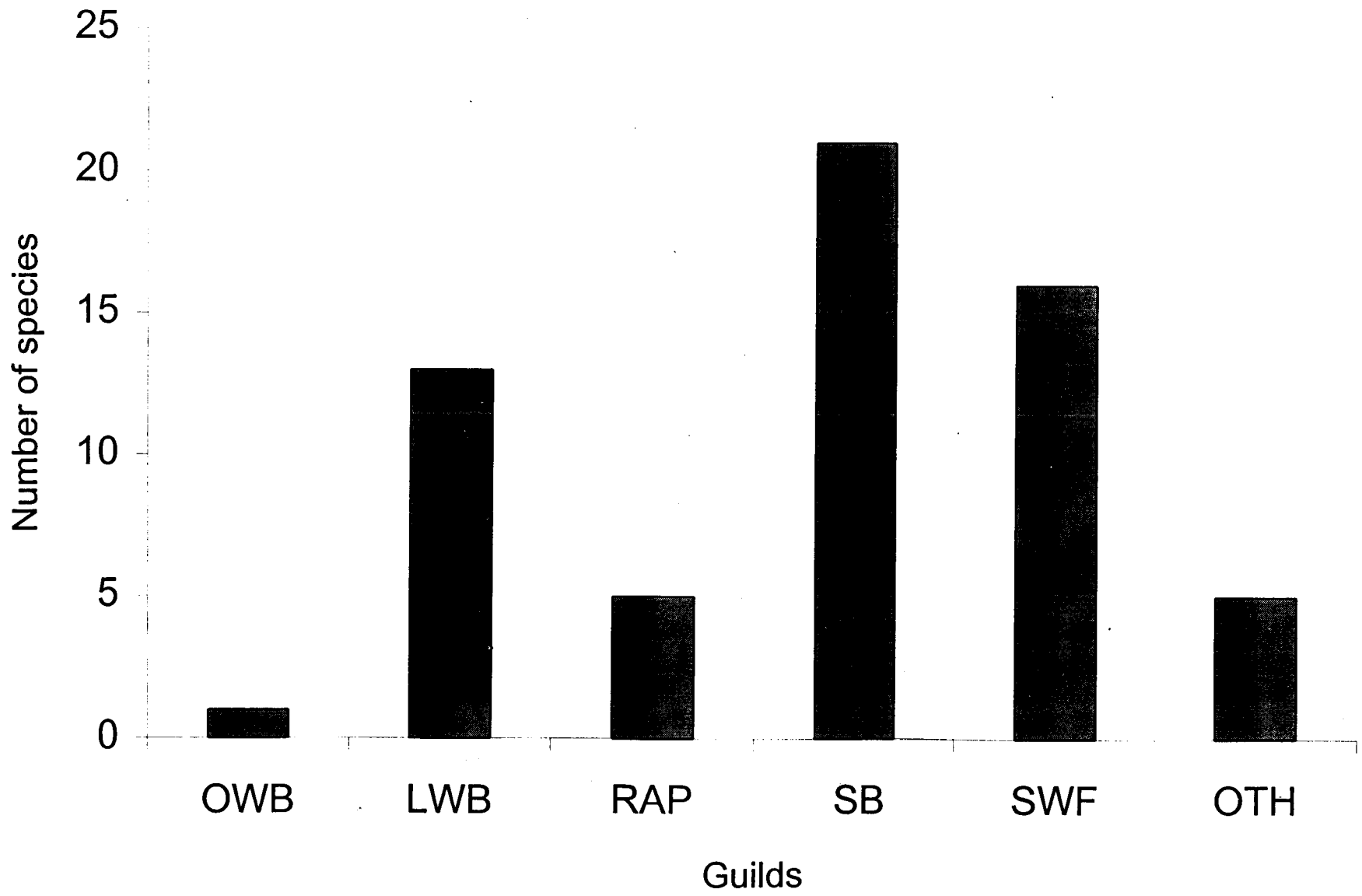


Fig.5.15. The foraging guild composition of Wetland birds of Payangadi.

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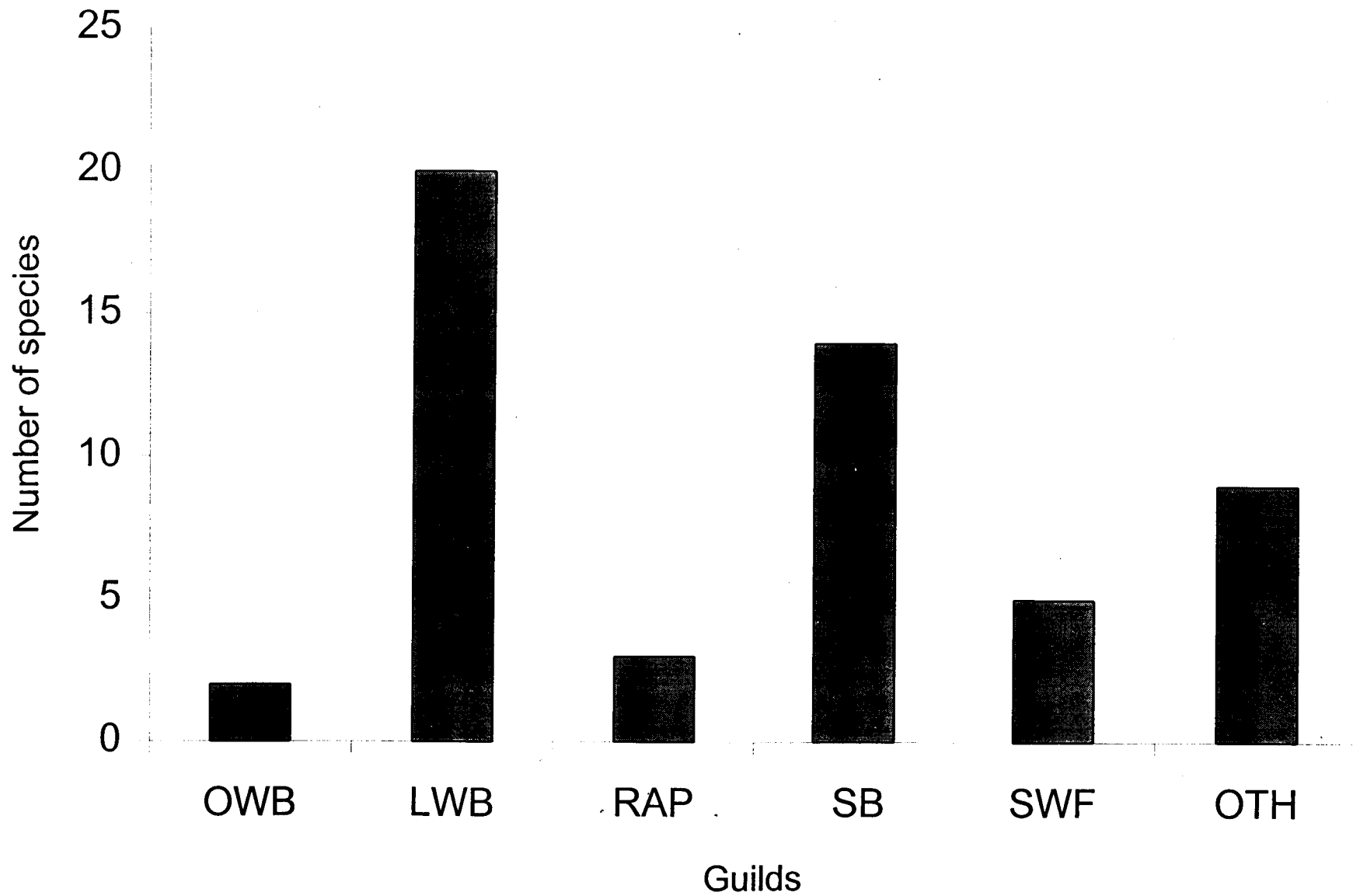


Fig.5.16. The foraging guild composition of Wetland birds of Kuniyan.

types of microhabitats and resources in Chemballikundu. Degraded mangrove vegetation and the presence of Pokkali fields are the specialities of Payangadi wetlands.

The variations in the bird community explained in the earlier section on diversity and species compositions seem to be the effect of this microhabitat variation. As per Root's (1967) definition, a guild is a group of species using the similar resource in a similar way. When the available microhabitats change from one place to another the composition of species in the community also varies.

5.5 Similarity of bird communities

The Table 5.2 summarises the computed similarity index values between the study localities. Though there are minor changes, both the indices give the same pattern. While Jaccard index gives the similarity in the composition of species only on the basis of presence and absence data, Morisita-Horn index takes into consideration of the relative abundance of the species. But this does not alter the pattern much. The best similarity is between Chemballikundu and Payangadi and the least is between Kuniyan and Madackara in both these indices.

Similarity between the bird assemblages observed in every month varies between sites. Payangadi riverine wetlands shows the best one. On an average 15.3 (with a SD 7.17) species shared between any two month of this study period of two years. The values of the other three sites are, 14 (5.68) for Chemballikundu, 10.88 (4.45) for Kuniyan and 11.07(7.22) for Madackara.

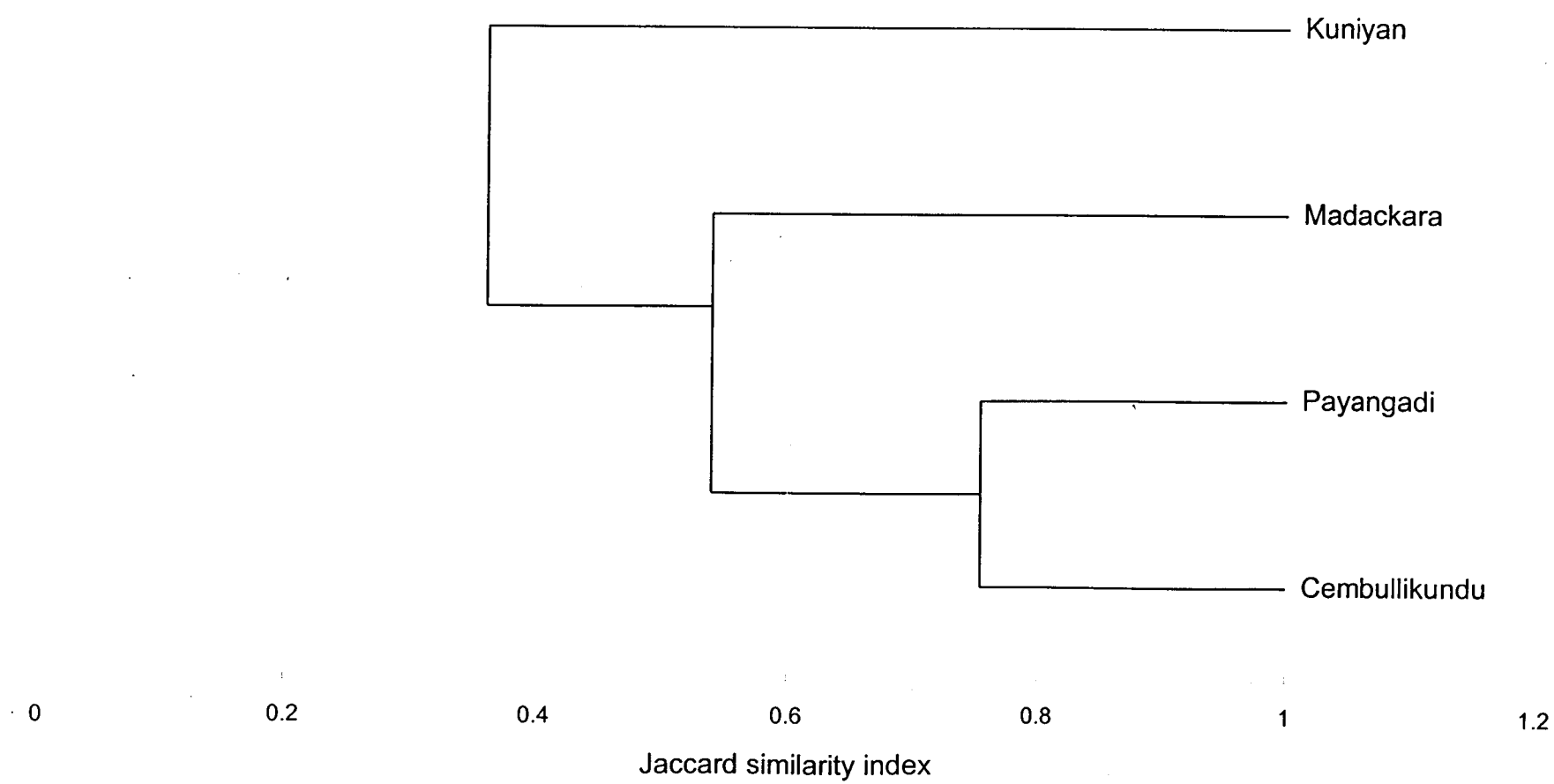


Fig.5.17. Complete linkage cluster diagram of the similarities between bird communities of four different wetland habitats.

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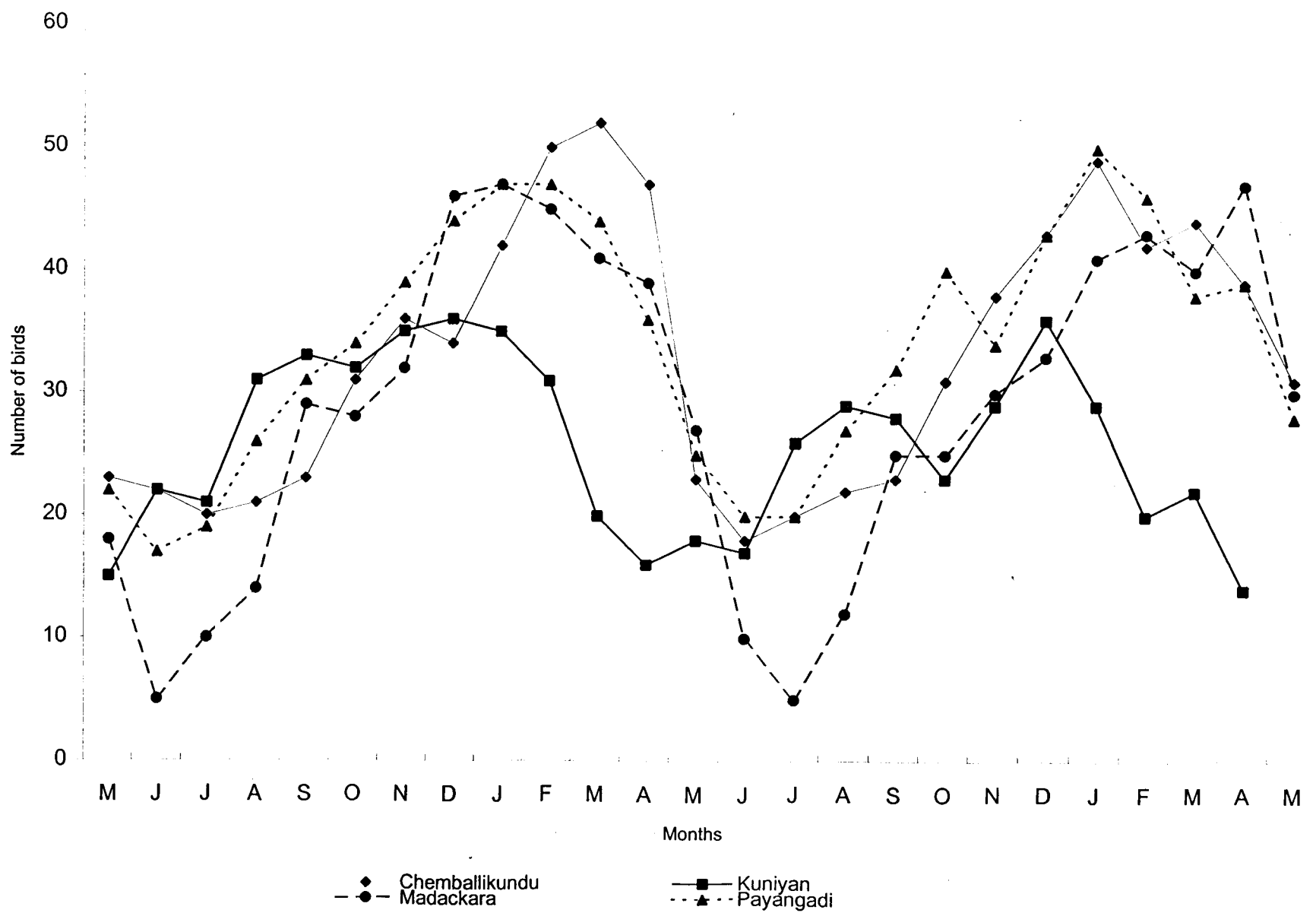


Fig.5.18. Overall bird population fluctuation of observed birds in the four study localities.

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bird

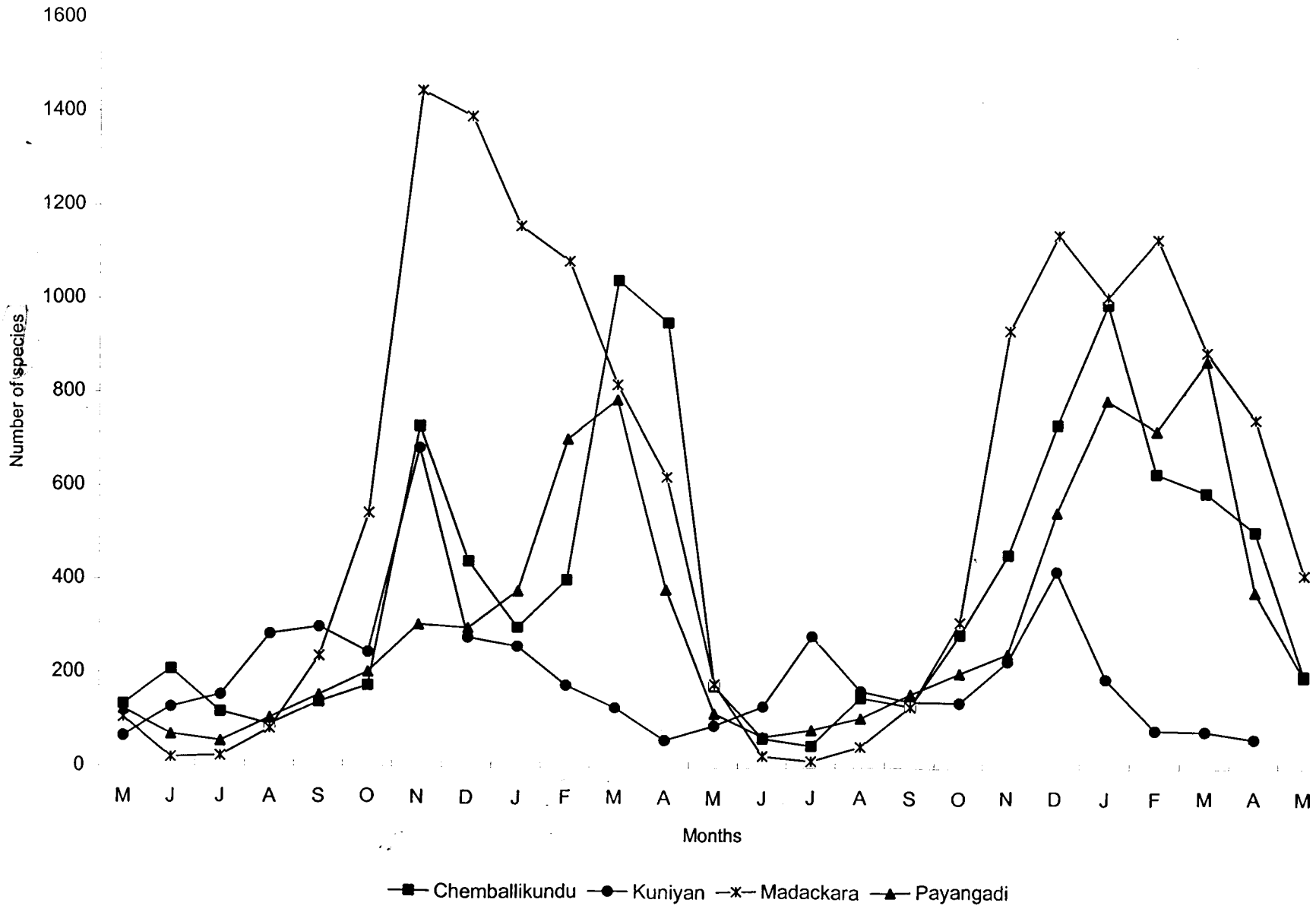


Fig.5.19. Fluctuation of number of species observed in the four study habitats during the study period.

Figure.5.17 gives the complete linkage cluster diagram of the similarity between the bird communities of the four wetland habitats.

5.6 Seasonal fluctuations

Coastal wetlands of north Malabar is a regular feeding ground for a large number of long distant migratory birds. Of all the birds observed in the four habitats 41.5 % are migratory. Figures. 5.18 and 5.19 shows the fluctuations of the number of individuals and species of birds observed in the study localities. Migratory season starts in the September and end in April and reaches at its peak during December and January months. All the three habitats show a significant difference in the number and composition of birds observed during these months, but Kuniyan shows a different picture. During the non -migratory months of June and July more birds are observed in Kuniyan when compared to other sites. Figure 5.19 shows that all the four habitats show significant fluctuations of species composition during the period of migratory season. This indicate that though large flocks avoid Kuniyan, many migratory birds reach here and use this habitat.

