ADAPTATIONS OF BIRDS IN THE SUB FAMILIES OF *TIMALIINAE* AND *SYLVIINAE*

Thesis
submitted to