Figure 5.20 presents the cumulative species curve for the period of study. All the curves get plateau just after the first year of observation. This indicate the adequacy of the collected data for the one time analysis of structure, diversity and variability and the short duration temporal analysis of the seasonal fluctuations and variability of the wetland bird community studied.

Migrant birds form an important components in the ecology of coastal wetlands. Fig 5.21 show the percentage division of all the four bird communities

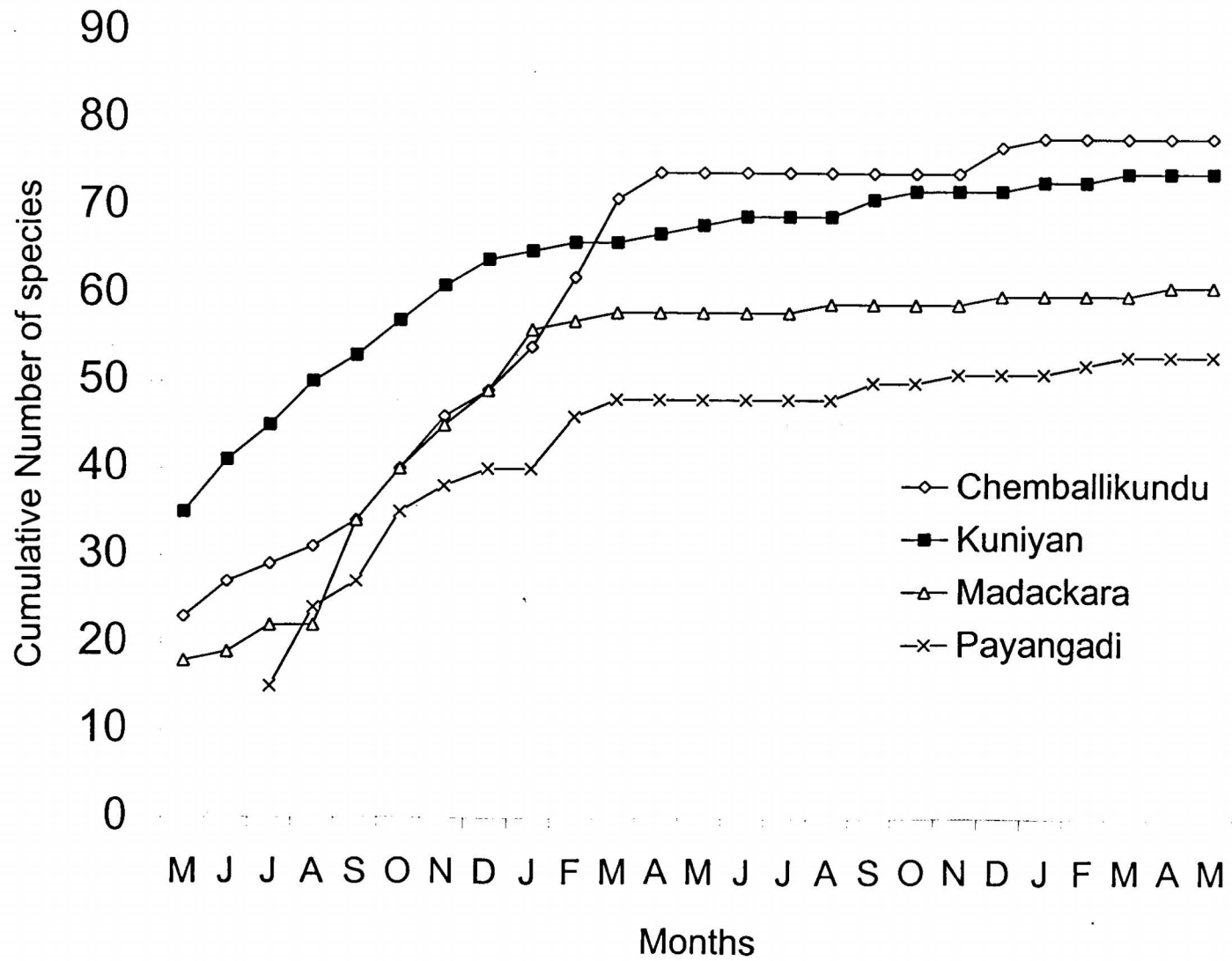


Fig.5.20. Cumulative species curve of four study areas for the study period.

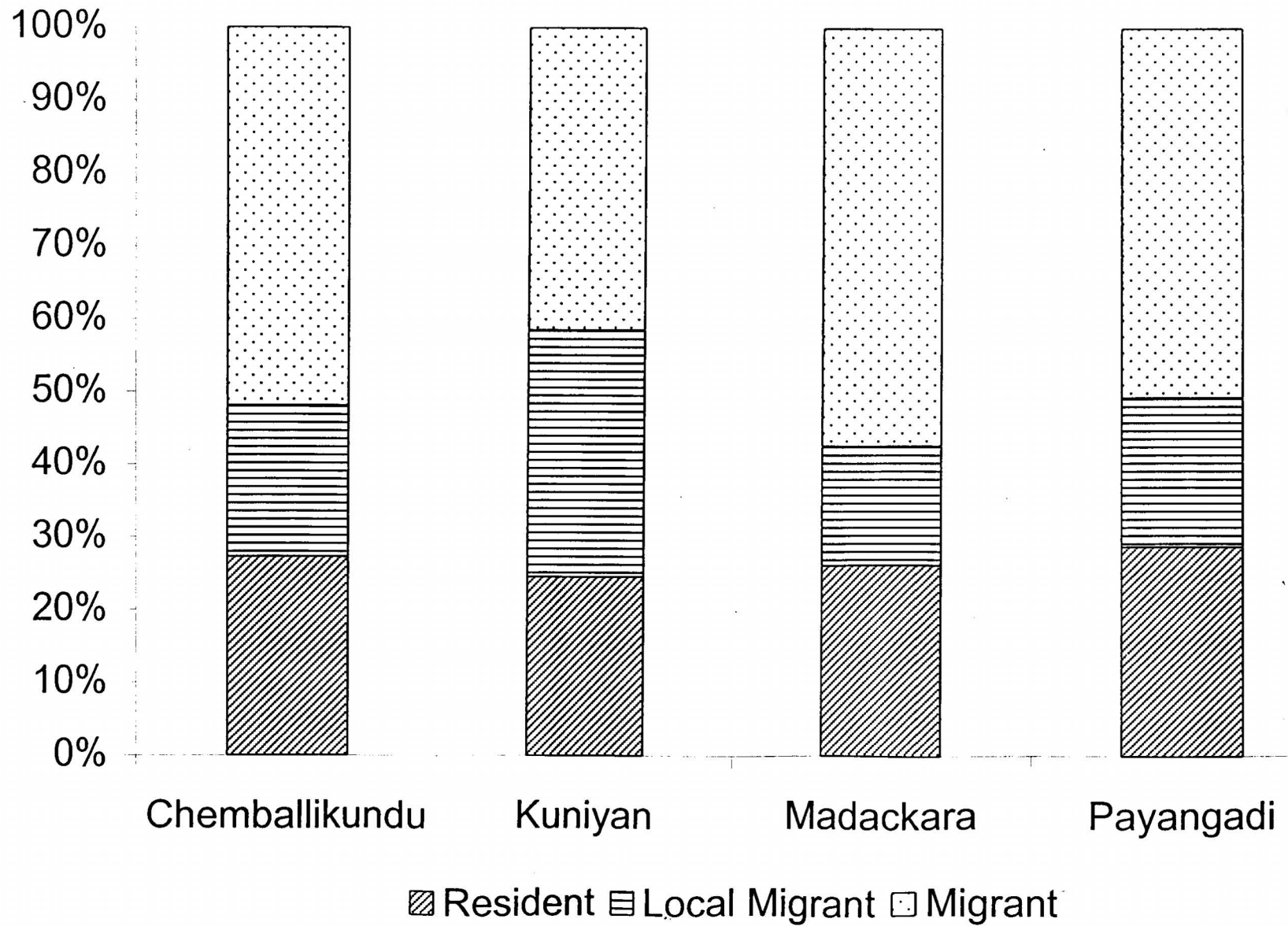


Fig.5.21. Percentage division of the bird communities of the four habitats with their status category.

studied into their status categories. It is evident from most of the analysis Madackara is more dominated by migratory species when compared to the other sites. Locally moving species like egrets and herons have dominated at Kuniyan wetlands.

5.7 Conclusion

The four study sites represent four different types of wetlands in the North Malabar. It also experience a gradation in the effect of sea in terms of salinity as it has increasing geographical distance from the sea. Moreover they differ between themselves in the general vegetation complexity and in the availability of food. This difference in the habitats are visible in the community structure and variations in these sites. The availability of microhabitats and food primarily determines the choice of habitats. As the choices varies so does the species assemblage.

BIRD COMMUNITY OF PADDY FIELD WETLANDS

Muhamed Jafer.P “Habitat use of birds of north malabar coast with special reference to the white bellied sea eagle, *haliaeetus leucogaster*” Thesis.
Department of Zoology, St. Joseph 'S College Devagiri, University of Calicut,
2000

CHAPTER 6.

BIRD COMMUNITY OF PADDY FIELD WETLANDS

6.1 Introduction

Rice is the staple food of people of Kerala and the 65 percent of the population in India. Globally, India ranks first in having the area under cultivation of rice. A total of 537608 ha. area is under rice cultivation (Mathew and Dev,1997) in Kerala.

Rice is a seasonal crop grown one to three times every year; the monsoon crop from late May or early June to August-September, followed by the post monsoon crop which may grow up to February, and a third crop, from February to May, which depend upon the availability of water. Rice cultivation provides extensive stretches of managed wetlands, which form the feeding ground of many birds.

Paddy field is a very transient wetland habitat. The microhabitat created by plant cover, and the water profile, changes between every cropping seasons. This change in the microhabitat structure affects the changes in the species assemblages, which depends on this wetland ecosystem. Birds form part of this ecosystem at all stages of paddy growth and their occurrence varies temporally depending on the finer changes in ecosystem. This study is aimed at

Table 6.1 The abundance distribution of the birds in the four different stages of the crop I

Species	Land Preperation	Growing stage	Seed stage	Harvest stage	TOTAL
<i>Ardeola striatus</i>	0	2	5	0	7
<i>Ardeola grayii</i>	131	320	149	87	687
<i>Bubulcus ibis</i>	158	145	333	52	688
<i>Egretta intermedia</i>	12	0	2	1	15
<i>Egretta garzetta</i>	109	43	12	4	168
<i>Ixobrychus cinnamomeus</i>	0	1	7	3	11
<i>Ixobrychus flavicollis</i>	0	11	0	0	11
<i>Haliastur indus</i>	2	9	2	0	13
<i>Amaurornis phoenicurus</i>	1	1	2	0	4
<i>Vanellus indicus</i>	0	0	2	0	2
<i>Pluvialis dominica</i>	62	0	0	0	62
<i>Charadrius dubius</i>	137	2	0	0	139
<i>Charadrius hiaticula</i>	13	6	0	0	19
<i>Charadrius alexandrinus</i>	16	5	0	0	21
<i>Tringa totanus</i>	2	5	0	0	7
<i>Tringa stagnatilis</i>	2	22	0	0	24
<i>Tringa nebularia</i>	2	0	0	0	2
<i>Tringa ochropus</i>	2	1	0	0	3
<i>Tringa glareola</i>	2	3	0	0	5
<i>Gallinago spp.</i>	20	35	29	14	98
<i>Ceryle rudis</i>	6	9	3	0	18
<i>Alcedo atthis</i>	0	7	8	1	16
<i>Pelargopsis capensis</i>	0	8	4	0	12
<i>Halcyon smyrnensis</i>	2	11	5	1	19
<i>Motacilla flava</i>	6	2	0	0	8
<i>Motacilla citreola</i>	15	0	0	0	15
<i>Motacilla cinerea</i>	56	2	0	0	58
<i>Motacilla alba</i>	10	0	0	0	10
<i>Motacilla maderaspatensis</i>	2	15	0	0	17
TOTAL	768	665	563	163	2159

Table.6.2. The abundance distribution of the birds in the four different stages of the crop II

Species	Land Preperation	Growing stage	Seed stage	Harvest stage	TOTA
<i>Phalacrocorax niger</i>	0	33	51	9	93
<i>Ardeola grayii</i>	23	199	133	42	397
<i>Bubulcus ibis</i>	121	442	8	0	571
<i>Ardea alba</i>	0	6	0	2	8
<i>Egretta garzetta</i>	4	16	9	20	49
<i>Egretta intermedia</i>	0	17	0	4	21
<i>Ixobrychus cinnamomeus</i>	0	12	6	0	18
<i>Ixobryhus flavicollis</i>	0	13	1	0	14
<i>Nycticorax nycticorax</i>	0	1	0	0	1
<i>Haliastur indus</i>	0	17	39	4	60
<i>Dendrocygna javanica</i>	0	6	3	0	9
<i>Amaurornis phoenicurus</i>	0	36	16	2	54
<i>Vanellus indicus</i>	0	0	1	0	1
<i>Alcedo atthis</i>	0	22	21	3	46
<i>Ceryle rudis</i>	2	30	4	1	37
<i>Halcyon smyrnensis</i>	8	76	66	10	160
<i>Ceryle rudis</i>	0	1	4	1	6
<i>Motacilla maderaspatensis</i>	0	1	0	0	1
TOTAL	158	928	362	98	1546

Table 6.3 The abundance distribution of the birds in the four different stages of the crop III

Species	Land Preperation	Growing stage	Seed stage	Harvest stage	TOTAL
<i>Phalacrocorax niger</i>	2	13	0	0	15
<i>Ardeola grayii</i>	70	470	270	84	894
<i>Bubulcus ibis</i>	23	286	55	36	400
<i>Ardea alba</i>	6	2	3	0	11
<i>Egretta intermedia</i>	2	26	26	3	57
<i>Egretta garzetta</i>	13	186	38	1	238
<i>Ixobrychus cinnamomeus</i>	1	3	0	0	4
<i>Ciconia episcopus</i>	0	0	9	3	12
<i>Haliastur indus</i>	2	16	21	4	43
<i>Circus macrourus</i>	0	2	5	0	7
<i>Circus melanoleucos</i>	0	6	2	4	12
<i>Amaurornis phoenicurus</i>	0	6	5	4	15
<i>Vanellus indicus</i>	8	20	0	2	30
<i>Pluvialis dominica</i>	43	101	0	1	145
<i>Charadrius dubius</i>	0	25	0	0	25
<i>Charadrius hiaticula</i>	0	1	0	0	1
<i>Charadrius alexandrinus</i>	0	9	0	0	9
<i>Tringa totanus</i>	0	0	0	0	0
<i>Tringa nebularia</i>	1	0	0	0	1
<i>Tringa stagnatilis</i>	1	14	0	0	15
<i>Tringa ochropus</i>	4	27	7	0	38
<i>Tringa glareola</i>	1	2	0	0	3
<i>Tringa hypoleucos</i>	0	10	3	0	13
<i>Gallinago spp.</i>	1	39	32	5	77
<i>Ceryle rudis</i>	1	7	0	1	9
<i>Alcedo atthis</i>	3	20	0	1	24
<i>Pelargopsis capensis</i>	2	7	10	2	21
<i>Halcyon smyrnensis</i>	2	7	8	0	17
<i>Ceyx erithacus</i>	0	2	0	4	6

<i>Motacilla flava</i>	1	1	2	0	4
<i>Motacilla citreola</i>	2	3	1	2	8
<i>Motacilla cinerea</i>	0	25	0	0	25
<i>Motacilla alba</i>	1	0	0	2	3
<i>Motacilla maderaspatensis</i>	0	2	0	4	6
TOTAL	190	1338	497	163	2188

Table 6.4. The abundance distribution of the birds in the four different stages of the crop IV

Species	Land Preparation	Growing stage	Seed stage	Harvest stage	TOTA
<i>Phalacrocorax niger</i>	2	2	0	0	4
<i>Ardeola grayii</i>	90	261	184	101	636
<i>Bubulcus ibis</i>	134	288	95	171	688
<i>Ardea alba</i>	1	0	0	0	1
<i>Egretta intermedia</i>	2	22	11	5	40
<i>Egretta garzetta</i>	7	32	14	8	61
<i>Ixobrychus cinnamomeus</i>	0	1	1	0	2
<i>Ciconia episcopus</i>	5	0	0	0	5
<i>Haliastur indus</i>	2	17	9	4	32
<i>Haliaeetus leucogaster</i>	0	0	2	0	2
<i>Circus macrourus</i>	1	0	0	0	1
<i>Circus melanoleucos</i>	2	0	0	0	2
<i>Amaurornis phoenicurus</i>	4	17	18	4	43
<i>Vanellus indicus</i>	0	5	0	0	5
<i>Vanellus malabaricus</i>	1	1	0	0	2
<i>Pluvialis dominica</i>	32	1	0	0	33
<i>Charadrius dubius</i>	310	205	0	0	515
<i>Charadrius hiaticula</i>	8	7	0	0	15
<i>Charadrius alexandrinus</i>	90	57	0	0	147
<i>Tringa totanus</i>	0	1	0	0	1
<i>Tringa stanatilis</i>	0	7	0	0	7
<i>Tringa ochropus</i>	17	4	0	0	21
<i>Tringa glareola</i>	14	15	1	0	30
<i>Tringa hypoleucos</i>	10	18	0	0	28
<i>Gallinago spp.</i>	20	43	32	4	99
<i>Chlidonias hybrida</i>	0	1	0	0	1
<i>Ceryle rudis</i>	1	5	2	1	9
<i>Alcedo atthis</i>	1	7	8	1	17
<i>Pelargopsis capensis</i>	1	13	12	3	29
<i>Halcyon smyrensis</i>	2	2	13	6	23
<i>Motacilla flava</i>	2	6	0	0	8
<i>Motacilla citreola</i>	2	0	0	0	2
<i>Motacilla cinerea</i>	2	15	1	0	18
<i>Motacilla alba</i>	1	6	0	0	7
<i>Motacilla maderaspatensis</i>	0	3	0	0	3
TOTAL	764	1062	403	308	2537

understanding this variability and the effect of the transient microhabitats on the structure of wetland bird community.

Four continuous cropping seasons have been studied in the years of 1995 – 96. A total of 454 days were spent in the field and data on the changes of bird diversity and composition in relation to the changes in this wetland were collected.

6.2 Crops stages

The crops are named sequentially into crop1, crop2 and crop3 and crop4. Crop1 and crop4 are pre-monsoon or dry season crops. Crop2 is the monsoon season crop and crop3 the post monsoon crop or winter crop. Growth of Paddy crop is divided in to four stages. First, is the stage of land preparation, which include the activities like ploughing and puddling. This stage is called stage of Preparation in this study. Second stage starts with the sowing of seed and ends with the formation of the earheads, the stage of growth. Third is the stage of Seed. This is the phase in which the seeds matures and ripen. Last is the harvesting stage. Each of this stage is characterised by different microhabitats and the food available for birds in that habitat is likely to vary. This study has shown that the bird community also varies accordingly. The list and the abundance of wetland birds observed in the four stages of each crop is given in the table 6.1 to table 6.4

6.3 Wetland birds and community composition

The composition of species assemblage varies on a temporal scale, due to the fast changing nature of the microhabitat in the paddy field. Considering the four crops as the temporal variations of the same community, the species composition

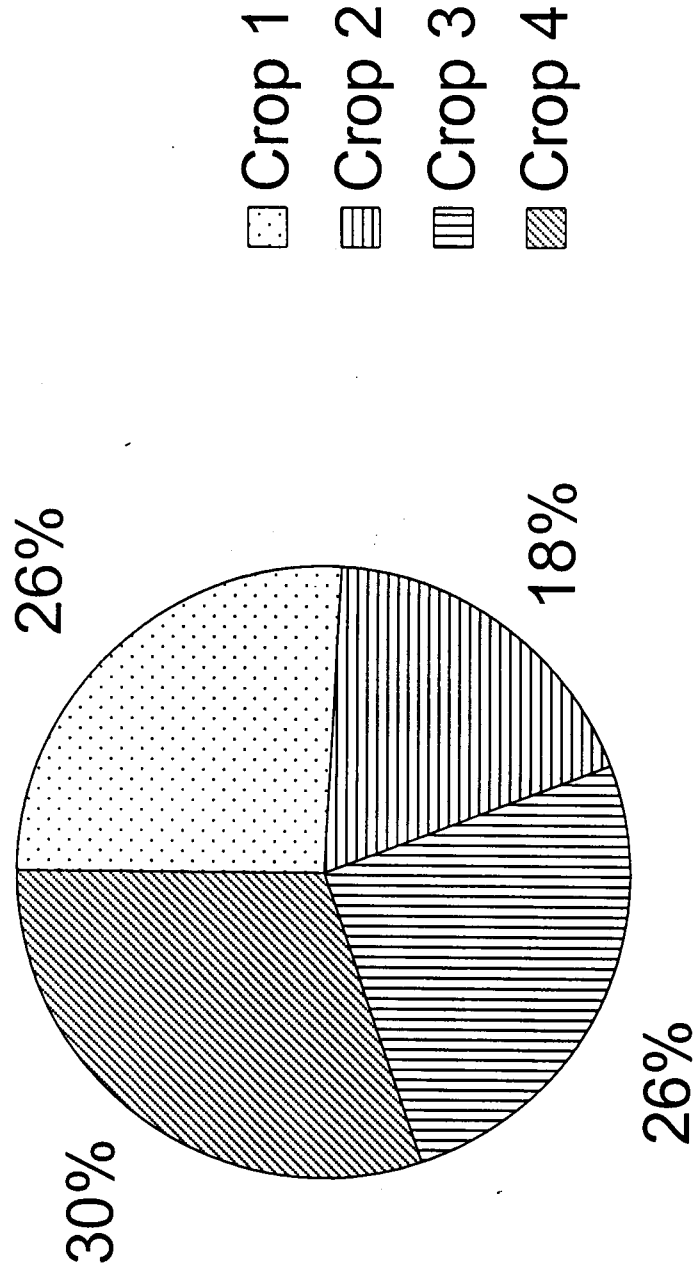


Fig.6.1. The Percentage division of total wetland birds observed in the four Crops.

10/5

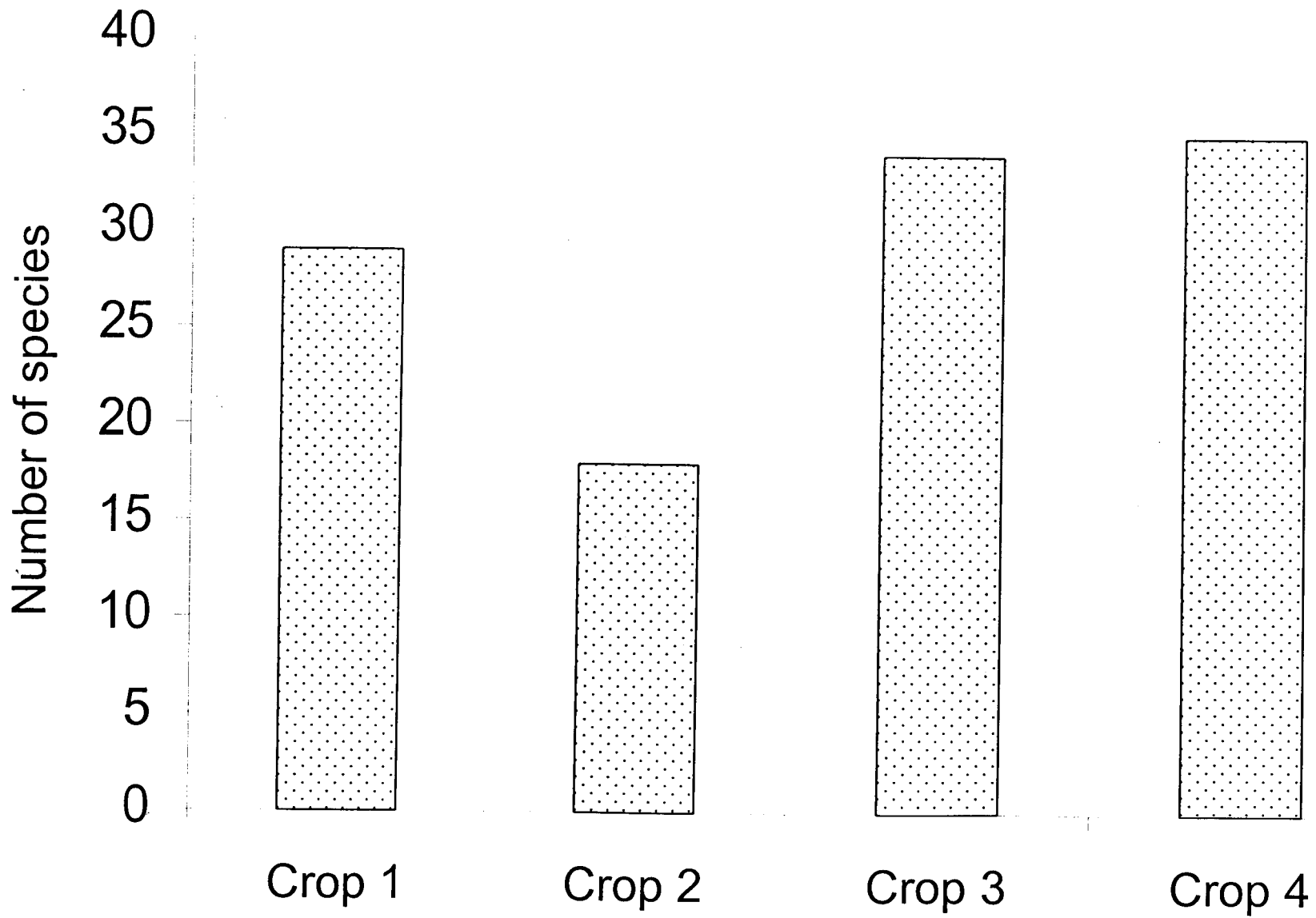


Fig.6.2. The species richness observed during the four Crops

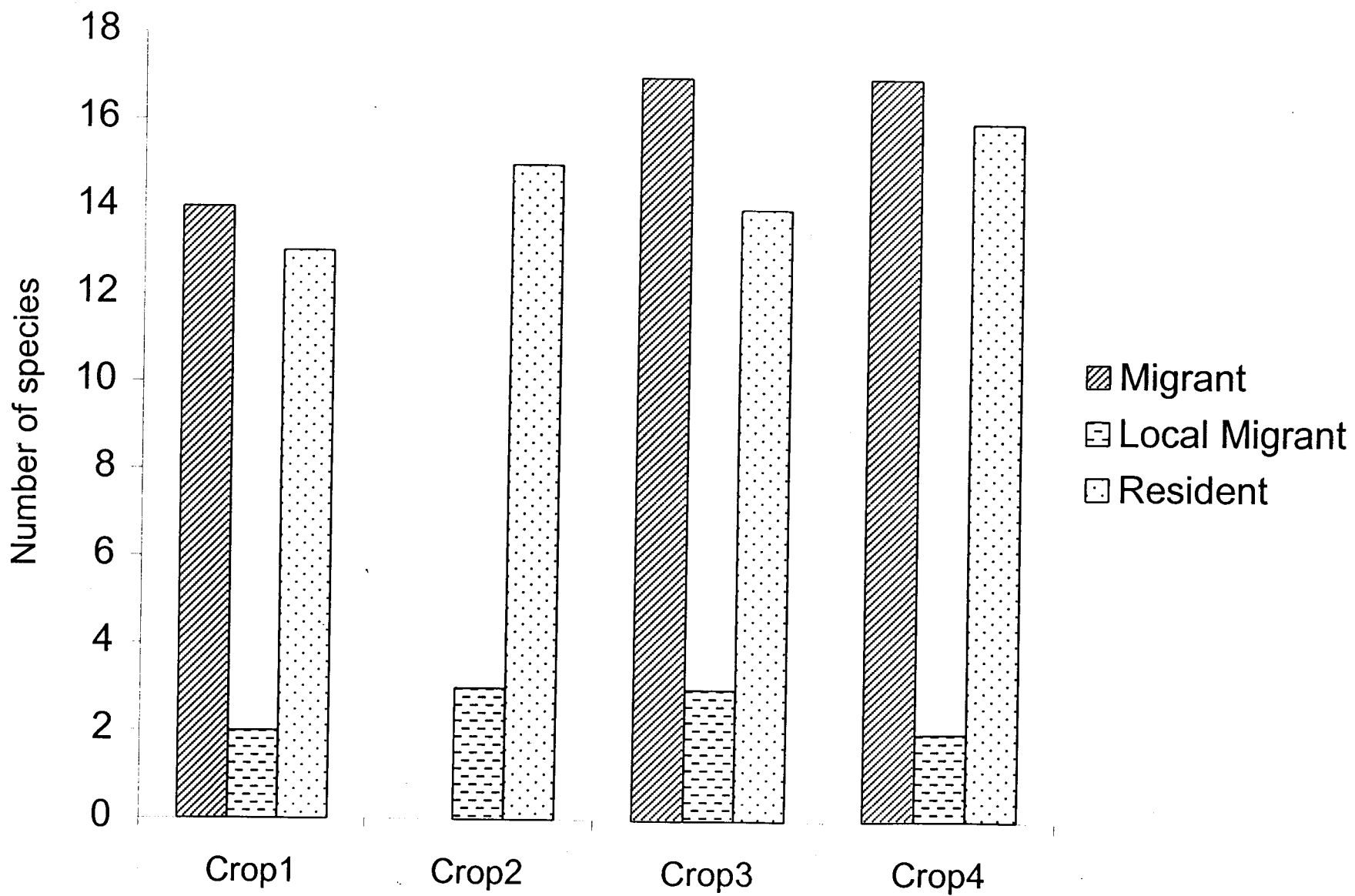


Fig.6.3. Number of Species in the four crops showing their status category.

145

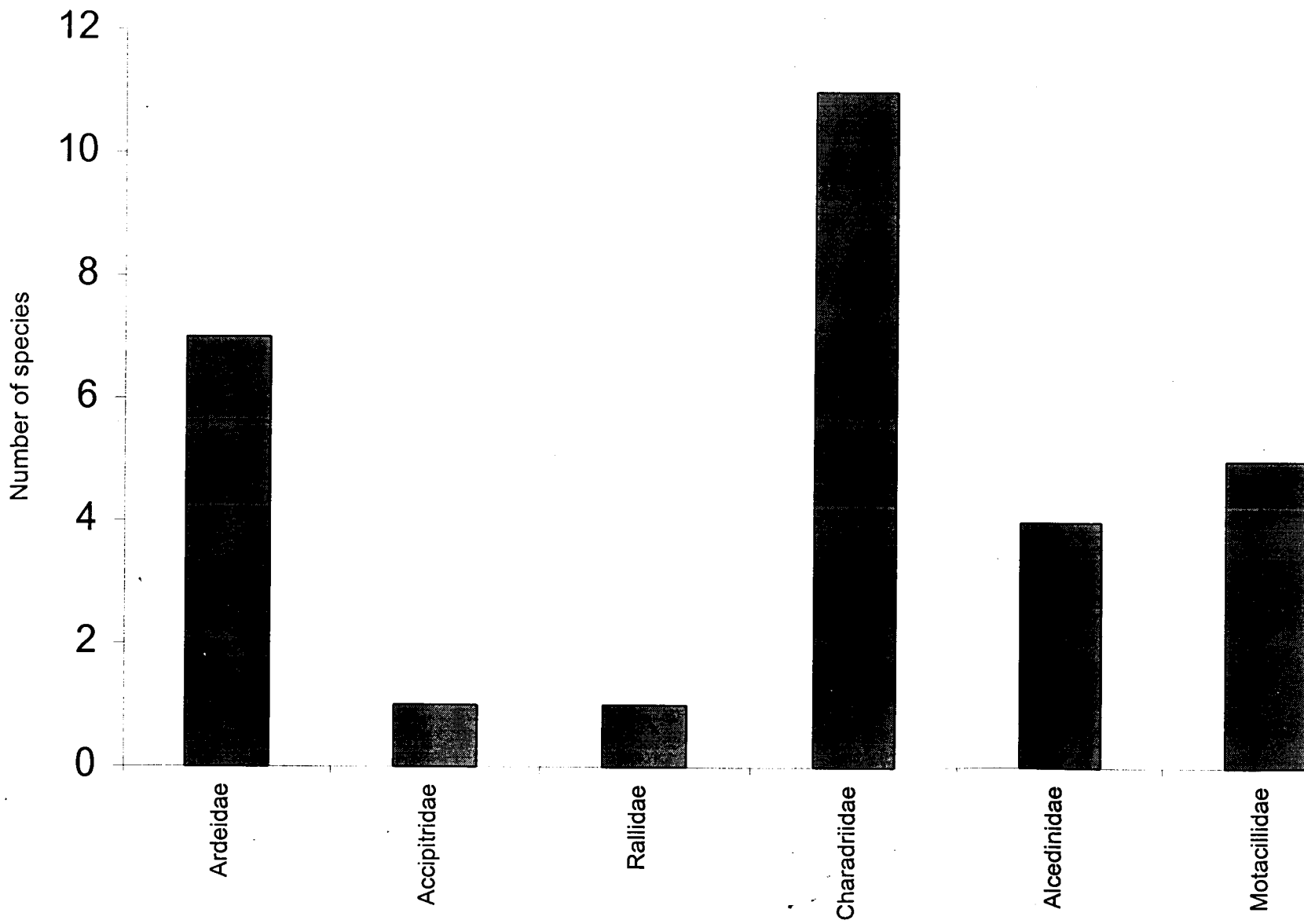


Fig.6.4. The family-wise species richness observed with CropI.

156

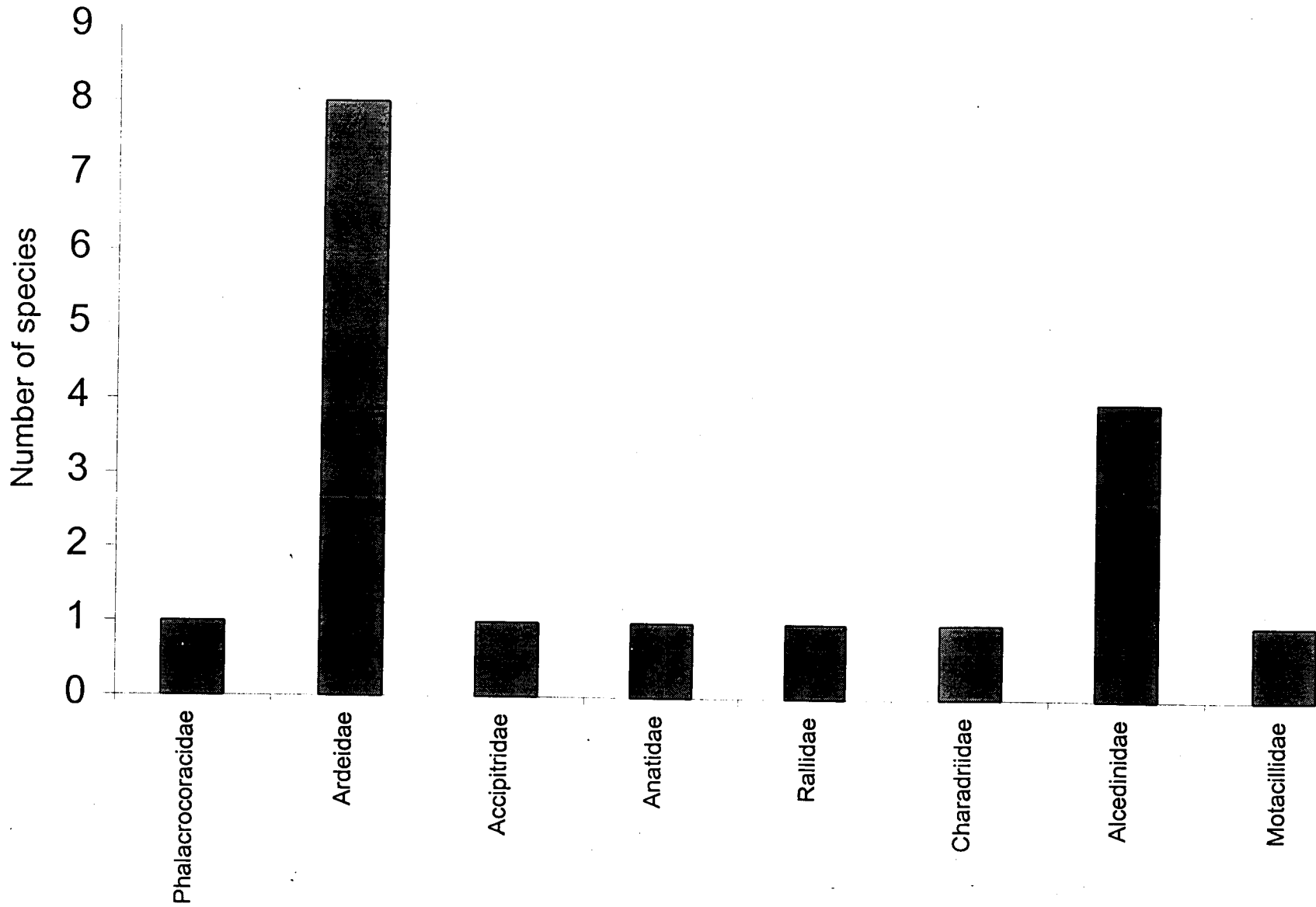
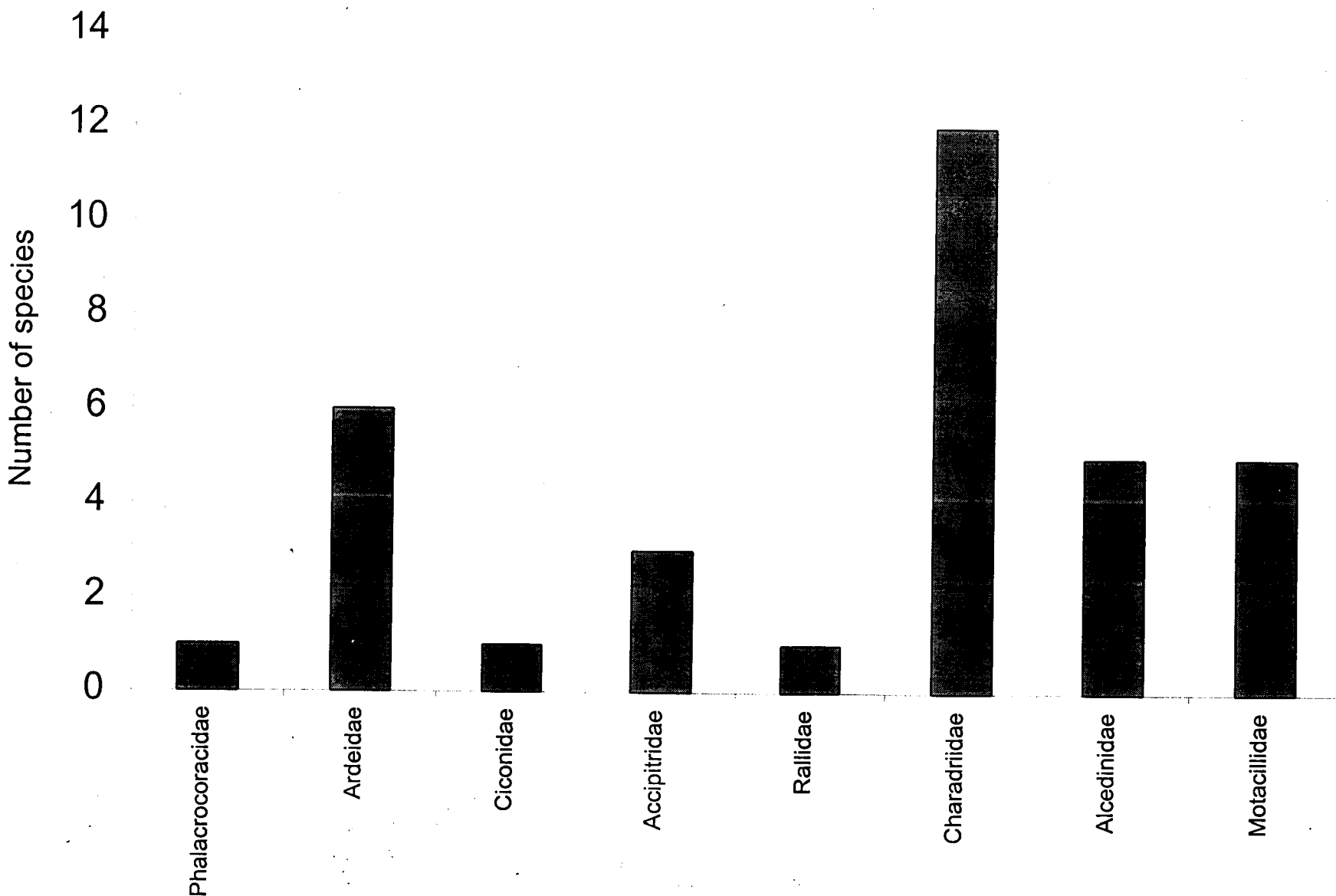


Fig.6.5. The family-wise species richness observed with CropII.



1477

Fig.6.6. The family-wise species richness observed with CropIII.

14
96

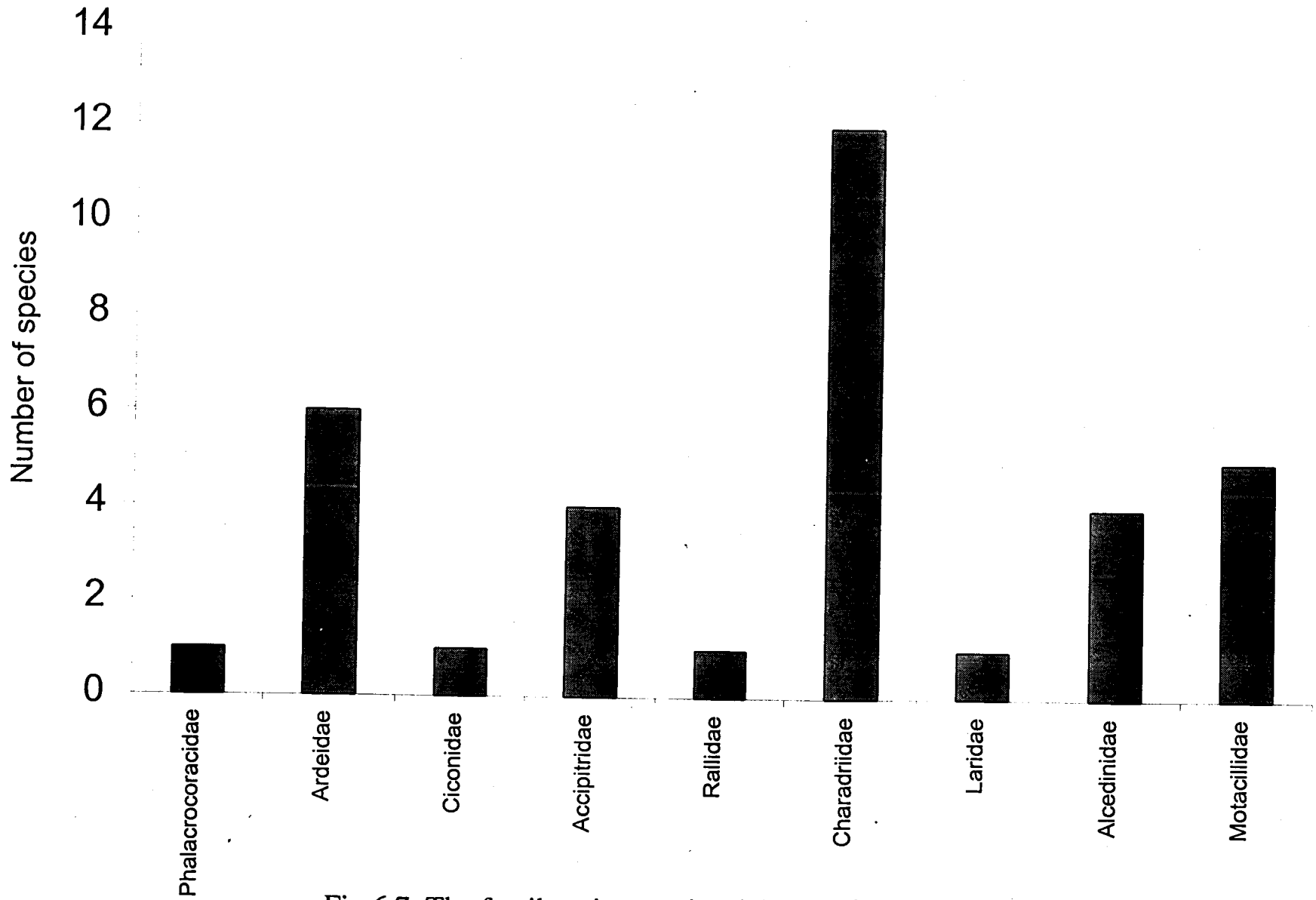


Fig.6.7. The family-wise species richness observed with CtopIV.

1979

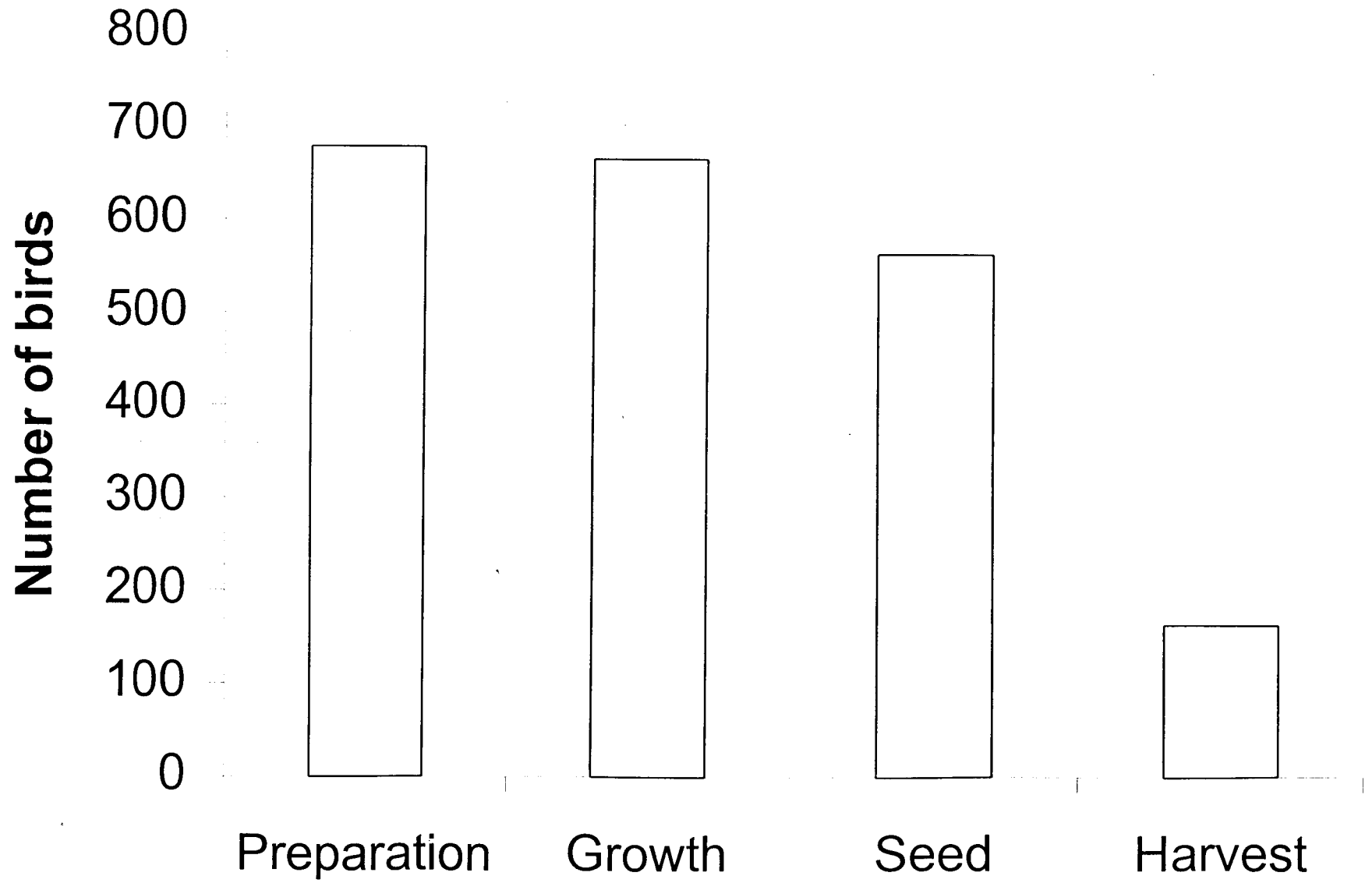


Fig.6.8. The overall population fluctuations of the birds in four different stages of Crop.1.

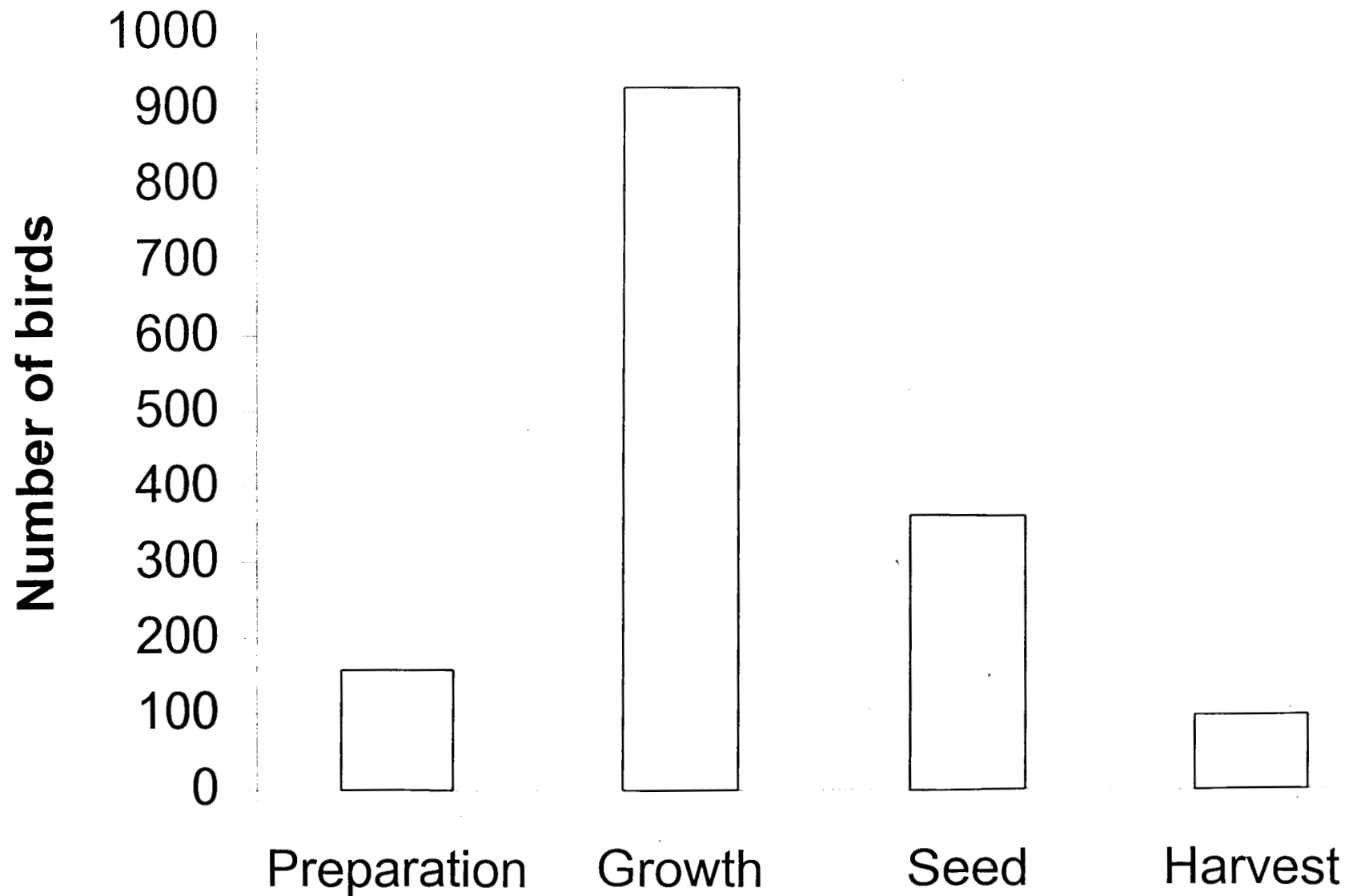


Fig.6.9. The overall population fluctuations of the birds in four different stages of Crop.II.

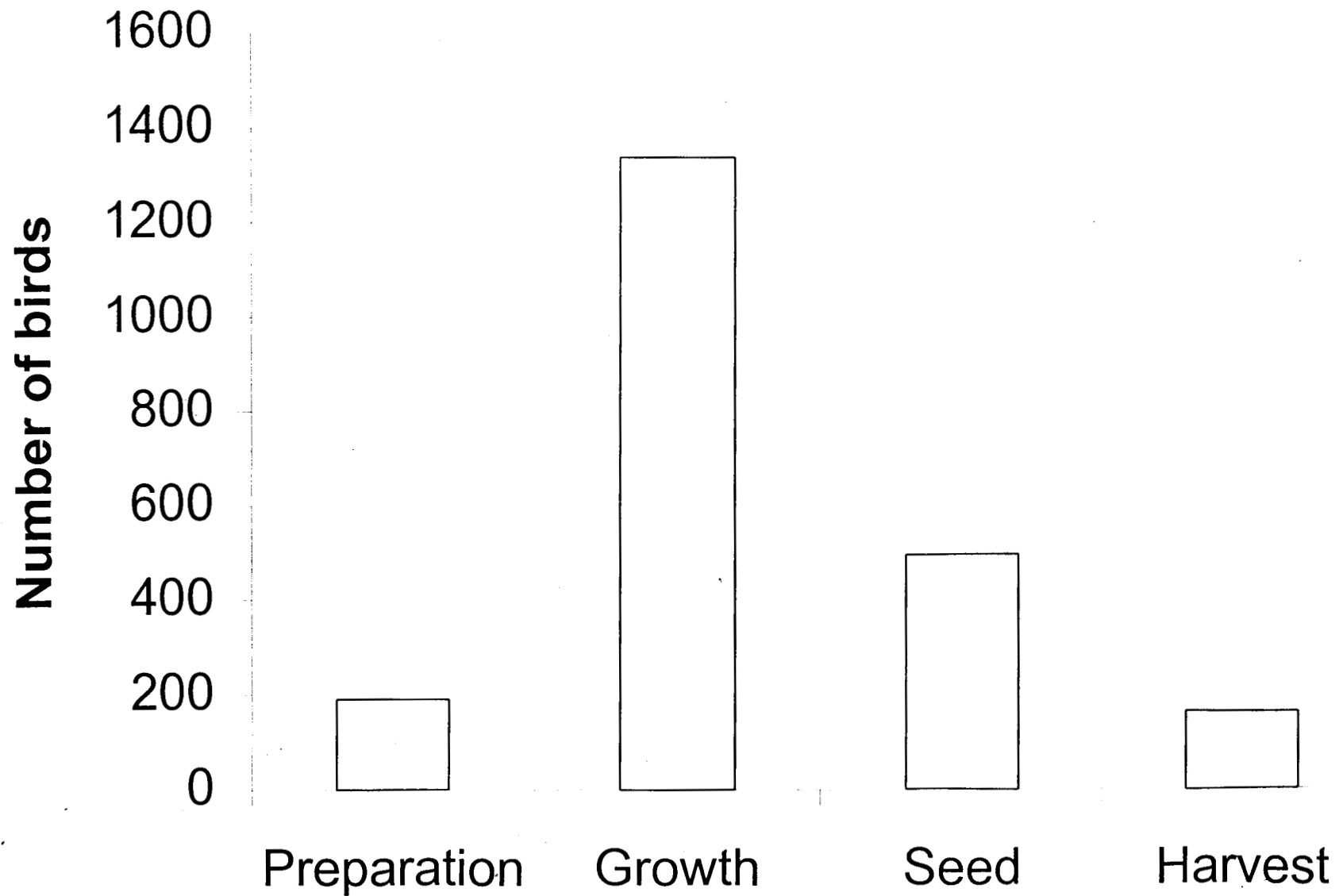


Fig.6.10. The overall population fluctuations of the birds in four different stages of Crop.III.

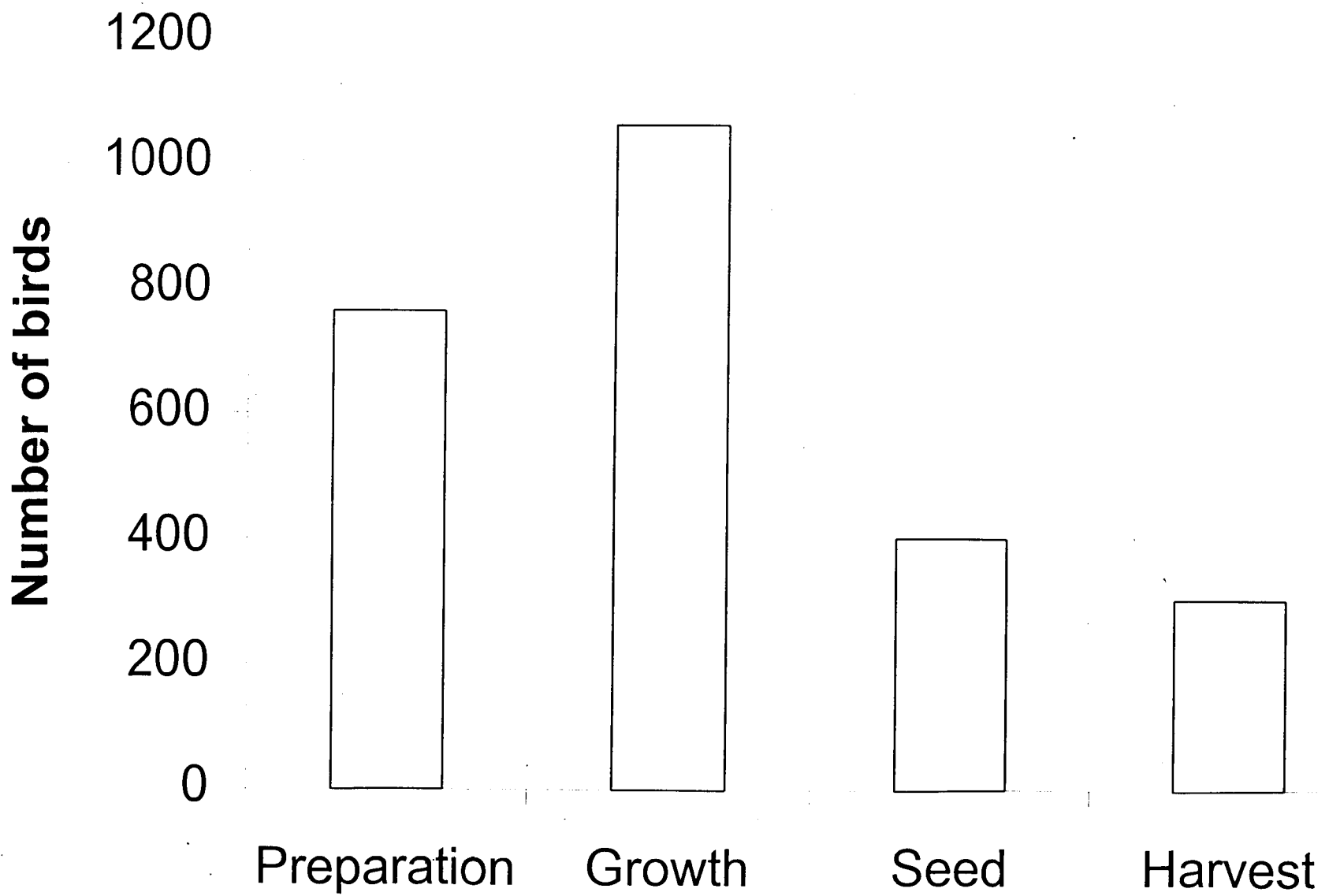


Fig.6.11. The overall population fluctuations of the birds in four different stages of Crop.IV.

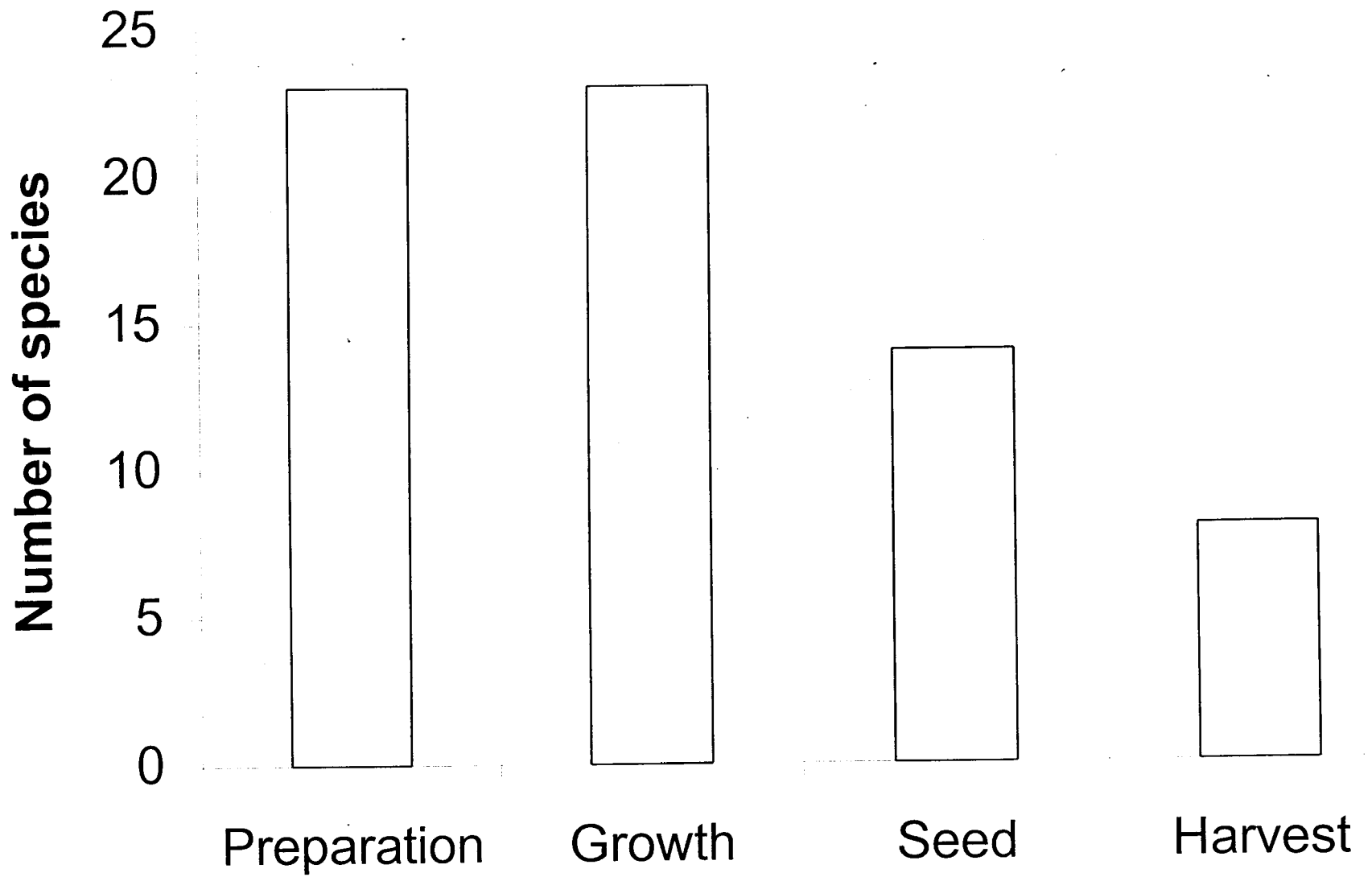


Fig.6.12. The Changes in the number of species observed during four different stages of Crop.I

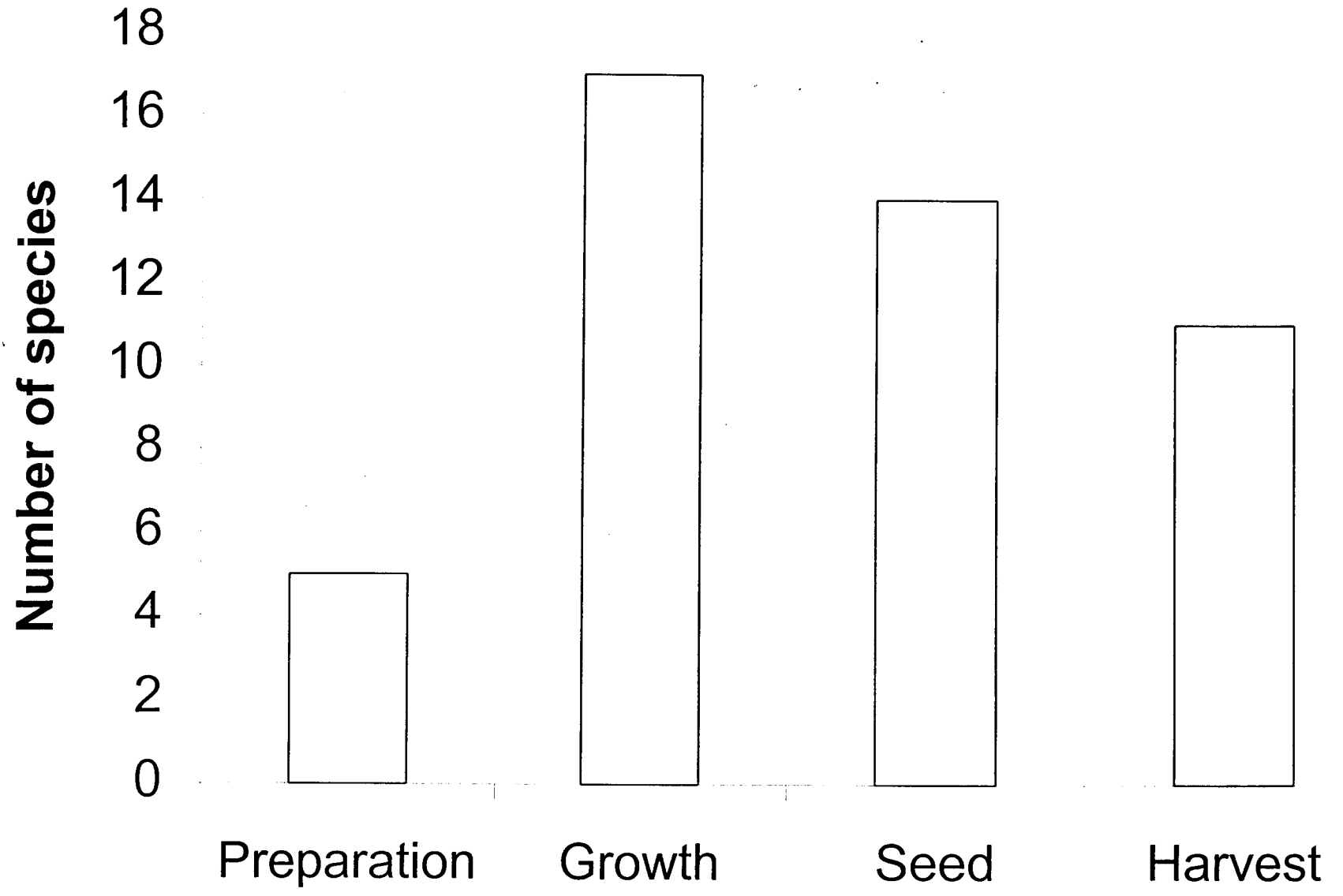


Fig.6.13. The Changes in the number of species observed during four different stages of Crop.II

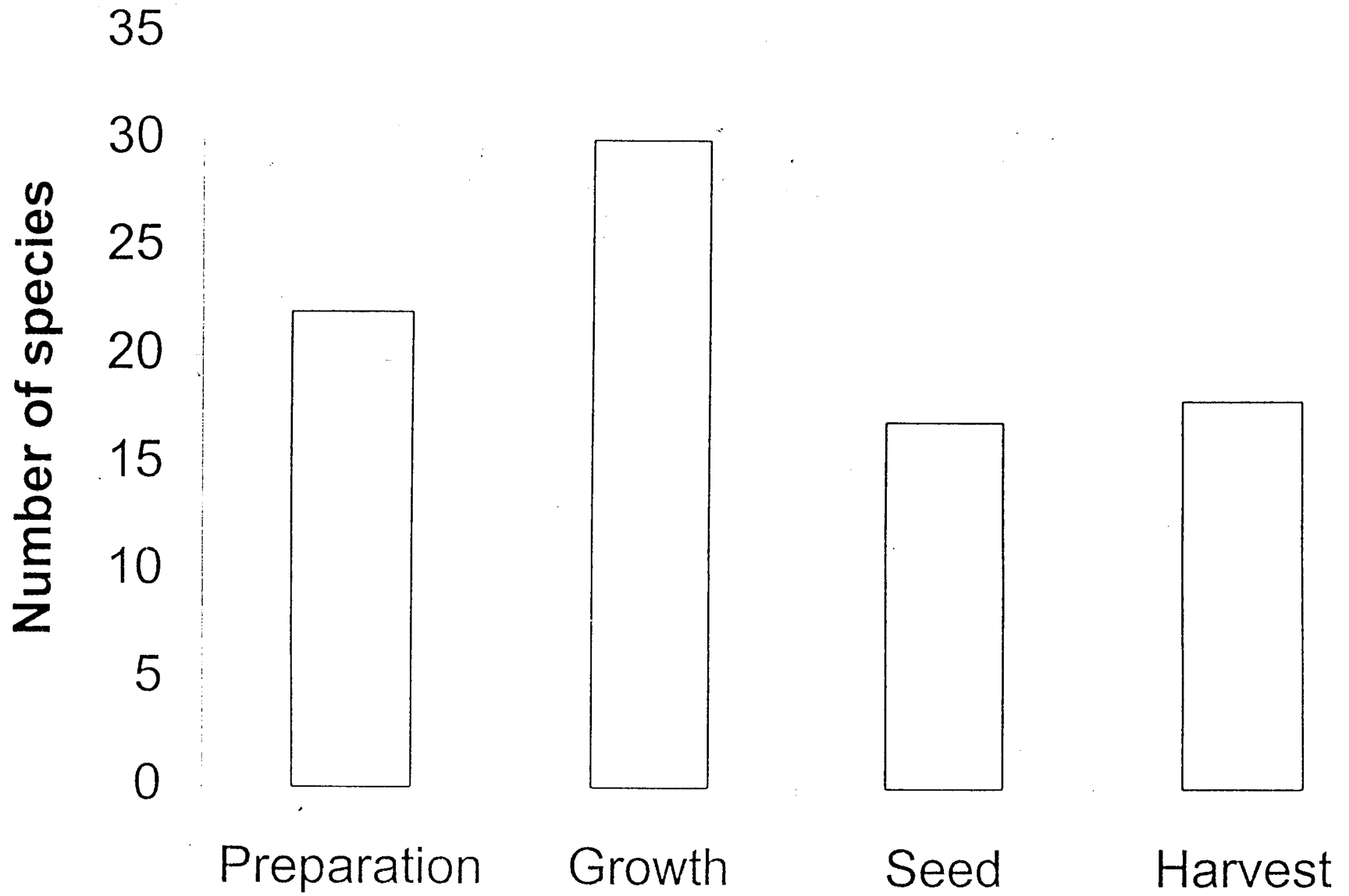


Fig.6.14. The Changes in the number of species observed during four different stages of Crop.III.

14
96

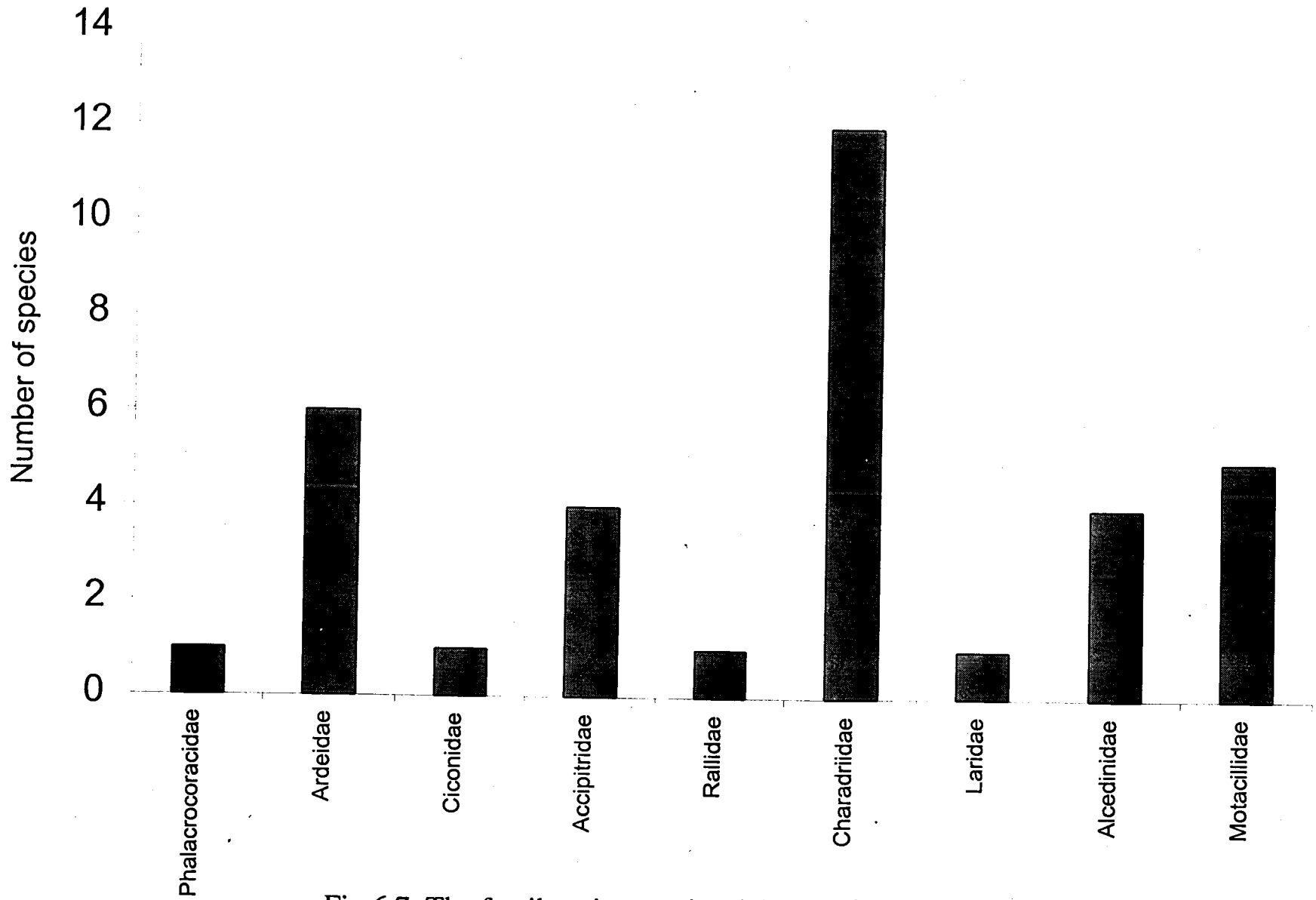


Fig.6.7. The family-wise species richness observed with CtopIV.

1979

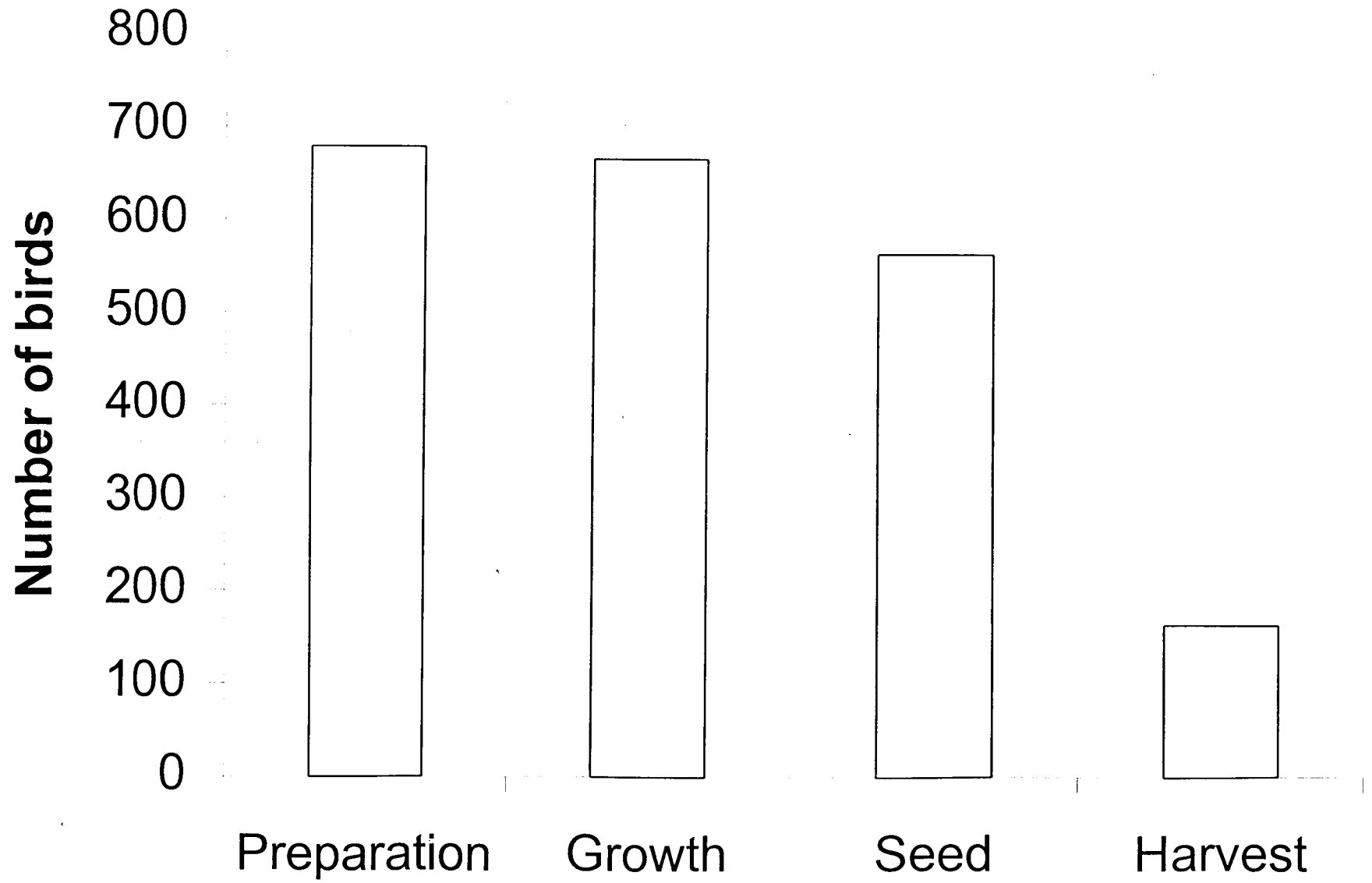


Fig.6.8. The overall population fluctuations of the birds in four different stages of Crop.1.

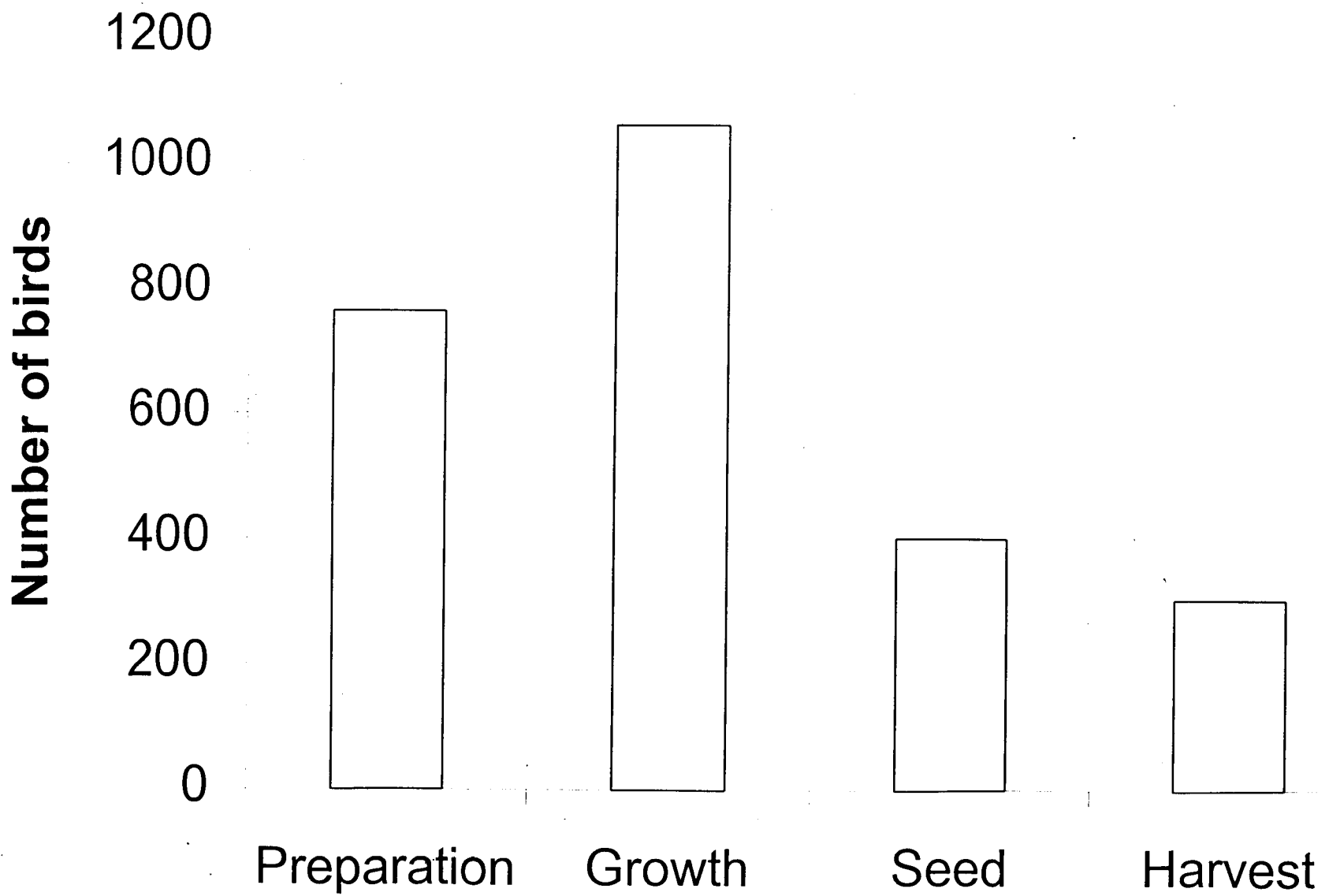


Fig.6.11. The overall population fluctuations of the birds in four different stages of Crop.IV.

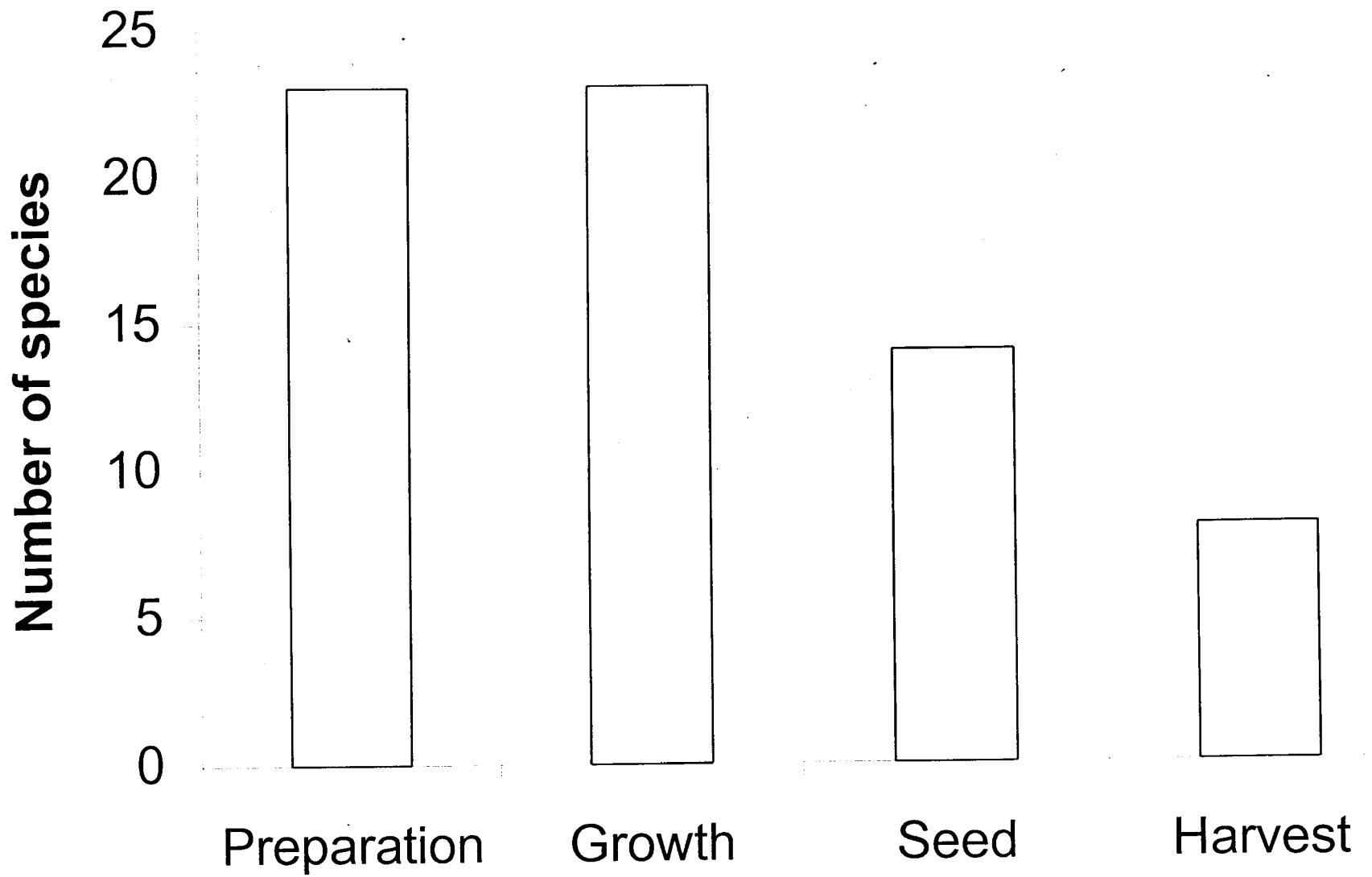


Fig.6.12. The Changes in the number of species observed during four different stages of Crop.I

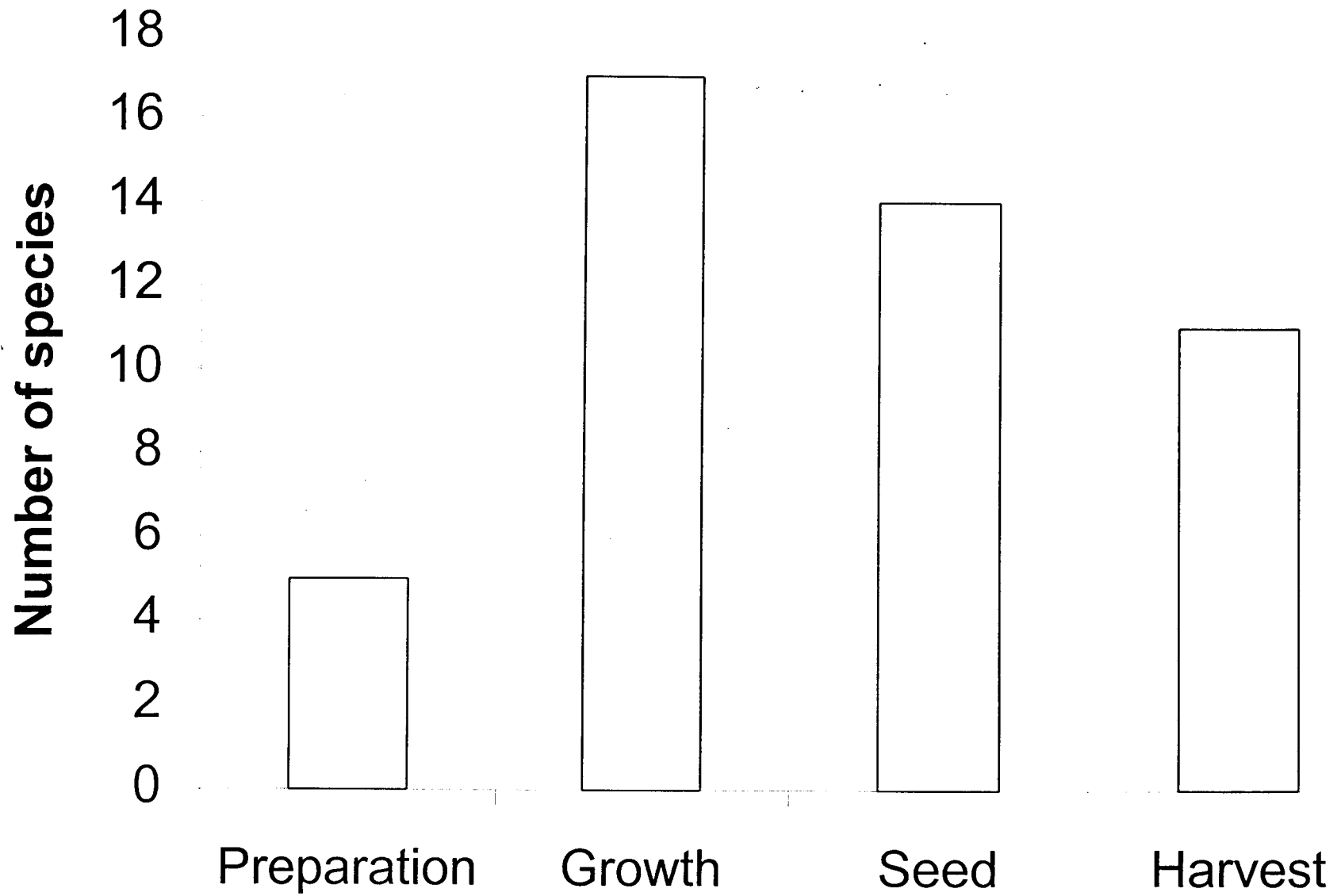


Fig.6.13. The Changes in the number of species observed during four different stages of Crop.II

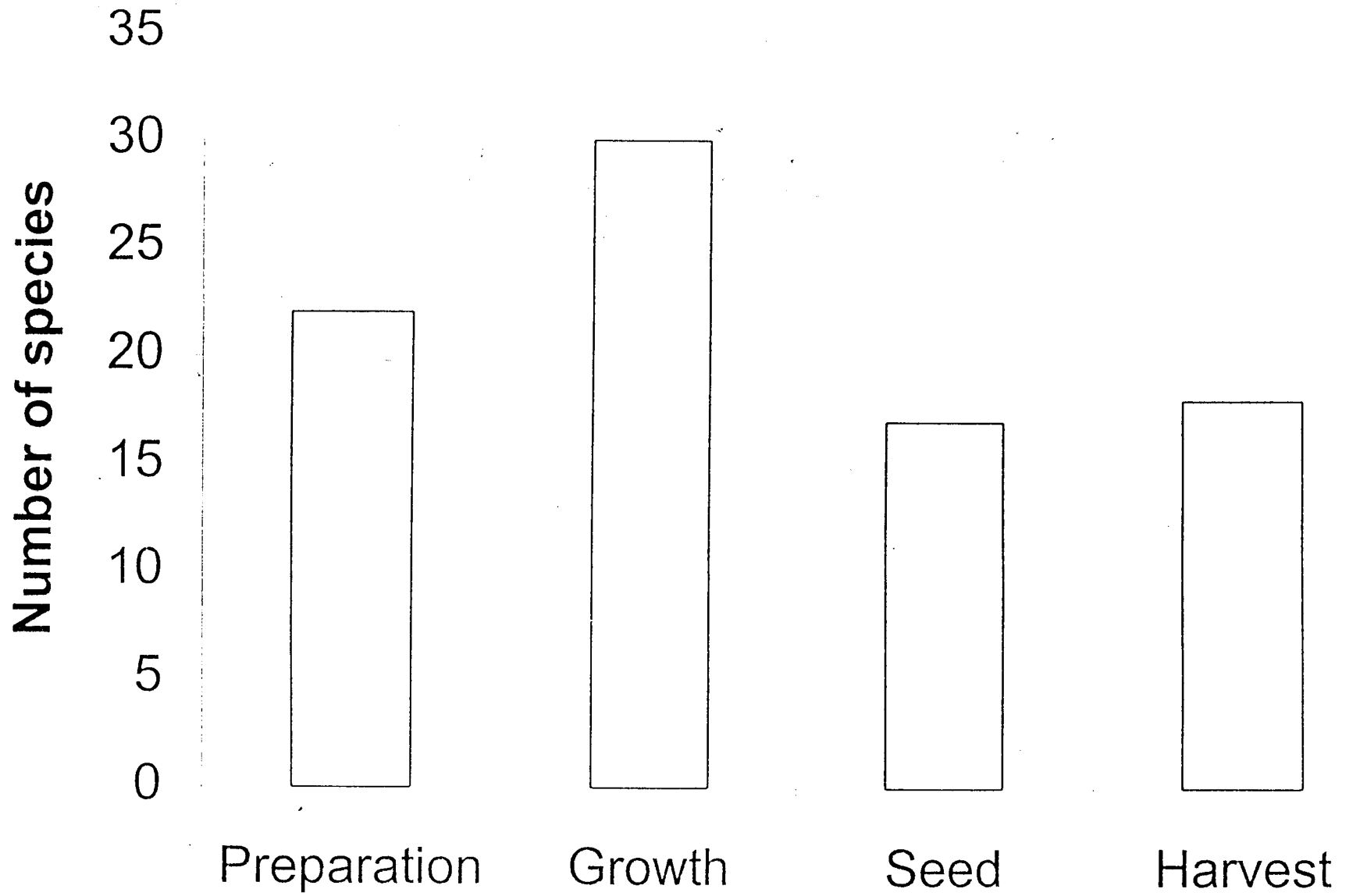


Fig.6.14. The Changes in the number of species observed during four different stages of Crop.III.

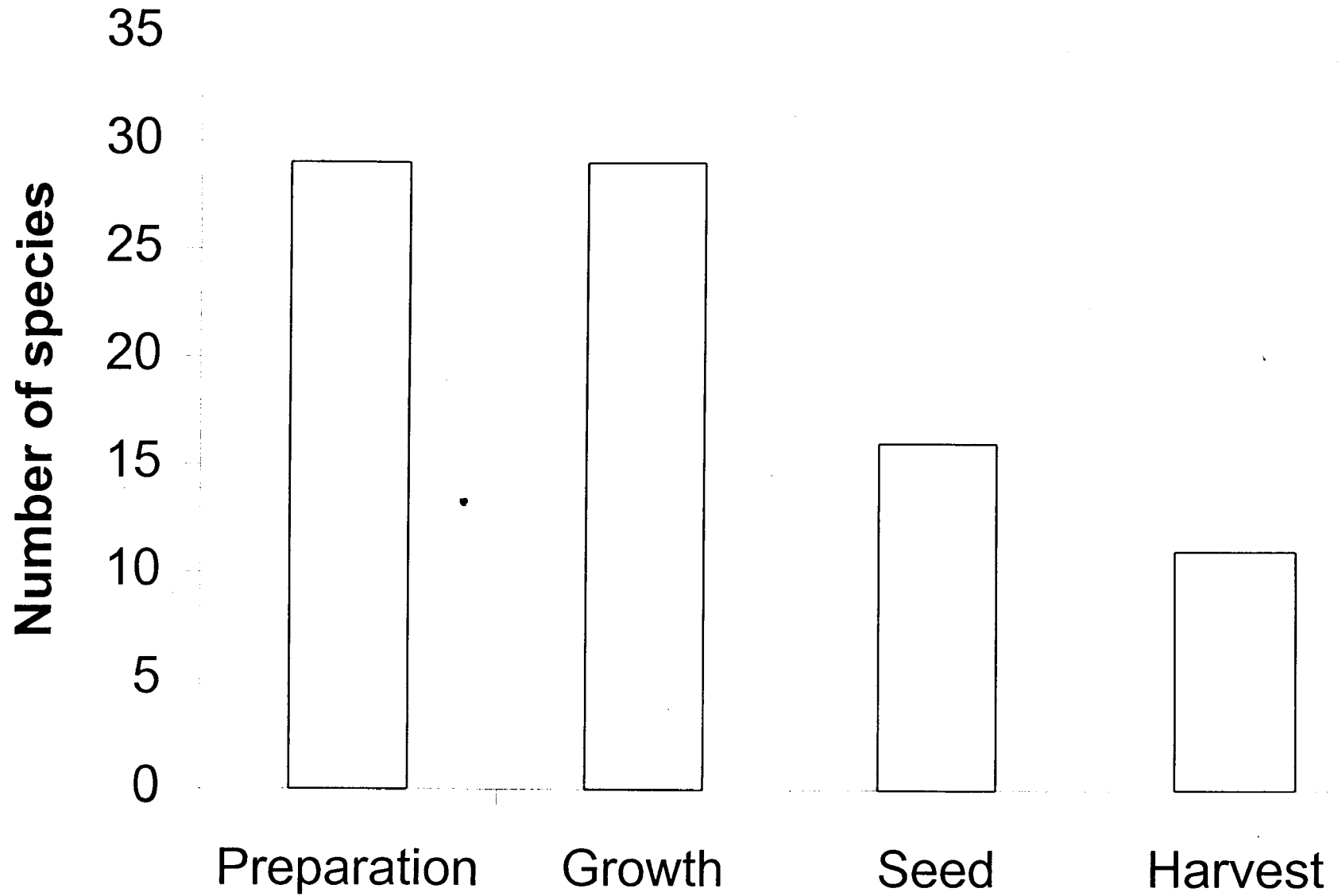


Fig.6.15. The Changes in the number of species observed during four different stages of Crop.IV.

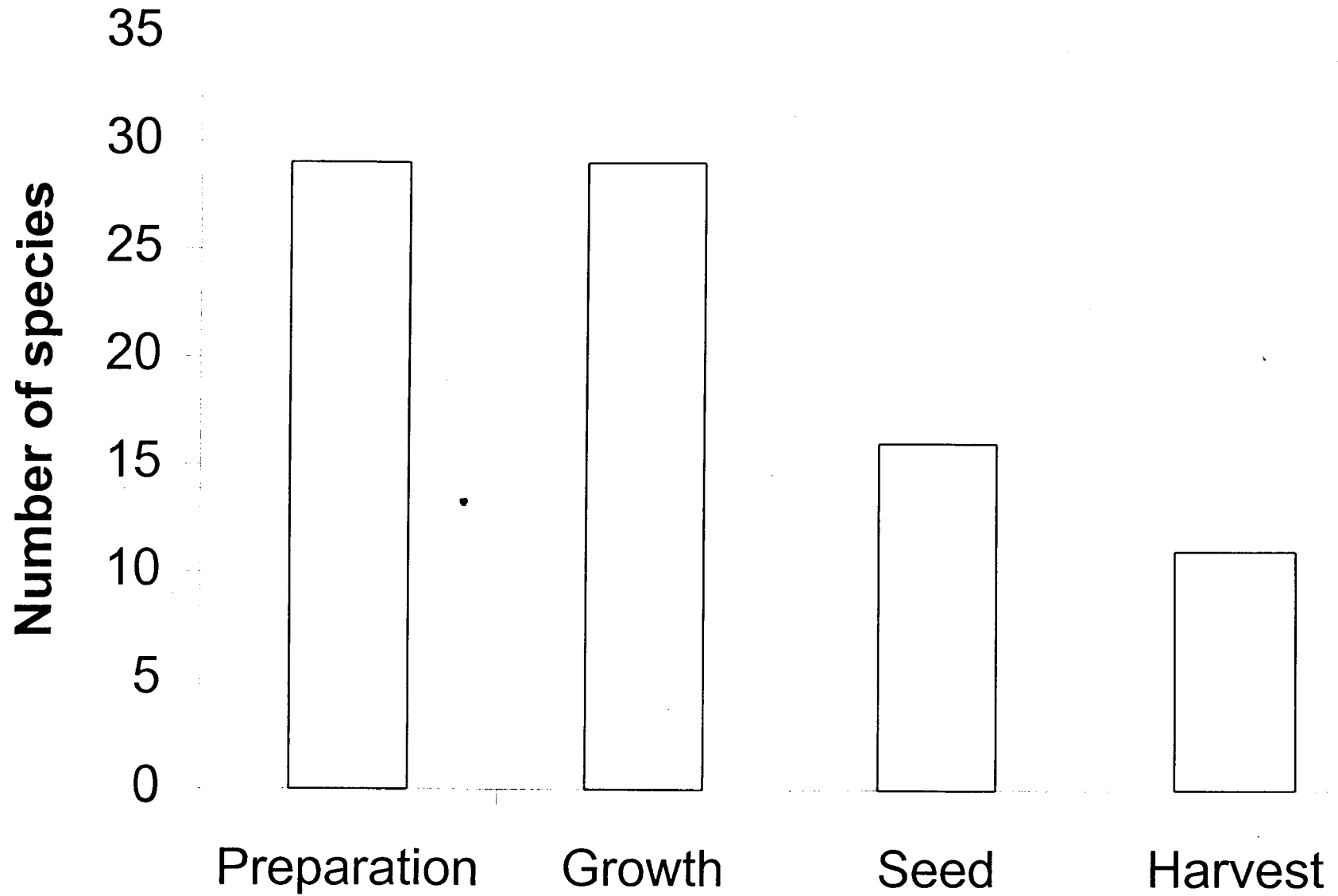


Fig.6.15. The Changes in the number of species observed during four different stages of Crop.IV.

can be analysed to understand the patterns of diversity and the similarity between them. Figure 6.1 gives the total number of wetland birds observed in the paddy fields in four different crops during this study period. The total wetland bird species observed in each of these crops are given in Fig 6.2. The second crop shows the least diversity and abundance of birds. The absence of migratory birds in the monsoon season is the cause for this lesser number. Figure.6.3 shows the composition of bird community observed in the four crops with their status and distribution.

Figures 6.4. to 6.7 gives the distribution of species belonging to the different families in each crop. Here also fig. 6.5 representing the crop2 show a significant difference from those of others which is due to the lack of influence of migratory species.

6.4 Effect of microhabitat variation

Gaston (unpublished) and Kurup (1991) discussed the preferences of wetland birds to the changing microhabitats during the growth of paddy crop. The Figures. 6.8 to 6.15 show changes in the total number of birds and the number of species observed during the four different stages of crops. Each of these stages represents different kind of activities and physical changes in the habitat, which lead to the changes in differences in the microhabitats. Colwell and Dodd (1995) discussed the effect of vegetation height of coastal pastures on the water bird assemblages. They have highlighted the inverse relationship between the vegetation height and the waterbird diversity, densities and species composition. The figures 6.9 to 6.15

show the total birds as well as species decreases in the later stages of the crop growth. Thus the results agrees with the Colwell and Dodd. Moreover this suggest that the changing vegetation characteristics of the paddyfield provides varying microhabitats and allow greater waterbird diversity as well as density in that landscape.

Many migrating shorebirds enter paddy field as an alternative habitat to supplement their usual feeding ground of estuary and other coastal wetlands. Kurup studied the preferences of shorebirds to the different crop stages in the paddy fields of Thirunavaya. This study also agrees with Kurup and Gaston that the different wetland birds show preferences in the use of this habitat, which are depended on the growth stage of the crop. The bird species richness and abundance of wetland birds were maximum during the early stages of preparation and growth in all the crops. The openness of the habitat in the early stages of the crop increases the chance of detecting potential predators; a selective advantage preferred by migrating species flocks. Hence the birds dominating in these stages are the migratory ones primarily belonging to the family Charadriidae and Motacillidae. Similarly the later two stages of the crop with full-grown paddy plants provide a cover to the larger resident birds. Hence larger wading birds like Egrets and Herons are observed using this microhabitat more frequently than those of other stages. Predation on Little egrets by Marsh Harrier observed during the study shows the importance of grown up paddy to the larger wading birds like egrets and herons.

Table 6.5. Status distribution of the wetland birds of Crop 1 for different families

Family	Migrant	Resident	Local Migrant	Total
Ardeidae	0	5	2	7
Accipitridae	0	1	0	1
Rallidae	0	1	0	1
Charadriidae	10	1	0	11
Alcedinidae	0	4	0	4
Motacillidae	4	1	0	5
Total	14	13	2	29

Table 6.6. Status distribution of the wetland birds of Crop 2 for different families

Family	Migrant	Resident	Local Migrant	Total
Phalacrocorac	0	1	0	1
Ardeidae	0	6	2	8
Accipitridae	0	1	0	1
Anatidae	0	0	1	1
Rallidae	0	1	0	1
Charadriidae	0	1	0	1
Alcedinidae	0	4	0	4
Motacillidae	0	1	0	1
Total	0	15	3	18

6.5 Species composition and microhabitat preferences

6.5.1 Crop 1 (Between 5.2.1995 to 3.5.1995)

A Total of 29 wetland associated bird species belonging to 6 families were sighted during the first crop. The family Charadriidae was represented with 11 species followed by Ardeidae (7 species) and Motacillidae (5 species) (Table 6.5). Fourteen species are migrants, including 10 species of shorebirds and four species of wagtails.

The succession of rice field ecosystem is very sequential due to different cultivation practice and growth in a shorter period of time. Hence a sequential change in the avian use of habitat is evident. During the preparatory stage of the paddy a higher number of shore birds observed feeding within the plough field, actively with good number of egrets and herons. Golden plovers and Little Ringed Plovers are the most prominent shore birds of this stage.

The number of birds and species observed were maximum in paddy fields, ploughed and inundated during the preparatory stage. Smaller shorebird species like Little Ringed Plover, Kentish Plover and Golden Plover were found in good numbers during the early stage. Other larger shorebirds such as Marsh Sandpiper and Spotted sandpiper were observed sparingly till the paddy was in a growing stage. While snipes were observed throughout the crop within the paddy field. Among the larger wading birds the Pond heron, Cattle Egret and Little Egrets used the paddy till harvesting stage. The number of Cattle Egrets dominated all

through the crop, whereas the Median Egrets were rarely sighted. During growing stage, Little Green Heron, Chestnut Bittern and Black Bittern were found foraging with in the paddy field. Kingfishers were represented by four species, the most common being the Lesser Pied Kingfisher and the Whitebreasted Kingfisher. Four species of migratory wagtails such as Yellow Wagtail, Yellowheaded Wagtail, Grey Wagtail and White Wagtail showed a preference for the ploughed fields. A breeding pair of Large Pied Wagtail was also observed foraging during the early preparatory stage. In this crop a dominance of migrating shorebirds was observed. The early preparatory and growing stages provided good feeding ground for these migratory shorebirds, which have been refueling for their return migration.

6.5.2 Crop2 (Between 12.5.1995 to 10.10.1995)

Observation was started on 12th May, when the preparatory stage of paddy was initiated. A total of 18 wetland associated bird species belonging to seven families were recorded. The number of wetland birds observed were very low with a high representation of eight species of the family Ardeidae (Table 6.6). No migratory birds were sighted in the paddy field, though migrants have reached in the adjacent wetlands..

In this crop a dominant population of Little Cormorants was observed in the early growing stage of the paddy. These species were breeding near the paddy field during the rainy season. Cattle Egrets have also dominated the bird fauna in the early part, during ploughing and puddling. The locally moving species like

Table 6.7. Status distribution of the wetland birds of Crop 3 for different families

Family	Migrant	Resident	Local Migrant	Total
Phalacrocoracidae	0	1	0	1
Ardeidae	0	5	1	6
Ciconidae	0	0	1	1
Accipitridae	2	1	0	3
Rallidae	0	1	0	1
Charadriidae	11	1	0	12
Alcedinidae	0	4	1	5
Motacillidae	4	1	0	5
Total	17	14	3	34

Table 6.8. Status distribution of the wetland birds of Crop 4 for different families

Family	Migrant	Resident	Local Migrant	Total
Phalacrocoracidae	0	1	0	1
Ardeidae	0	5	1	6
Ciconidae	0	0	1	1
Accipitridae	2	2	0	4
Rallidae	0	1	0	1
Charadriidae	10	2	0	12
Laridae	1	0	0	1
Alcedinidae	0	4	0	4
Motacillidae	4	1	0	5
Total	17	16	2	35

Black Bittern and Chestnut Bittern made their appearance during the growing stage of the paddy. A small number of Lesser Whistling Teals were observed during the growing stage. The breeding Whitebreasted Waterhen have frequented the growing stage and used the half grown paddy for foraging and as cover.

Four species of Kingfishers were observed in the paddy field. Among them, the Whitebreasted Kingfisher was found breeding near the paddy field. Their activity also increased from growing stage and continued till harvesting stage. Many birds were found nesting around the study plot. Pond Heron, Little cormorants, Redwattled Lapwings, Chestnut Bittern, Whitebreasted Waterhen, and Whitebreasted Kingfishers were observed nesting in this area during the monsoon season.

6.5.3 Crop 3 (Between 11.10.1995 to 11.2.1996)

After a good Northeast monsoon shower the preparations for the third crop initiated, in the second week of October. This crop lasted upto mid February, covering 124 days. Altogether 34 species of birds belonging to 7 families were observed. Maximum number of species observed belonged to the family Charadriidae (12 species), followed by Ardeidae (6 species) (Table 6.7). During this crop a dominance of 18 migratory species were noted. The high number was probably due to the influx of commencement of migratory species. Of the 18 species of migrants 11 were shorebirds which were using the paddy crop during the early stage. Golden Plovers were the first to appear in crop, followed by other waders like Little Ringed Plover, Marsh Sandpiper, Green Sandpiper, Wood

Sandpiper and Common Sandpiper. They were seen foraging at the edge of inundated plots with standing paddy but invariably sought refuge among the rice plants.

Migratory raptors like Marsh Harriers and Pale Harriers frequented the paddy fields during the early stage. The movements of these Harriers flushed the populations of egrets and herons from the cover. Snipes were the only shorebird, which used the paddy crop effectively throughout the season. A higher number was observed at the edge of the crop especially during the growing stage.

A high diversity of migratory bird species was noted in the third crop. Besides shorebirds, the migratory wagtails were also noted. Grey Wagtails were the dominant species foraged among the tillers during the growing stage. Locally moving species like the Whitenecked Stork was found towards the seed stage and stayed till harvesting. Three-toed Kingfisher was rarely observed in this crop along with the other four common Kingfisher species.

6.5.4 Crop 4 (Between 12.2.1996 to 11.5.1996)

The third crop of the paddy cultivation was taken up in Paddy growing areas depending upon the availability of the water. This dry season crop spreads from second week of February to mid May. A total of 35 species of birds were observed belonging to 9 families. Maximum number of species observed belonged to the family Charadriidae (12 species) followed by Ardeidae (6 species) and

Motacillidae (5 species) (Table 6.8). Of the 35 species, 17 were migrants, dominated by 10 species of the family Charadriidae.

Shorebirds dominated the scene during the early part of the preparatory stage. Eastern Golden Plover, Little Ringed Plover, Kentish Plover, Green Sandpiper, Spotted Sandpiper and Common Sandpiper were seen in good numbers. The snipes were observed throughout the growth of the paddy hiding at the edge of the bund or among the growing seedlings. Larger birds like Pond Heron and Cattle Egret were seen in good numbers the crop; their presence continued till harvest. Lesser numbers of Median Egrets and Little Egrets were observed. Egrets, Pond Herons and Whitenecked Storks were also recorded during the early preparatory stage of the crop.

Marsh Harrier and Pale Harrier were observed only for a brief of period of time during the preparatory stage. Five species of Wagtails were found using the paddy crop during the early stages. In the third crop a larger number of water bird species were noted. The inundated fields of paddy in the dry summer months attracted waterfowls. Since the shrinking natural wetlands are unable to support the large number of migrants during their onward and return migration, paddy fields are used as feeding ground by these birds, it seems.

6.6 Conclusion

Paddy fields are temporary wetlands with fast changing microhabitat characteristics. Bird community shows variation in accordance with this change of habitats. The bird community variation between the crops indicates the seasonal

fluctuation of the birds of the entire landscape. The major and significant pattern emerging from the analysis of data between the crops shows that the pattern of diversity and density between the crops were mainly influenced by the seasonal migration. The variation of bird assemblage composition between the different stages of the crop indicate that on a very finer level, the diversity changes are determined by the variation in the microhabitats during those stages. Density and diversity of wetland birds observed in the early stages in the growth of paddy were high. Water birds also showed preferences for the microhabitats. Migratory flocks and smaller wading birds preferred more open paddy fields with smaller or no crop plants, whereas resident and larger birds preferred paddy fields with taller paddy plants in the later days of the growth.

SUMMARY AND CONCLUSIONS

Muhammed Jafer.P “Habitat use of birds of north malabar coast with special reference to the white bellied sea eagle, *haliaeetus leucogaster*” Thesis.
Department of Zoology, St. Joseph'S College Devagiri, University of Calicut,
2000

CHAPTER 7. SUMMARY AND CONCLUSIONS

This study was aimed at investigating the patterns in habitat use by wetland birds in North Malabar area in Kannur and Kasaragod district of Kerala. Field observation part of study was carried out between 1992 to 1998.

The study involved a detailed investigation on the ecology and biology of the Whitebellied Sea Eagle. This endangered raptor is the only fish eating Sea Eagle occurring in the study area. A survey for its nests conducted the whole study area has shown that 14 pairs breed in this area every year. The total population of the species in this area is about 39birds. They feed on fishes and sea snakes, which are collected from the sea within the littoral zone, and from the estuaries and the tidal rivers. They start hunting for their prey from morning till evening. The prey animals are brought to the land and eaten by perching on tall trees and the bones are left out. The food of the species comprised crabs like *Scylla serrata*, *Portunus pelagicus* and sea snakes such as *Enhydrina schistosa* and *Lapemis curtus* and fishes like *Scoliodon spp*, *Pampus argentiis*, *Thysariophrys spp.*, *Etroplus suratensis*, *Tilapia mossambica*, etc. We did not see much variation in the selection of prey species by the Whitebellied Sea Eagle in the different months of the year in the study area.

The Whitebellied Sea Eagle in the study area started its breeding activity in October and completed by April. The breeding activity is initiated by bringing

nesting material by both sexes. Courtship displays were often observed, but copulation was observed only once during the study period. Nests are built on tall trees at an average height of 22m. The nesting tree had an average GBH of 3.92m and an average height of 23.6m. Trees such as *Mangifera indica*, *Ficus benghalensis*, *Ficus callosa*, *Hopea ponga*, *Alstonia scholaris*, *Casuarina* sp. were selected for building nests. The nest material comprised of the large twigs of *Mangifera india*, *Loranthus spp*, *Adenanthera pavonina*, *Avicennia officinaslis* etc; which are collected from the vicinity of the nest. In all the cases observed old nests were modified by adding new nest material and used.

In the study area the Whitebellied Sea Eagle start laying eggs in November. Usually one egg is laid though in so many cases I have observed two eggs in the nest. Incubation is carried out by both sexes though female spent more time in the nest. Eggs hatched in 41-43 days. Nothing is known about the disposal of eggshells though some eggshells were found amongst the twigs lining the bottom of the nest. The chicks were fed from the first day of the hatching with sea snakes. Both sexes took part in feeding the chicks. The snakes brought to the nest by the adults are torn into small pieces and given to the chick. The newborn chick is naked. Feathers start growing on the feather tracks on 5-6th day of hatching, first to appear is the rusty golden brown feathers on the head and neck. Darker body feathers appeared later and pins of small dark brown primaries and lighter secondaries emerged. After three weeks the bird become slightly heavier in their

appearance and tinged with golden mottled brown.. Faecal matters of the chick are tossed out of the nest.

A week old chick is fed with fishes and sea snakes. Small fishes and snakes are given intact and larger ones were given in pieces. Two weeks old chick has feathers almost covered the body. Three week old chick is able to start moving and produces weak calls. At this stage the food was eaten independently by chicks and the chicks attempted to get out of the nest by sitting on the rim of the nest and exercising regularly on their wings. On the 34th day the chick gets out of the nest and moved to the adjacent branches. Fledgling start flying on the 39th day. It is able to hunt after 50th days of the hatching. After leaving the nest, the fledgling did not return to the nest site. The average nesting success of the Whitebellied Sea Eagle in the area during the study period was 36.5%. The nesting birds are disturbed by destruction of larger trees and sacred groves on the coastal habitats. Strict conservation measures for the protection of the remaining sacred groves and the larger trees are essential for the survival of the Whitebellied Sea Eagle in the study area. The traditional cultural practices which conserved the big trees in the sacred groves of this primarily wetland dominated landscape, seem to have protected this magnificent bird from extinction in this study area. May be because of the sense of protection, most of the nests identified are in sacred groves. In the context of declining belief systems, sacred groves are being threatened with destruction, which is of a great concern about the survival of this bird in this area in future.

The study also involved an investigation on the patterns of wetland bird community in four different habitats in the coastal north Kerala, an Estuary, Backwater swamp, Riverine wetland and the Inland wetland. . These four habitats represented four different types of wetlands in the North Malabar and also a gradation in the effect of sea in terms of distance and salinity. Regular monthly observation on population and habitat use of birds was conducted to investigate the changes in species composition in the community, in these different habitats. The results showed the diversity of microhabitats determines the choice of habitats and hence the distribution of the birds.

In all these places the bird species and their numbers met with in the different months of the year were recorded for a period from May 1994 to May 1996, covering two migratory seasons. Chembullikundu backwater swamp supported a rich avifauna. Sixtythree species of wetland birds belonged to 14 families were recorded here. Of these 30 species are migrants. Fiftysix species of wetland birds belonged 7 families were observed at Madackara estuary including a high number of 36 species of migrants. Fiftyfive species of wetland birds were observed in the riverine bank wetlands of Payangadi and 47 species in the inland wetlands of Kuniyan. The bird population was found to fluctuate in different months mostly due to the influx of migrants. The changes in microhabitat caused by the land use pattern, mostly agriculture and the movements of the resident wading birds such as egrets, herons, bitterns and cormorants have also contributed

to the population fluctuation here. Of the four wetland areas studied, Chemballikundu showed a high diversity, this is due to the large number of microhabitat, which attracted the different species of migrants as well as residents. This area is also known to harbour a large number of crustaceans, molluscs and fishes besides a fairly rich growth of mangroves and reed beds, which form a hiding place for number of wading birds

Migrants start coming by late August and their number gradually increases by December. They start leaving by April or May. However a spurt in their numbers during September and April could be attributed to the passage migrants, which might be using the area as a stop over. A small population of plovers and terns were observed over-wintering in the area. A decline of the resident bird population was noted during monsoon months, which is due to their departure for breeding elsewhere. Little Cormorants and Pond Herons nested in colonies in the neighbouring areas from June to August.

Besides these 4 natural wetlands, the avian utilization of a paddy field also been studied in four continuous cropping seasons in the year 1995-96. Growth of the paddy crop is divided into four stages viz., preparatory stage, growing stage, seed stage and harvest stage. The diversity and abundance of wetland birds observed in the four stages of each crop varied with the changing microhabitat. In the first crop a total of 29 wetland birds belonged to 6 families were recorded and the 2nd crop had 18 species which belonged to 8 families. Third and 4th crops are comparatively richer in species and represented by 34 and 35 species of wetland

birds respectively. The four stages of the crop accommodated different species of wetland birds. The species richness and the abundance of wetland birds were maximum during the stages of preparation and early growth of seedlings. In all crops migratory wading birds like plovers preferred more open paddy fields with smaller or no crop plants, whereas resident and larger wading birds like herons and egrets preferred paddy fields with taller paddy plants in the later days of the crop. This could be attributed to the safety they get from predation, a hypothesis that has to be tested in detail. However some rare incidences of predation and predation attempt on the wetland birds by raptors like the Marsh Harrier seem to support this hypothesis.

The coastal zone itself is an endangered ecosystem, and its conservation is essential for conservation of its fauna particularly the bird community which include, both the residents and migrant species as well as the globally threatened species like the Whitebellied Sea Eagle. The north Malabar coast still harbours a fairly rich and diverse bird fauna. A number of bird species such as the Glossy Ibis, Ringed Plover, Whitebellied Sea Eagle, etc. Which are not met with in the south and central Kerala are observed here. Species like Pintail, Blackwinged Stilt, Large Indian Pratincole, Bartailed Godwit, Ringed Plover, Sandwich Tern which are reported to be rare by investigators like Salim Ali in the other parts of the state are found to occur in fairly good numbers in this area. However this part of Kerala is also being subjected to human pressure like aquaculture and various

developmental activities. The increased number of Little Cormorants, which are reported to be rare or absent by earlier investigators could be due to the changes taking place in the habitat by intensive aquaculture, practices. The absence of Darter in the area could also be attributed to the changes in the habitat consequent to the land use pattern. The following are some recommendations for the conservation of this wetlands and wetland birds, brought out from this study.

1. All the activities, which are harmful to the coastal habitat, should be stopped to conserve the remaining biodiversity in coastal north Malabar. The government departments should be persuaded to have strict environmental Impact assessment before the implementation of any Project in this area.
2. The local people should be made aware of the importance of coastal zone including wetlands and its flora and fauna particularly birds. NGOs and individual bird watchers could take up this matter seriously and they should be encouraged.
3. Generate public opinion to pressurise the local bodies and the state Government to implement the Wetland Conservation Act and Coastal Regulation Zone Act effectively. This could reduce and control the pressure on Wetlands and Waterfowls .

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APPENDIX. I

A Systematic List of Birds of Coastal North Malabar

Order/Family/Species	Scientific Name	Madackara	Chembalikunc	Payangadi	Kuniyan	Edattummal
Order: Podicipidiformes						
Family: Podicipididae						
Little Grebe	<i>Podiceps ruficollis</i>	-	+	+	+	-
Order : Pelicaniformes		-	-	-	-	-
Family : Pelecanidae		-	-	-	-	-
Masked Booby	<i>Sula dactylatra</i>	-	-	-	-	-
Family : Phalacrocoracidae		-	-	-	-	-
Indian Shag	<i>Phalacrocorax fuscicollis</i>	-	-	-	-	-
Little Cormorant	<i>Phalacrocorax niger</i>	+	+	+	+	+
Family : Fregatidae		-	-	-	-	-
Lesser Frigate Bird	<i>Fregata minor</i>	-	-	-	-	-
Order: Ciconiiformes		-	-	-	-	-
Family : Ardeidae		-	-	-	-	-
Grey Heron	<i>Ardea cinerea</i>	+	+	+	+	-
Purple Heron	<i>Ardea purpurea</i>	-	+	+	+	-
Little Green Heron	<i>Ardeola striatus</i>	+	+	+	+	+
Pond Heron	<i>Ardeola grayii</i>	+	+	+	+	+
Cattle Egret	<i>Bubulcus ibis</i>	-	+	+	+	+
Large Egret	<i>Ardea alba</i>	+	+	+	+	+
Smaller Egret	<i>Egretta intermedia</i>	+	+	+	+	+
Little Egret	<i>Egretta garzetta</i>	+	+	+	+	+
Indian Reef Heron	<i>Egretta gularis</i>	+	-	+	+	-
Night Heron	<i>Nycticorax nycticorax</i>	+	+	+	+	+
Tiger Bittern	<i>Gorsachius melanolophus</i>	-	-	-	-	-
Chestnut Bittern	<i>Ixobrychus cinnamomeus</i>	-	+	+	+	+
Yellow Bittern	<i>Ixobrychus sinensis</i>	-	+	+	+	+
Black Bittern	<i>Ixobrychus flavicollis</i>	+	+	+	+	+
Family : Ciconiidae		-	-	-	-	-
Painted Stork	<i>Mycteria leucocephala</i>	-	-	+	+	-
Openbill stork	<i>Anastomus oscitans</i>	-	+	-	+	-

Whitenecked Stork	<i>Ciconia episcopus</i>	+	+	+	+	+
White Stork	<i>Ciconia ciconia</i>	-	+	-	+	-
Family : Threskiornithidae		-	-	-	-	-
White Ibis	<i>Threskiornis aethiopica</i>	-	-	-	+	-
Glossy Ibis	<i>Plegadis falcinellus</i>	-	-	+	-	-
Spoonbill	<i>Platalea leucorodia</i>	-	+	+	-	-
Order: Anseriformes		-	-	-	-	-
Family : Anatidae		-	-	-	-	-
Lesser Whistling Teal	<i>Dendrocygna javanica</i>	-	+	-	+	+
Pintail	<i>Anas acuta</i>	-	+	+	-	-
Common Teal	<i>Anas crecca</i>	-	+	-	-	-
Spotbilled Duck	<i>Anas poecilorhyncha</i>	+	-	-	-	-
Garganey	<i>Anas querquedula</i>	-	+	+	+	-
White-eyed Pochard	<i>Aythya nyroca</i>	-	-	-	+	-
Cotton Teal	<i>Nettapus coromandelianus</i>	-	+	-	+	-
Order : Falconiformes		-	-	-	-	-
Family: Accipitridae		-	-	-	-	-
Blackwinged Kite	<i>Elanus caeruleus</i>	-	+	+	+	+
Honey Buzzard	<i>Pernis ptilorhyncus</i>	-	-	-	+	+
Pariah Kite	<i>Milvus migrans</i>	+	+	+	+	+
Brahminy Kite	<i>Haliastur indus</i>	+	+	+	+	+
Shikra	<i>Accipiter badius</i>	+	+	+	+	+
Crested Hawk- Eagle	<i>Spizaetus cirrhatus</i>	-	-	-	+	-
Whitebellied Sea Eagle	<i>Haliaeetus leucogaster</i>	+	+	+	+	+
Indian Whitebacked Vulture	<i>Gyps bengalensis</i>	-	-	-	-	-
Pale Harrier	<i>Circus macrourus</i>	-	+	+	+	+
Marsh Harrier	<i>Circus aeruginosus</i>	-	+	+	+	+
Crested Serpent Eagle	<i>Spilornis cheela</i>	-	+	+	-	-
Osprey	<i>Pandion haliaetus</i>	+	+	+	-	-
Family: Falconidae		-	-	-	-	-
Peregrine Falcon	<i>Falco peregrinus</i>	-	+	+	-	-
Kestrel	<i>Falco tinnunculus</i>	-	+	-	-	-
Order::Galliformes		-	-	-	-	-
Family: Phasianidae		-	-	-	-	-
Red Spurfowl	<i>Galloperdix spadicea</i>	-	+	+	+	-

Grey Junglefowl	<i>Gallus sonneratii</i>	-	-	+	+	-
Common Peafowl	<i>Pavo cristatus</i>	-	-	-	+	-
Order: Gruiformes		-	-	-	-	-
Family: Rallidae		-	-	-	-	-
Bluebreasted Banded Rail	<i>Rallus striatus</i>	+	+	+	+	-
Banded Crake	<i>Rallina eurizonoides</i>	-	+	-	-	-
Baillon's Crake	<i>Porzana pusilla</i>	+	-	+	-	-
Ruddy Crake	<i>Porzana fusca</i>	+	+	+	-	-
Whitebreasted Waterhen	<i>Amaurornis phoenicurus</i>	+	+	+	+	+
Water Cock	<i>Galicrex cinerea</i>	-	-	-	+	-
Moorhen	<i>Gallinula chloropus</i>	-	+	-	-	-
Purple Moorhen	<i>Porphyrio porphyrio</i>	-	+	+	+	-
Coot	<i>Fulica atra</i>	-	-	-	+	-
Order: Charadriiformes		-	-	-	-	-
Family : Jacanidae		-	-	-	-	-
Pheasant-tailed Jacana	<i>Hydrophasianus chirurgus</i>	-	+	-	+	-
Bronzewinged Jacana	<i>Metopidius indicus</i>	-	+	+	+	-
Family ; Haematopodidae		-	-	-	-	-
Oystercatcher	<i>Haematopus ostralegus</i>	+	-	-	-	-
Family : Rostratulidae		-	-	-	-	-
Painted Snipe	<i>Rostratula benghalensis</i>	-	+	+	+	-
Family : Recurvirostridae		-	-	-	-	-
Blackwinged Stilt	<i>Himantopus himantopus</i>	-	+	+	+	-
Avocet	<i>Recurvirostra avosetta</i>	+	-	-	-	-
Family: Dromadidae		-	-	-	-	-
Crab Plover	<i>Dromas ardeola</i>	+	-	-	-	-
Family :Burhinidae		-	-	-	-	-
Stone Curlew	<i>Burhinus oedicephalus</i>	-	+	+	-	-
Family : Glareolidae		-	-	-	-	-
Large Indian Pratincole	<i>Glareola pratincola maldivarum</i>	-	+	+	-	-
Smal Indian Pratincole	<i>Glareola lactea</i>	+	+	+	-	-
Family : Charadriidae		-	-	-	-	-
Redwattled Lapwing	<i>Vanellus indicus</i>	+	+	+	+	+
Yellowwattled Lapwing	<i>Vanellus malabaricus</i>	-	-	+	+	+
Grey Plover	<i>Pluvialis squatarola</i>	+	+	+	-	-

Eastern Golden Plover	<i>Pluvialis dominica</i>	+	+	+	+	+
Large Sand Plover	<i>Charadrius leschenaultii</i>	+	+	+	-	-
Ringed Plover	<i>Charadrius hiaticula</i>	-	-	-	+	+
Little Ringed Plover	<i>Charadrius dubius curonicus</i>	+	+	+	+	+
Indian Little Ringed Plover	<i>Charadrius dubius jerdoni</i>	+	+	+	+	+
Kentish Plover	<i>Charadrius alexandrinus</i>	+	+	+	+	+
Lesser Sand Plover	<i>Charadrius mongolus</i>	+	+	+	-	-
Whimbrel	<i>Numenius phaeopus</i>	+	+	+	-	-
Curlew	<i>Numenius arquata</i>	+	+	+	-	-
Blacktailed Godwit	<i>Limosa limosa</i>	+	-	-	-	-
Bartailed Godwit	<i>Limosa lapponica</i>	+	+	+	-	-
Red Shank	<i>Tringa totanus</i>	+	+	+	+	+
Marsh Sandpiper	<i>Tringa stagnatilis</i>	-	+	+	+	+
Greenshank	<i>Tringa nebularia</i>	+	+	+	+	+
Green Sandpiper	<i>Tringa ochropus</i>	-	+	+	+	+
Wood Sandpiper	<i>Tringa glareola</i>	+	+	+	+	+
Terek Sandpiper	<i>Tringa terek</i>	+	+	+	-	-
Common Sandpiper	<i>Tringa hypoleucos</i>	+	+	+	+	+
Turnstone	<i>Arenaria interpres</i>	-	+	+	-	-
Pintail Snipe	<i>Gallinago stenura</i>	-	+	+	+	+
Fantail Snipe	<i>Gallinago gallinago</i>	-	+	+	+	+
Jack Snipe	<i>Gallinago minima</i>	-	+	+	-	-
Eastern Knot	<i>Calidris tenuirostris</i>	+	-	-	-	-
Sanderling	<i>Calidris alba</i>	+	-	+	-	-
Little Stint	<i>Calidris minuta</i>	+	+	+	+	-
Temminck's Stint	<i>Calidris temminckii</i>	+	-	-	-	-
Dunlin	<i>Calidris alpina</i>	+	-	-	-	-
Curlew Sandpiper	<i>Calidris testacea</i>	+	+	+	-	-
Broadbilled Sandpiper	<i>Limicola falcinellus</i>	+	+	-	-	-
Family ; Laridae		-	-	-	-	-
Herring Gull	<i>Larus argentatus</i>	+	-	-	-	-
Lesser Blackbacked Gull	<i>Larus fuscus</i>	+	+	-	-	-
Great Blackheaded Gull	<i>Larus ichthyæetus</i>	+	-	-	-	-
Brownheaded Gull	<i>Larus brunnicephalus</i>	+	+	+	-	-
Blackheaded Gull	<i>Larus ridibundus</i>	+	-	-	-	-

Whiskered Tern	<i>Chlidonias hybrida</i>	+	+	+	+	+
Gullbilled Tern	<i>Geochelidon nilotica</i>	+	+	-	-	-
Caspian Tern	<i>Hydroprogne caspia</i>	+	-	-	-	-
Indian River Tern	<i>Sterna aurantia</i>	-	-	+	-	-
Common Tern	<i>Sterna hirundo</i>	+	-	+	-	-
Sooty Tern	<i>Sterna fuscata</i>	-	-	-	-	-
Little Tern	<i>Sterna albifrons</i>	-	+	-	-	-
Large Crested Tern	<i>Sterna bergii</i>	+	-	-	-	-
Indian Lesser Crested Tern	<i>Sterna benghalensis</i>	+	-	-	-	-
Sandwich Tern	<i>Sterna sandvicensis</i>	+	-	-	-	-
Order: Columbiformes		-	-	-	-	-
Family ; Columbidae		-	-	-	-	-
Greyfronted Green Pigeon	<i>Treron pampadora</i>	-	-	-	+	-
Yelowlegged Green Pigeon	<i>Treron phoenicoptera</i>	-	-	-	-	+
Blue Rock Pigeon	<i>Columba livia</i>	-	-	+	+	+
Spotted dove	<i>Streptopelia chinensis</i>	+	+	+	+	+
Emerald Dove	<i>Chalcophaps indica</i>	-	-	-	-	-
Order : Psittaciformes		-	-	-	-	-
Roseringed Parakeet	<i>Psittacula krameri</i>	-	+	+	+	+
Blossomheaded Parakeet	<i>Psittacula cyanocephala</i>	-	-	-	-	+
Lorikeet	<i>Loriculus vernalis</i>	-	-	+	+	+
Order: Cuculiformes		-	-	-	-	-
Family: Cuculidae		-	-	-	-	-
Pied Crested Cuckoo	<i>Clamator jacobinus</i>	-	-	+	-	-
Comon Hawk- Cuckoo	<i>Cuculus varius</i>	-	-	+	+	-
Indian Cuckoo	<i>Cuculus micropterus</i>	-	-	-	-	-
Indian Banded Bay Cuckoo	<i>Cacomantis sonneratii</i>	-	-	-	-	-
Koel	<i>Eudynamys scolopacea</i>	-	+	+	+	+
Small Greenbilled Malkoha	<i>Rhopodytes viridirostris</i>	-	-	-	-	-
Crow Pheasant	<i>Centropus sinensis</i>	+	+	+	+	+
Order : Strigiformes		-	-	-	-	-
Family : Strigidae		-	-	-	-	-
Barn Owl	<i>Tyto alba</i>	-	-	+	-	-
Collared Scops Owl	<i>Otus bakkamoena</i>	-	-	-	+	-
Jungle Owlet	<i>Glaucidium radiatum</i>	-	-	-	-	-

Spotted Owlet	<i>Athene brama</i>	-	-	+	+	+
Brown Hawk Owl	<i>Ninox scutulata</i>	-	-	-	-	-
Mottled Wood Owl	<i>Strix ocellata</i>	-	-	-	-	-
Order : Caprimulgiformes		-	-	-	-	-
Family: Caprimulgidae		-	-	-	-	-
Common Indian Nightjar	<i>Caprimulgus asiaticus</i>	-	-	-	-	-
Order : Apodiformes		-	-	-	-	-
Family : Apodidae		-	-	-	-	-
Large Brownthroated spinetail Swift	<i>Chaetura gigantea</i>	-	-	-	+	+
House Swift	<i>Apus affinis</i>	+	+	+	+	+
Palm Swift	<i>Cypsiurus parvus</i>	+	+	+	+	+
Order ; Coraciiformes		-	-	-	-	-
Family ; Alcedinidae		-	-	-	-	-
Lesser Pied Kingfisher	<i>Ceryle rudis</i>	+	+	+	+	+
Common Kingfisher	<i>Alcedo atthis</i>	+	+	+	+	+
Threetoed Kingfisher	<i>Ceyx erithacus</i>	-	-	-	+	+
Storkbilled Kingfisher	<i>Pelargopsis capensis</i>	+	+	+	+	+
Whitebreasted Kingfisher	<i>Halcyon smyrensis</i>	+	+	+	+	+
Blackcapped Kingfisher	<i>Halcyon pileata</i>	+	-	+	-	-
Family : Meropidae		-	-	-	-	-
Bluetailed Bee-eater	<i>Merops philippinus</i>	+	+	+	+	+
Small Green Bee-eater	<i>Merops orientalis</i>	+	+	+	+	+
Family : Coraciidae		-	-	-	-	-
Indian Roller	<i>Coracias benghalensis</i>	-	+	+	+	+
Family : Upupidae		-	-	-	-	-
Hoopoe	<i>Upupa epops</i>	-	-	-	+	+
Order : Piciformes		-	-	-	-	-
Family : Capitonidae		-	-	-	-	-
Small Green Barbet	<i>Megalama viridis</i>	-	-	-	+	+
Crimsonthroated Barbet	<i>Megalaima rubricapilla</i>	-	-	-	-	+
Crimsonbreasted Barbet	<i>megalaima haemacephala</i>	-	-	-	-	-
Family : Picidae		-	-	-	-	-
Goldenbacked Woodpecker	<i>Dinopium benghalense</i>	-	-	-	+	+
Pigmy Woodpecker	<i>Picoides nanus</i>	-	-	-	-	-
Yellowfronted Pied Woodpecker	<i>Picoides mahrattensis</i>	-	-	-	-	-

Order : Passeriformes		-	-	-	-	-
Family : Alaudidae		-	-	-	-	-
Bush Lark	<i>Mirafra assamica</i>	-	-	+	-	+
Ashycrowned Finch-Lark	<i>Eremopterix grisea</i>	-	+	+	+	+
Short-Toed Lark	<i>Calandrella cinerea</i>	-	+	+	-	-
Malabar Crested Lark	<i>Galerida malabarica</i>	-	+	+	+	+
Eastern Skylark	<i>Alauda gulgula</i>	-	-	+	+	-
Family : Hirundinidae		-	-	-	-	-
Plain Sand Martin	<i>Riparia paludicola</i>	-	+	-	-	-
Eastern Swallow	<i>Hirundo rustica</i>	+	+	+	+	+
Wiretailed Swallow	<i>Hirundo smithii</i>	+	+	+	+	+
Redrumped Swallow	<i>Hirundo daurica</i>	+	+	+	+	+
Family : Laniidae		-	-	-	-	-
Baybacked Shrike	<i>Lanius vittatus</i>	-	+	+	-	-
Rufousbacked Shrike	<i>Lanius schach</i>	+	+	+	+	-
Brown Shrike	<i>Lanius cristatus</i>	-	+	+	+	-
Family : Oriolidae		-	-	-	-	-
Golden Oriole	<i>Oriolus oriolus</i>	-	+	+	+	+
Blackheaded Oriole	<i>Oriolus xanthornus</i>	-	-	-	+	+
Family : Dicruridae		-	-	-	-	-
Black Drongo	<i>Dicrurus adsimilis</i>	+	+	+	+	+
Grey Drongo	<i>Dicrurus leucophaeus</i>	-	-	+	+	+
Greater Racket-tailed Drongo	<i>Dicrurus paradiseus</i>	-	-	-	-	-
Family ; Artamidae		-	-	-	-	-
Ashy Swallow Shrike	<i>Artamus fuscus</i>	+	+	+	+	+
Family : Sturnidae		-	-	-	-	-
Greyheaded Myna	<i>Sturnus malabaricus</i>	-	-	-	+	+
Blyth's Myna	<i>Sturnus malabaricus blythi</i>	-	-	-	+	+
Brahminy Myna	<i>Sturnus pagodarum</i>	-	-	-	-	-
Common Myna	<i>Acridotheres tristis</i>	-	+	+	+	+
Jungle Myna	<i>Acridotheres fuscus</i>	-	-	-	+	+
Family : Corvidae		-	-	-	-	-
Indian Tree Pie	<i>Dendrocitta vagabunda</i>	-	-	+	+	+
House Crow	<i>Corvus splendens</i>	+	+	+	+	+
Jungle Crow	<i>Corvus macrorhynchos</i>	+	+	+	+	+

Family : Campephagidae

Large Cuckoo Shrike	<i>Coracina novaehollandiae</i>	-	-	-	-	-
Blackheaded Cuckoo-Shrike	<i>Coracina melanoptera</i>	-	-	-	+	+
Scarlet Minivet	<i>Pericrocotus flammeus</i>	-	-	-	-	-
Small Minivet	<i>Pericrocotus cinnamomeus</i>	-	-	-	-	+

Family : Irenidae

Common Iora	<i>Aegithina tiphia</i>	-	+	+	+	+
Goldfronted Chloropsis	<i>Chloropsis aurifrons</i>	-	-	-	-	+
Goldmantled Chloropsis	<i>Chloropsis cochinchinensis</i>	-	-	-	-	-

Family : Pycnonotidae

Redwhiskered Bulbul	<i>Pycnonotus jocosus</i>	-	+	+	+	+
Redvented Bulbul	<i>Pycnonotus cafer</i>	-	-	-	-	+
Whitebrowed Bulbul	<i>Pycnonotus luteolus</i>	-	-	-	-	-

Family : Muscicapidae

Jungle Babbler	<i>Turdoides striatus</i>	-	-	-	+	-
Whiteheaded Babbler	<i>Turdoides affinis</i>	-	-	-	-	+
Brown Flycatcher	<i>Muscicapa latirostris</i>	-	-	-	-	+
Whitebrowed Fantail Flycatcher	<i>Rhipidura aureola</i>	-	-	-	+	+
Paradise Flycatcher	<i>Terpsiphone paradisi</i>	-	-	-	-	+
Streaked Fantail Warbler	<i>Cisticola juncidis</i>	-	+	+	+	+
Franklin's Wren Warbler	<i>Prinia hodgsonii</i>	-	+	+	+	+
Plain Wren Warbler	<i>Prinia subflava</i>	-	+	-	+	-
Ashy Wren Warbler	<i>Prinia socialis</i>	+	+	+	+	+
Tailor Bird	<i>Orthotomus sutorius</i>	-	-	-	-	+
Indian Great Reed Warbler	<i>Acrocephalus stentoreus</i>	-	+	+	+	+
Blyth's Reed Warbler	<i>Acrocephalus dumetorum</i>	-	+	+	+	+
Leaf Warbler	<i>Phylloscopus trochiloides</i>	-	-	-	+	-
Magpie Robin	<i>Copsychus saularis</i>	-	-	-	+	+
Pied Bush Chat	<i>Saxicola caprata</i>	-	+	-	-	-
Stone Chat	<i>Saxicola torquata</i>	-	-	-	-	-
Desert Wheatear	<i>Oenanthe deserti</i>	-	-	-	-	-
Indian Robin	<i>Saxicoloides fulicata</i>	-	-	+	-	+

Family : Motacillidae

Paddyfield Pipit	<i>Anthus novaeseelandiae</i>	-	+	+	+	+
Rechard's Pipit	<i>Anthus novaeseelandiae richardi</i>	-	-	-	+	-

Yellow Wagtail	<i>Motacilla flava</i>	-	-	-	+	+
Yellowheaded Wagtail	<i>Motacilla citreola</i>	-	-	-	+	+
Grey Wagtail	<i>Motacilla cinerea</i>	-	-	-	+	+
White Wagtail	<i>Motacilla alba</i>	-	-	-	+	+
Large Pied Wgtail;	<i>Motacilla maderaspatensis</i>	+	+	+	+	+
Family : Dicaeidae		-	-	-	-	-
Thickbilled Flowerpecker	<i>Dicaeum agile</i>	-	-	-	-	-
Tickell's Flowerpecker	<i>Dicaeum erythrorhynchos</i>	-	-	-	+	-
Family : Nectariniidae		-	-	-	-	-
Purplerumped Sunbird	<i>Nectarinia zeylonica</i>	-	-	-	-	+
Loten's Sunbird	<i>Nectarinia lotenia</i>	-	-	-	-	-
Purple Sunbird	<i>Nectarinia asiatica</i>	-	-	-	-	+
Family : Ploceidae		-	-	-	-	-
House Sparrow	<i>Passer domesticus</i>	-	-	-	-	-
Yellowthroated Sparrow	<i>Petronia xanthocollis</i>	-	+	-	+	+
Baya	<i>Ploceus philippinus</i>	+	+	+	+	+
Streaked Weaver Bird	<i>Ploceus manyar</i>	-	-	+	+	+
Whitebacked Munia	<i>Lonchura striata</i>	-	-	+	+	+
Spotted Munia	<i>Lonchura punctulata</i>	-	-	+	+	+
Whitethroated munia	<i>Lonchura malabarica</i>	-	-	+	+	-
Blackheaded Munia	<i>Lonchura malacca</i>	-	+	+	+	+

APPENDIX II.

Checklist of wetland associated plants of the study area

Family	Species
Acanthaceae	<i>Acanthus ilicifolius</i> <i>Hygrophila angustifolia</i> <i>Hygrophila schulli</i>
Amaranthaceae	<i>Achyranthus aspera</i>
Amarillidaceae	<i>Crinum defixum</i> <i>Sessamum indicum</i>
Apocynaceae	<i>Cerbera manghas</i>
Asteraceae	<i>Epaltes sp.</i> <i>Sphaeranthus indicus</i>
Avicenniaceae	<i>Avicennia marina</i> <i>Avicennia officinalis</i>
Bignoniaceae	<i>Dolichandrone spathaceae</i>
Caesalpinaceae	<i>Caesalpinia Nuga</i>
Clusiaceae	<i>Calophyllum inophyllum</i>
Companulaceae	<i>Sphaenoclea zeylanica</i>
Convolvulaceae	<i>Ipomoea biloba</i> <i>Ipomoea companulata</i>

	<i>Rotala malambuzhensis</i>
Malvaceae	
	<i>Hibiscus tiliaceus</i>
Marsiliaceae	
	<i>Marsilia quadrifolia</i>
Melastomaceae	
	<i>Melastoma malabathricum</i>
	<i>Memecylon sp.</i>
Mimosae	
	<i>Mimosa pudica</i>
Myrsilanaceae	
	<i>Aegiceras corniculatum</i>
Myrsinaceae	
	<i>Ardisia littoralis</i>
Myrtaceae	
	<i>Syzigium calophyllifolia</i>
Nymphaeaceae	
	<i>Nymphaea nouchali</i>
	<i>Nymphoides indica</i>
Onagraceae	
	<i>Ludwigia sp.</i>
Pandanaceae	
	<i>Pandanus tectorius</i>
Papilionaceae	
	<i>Dalbergia candenatensis</i>
	<i>Dalbergia spinosa</i>
Poaceae	
	<i>Cyanodon dactylon</i>
	<i>Panicum sp.</i>
	<i>Sacciolepis sp.</i>
Pontederiaceae	
	<i>Monochoria vaginalis</i>
Pteridaceae	

	<i>Ipomoea sepiaria</i>
Cyperaceae	
	<i>Cyperus difformis</i>
	<i>Cyperus haspen</i>
	<i>Cyperus malaccensis</i>
	<i>Cyperus pumilus</i>
	<i>Elaeocharis sp.</i>
	<i>Fimbristylis aestivalis</i>
	<i>Fimbristylis ferruginea</i>
	<i>Fimbristylis miliaceae</i>
	<i>Fimbristylis ovatus</i>
	<i>Fimbristylis spp.</i>
	<i>Mariscus javanicus</i>
	<i>Pycreus polystachyon</i>
Droseraceae	
	<i>Drosera indica</i>
Euphorbiaceae	
	<i>Excoecaria agallocha</i>
Fabaceae	
	<i>Crotalaria pallida</i>
	<i>Crotalaria quinquefolia</i>
	<i>Crotalaria retusa</i>
	<i>Crotalaria striata</i>
	<i>Derris trifoliata</i>
	<i>Geissaspis cristata</i>
	<i>Pongamia pinnata</i>
Lecythidaceae	
	<i>Careya arborea</i>
Lentibulariaceae	
	<i>Utricularia sp.</i>
Lythraceae	
	<i>Rotala malabarica</i>

	<i>Acrostichum aureum</i>
Rhizophoraceae	<i>Bruguiera cylindrica</i>
	<i>Carallia brachiata</i>
	<i>Kandelia candal</i>
	<i>Rhizophora apiculata</i>
	<i>Rhizophora mucronata</i>
Rubiaceae	<i>Morinda citrifolia</i>
Scrophulariaceae	<i>Bacopa moneiri</i>
	<i>Limnophila heterophylla</i>
Soneratiaceae	<i>Sonneratia alba</i>
	<i>Sonneratia caseolaris</i>
Verbenaceae	<i>Clerodendrum inerma</i>
	<i>Premna serratifolia</i>
	<i>Vitex trifoliata</i>
Vitaceae	<i>Cayratia trifolia</i>

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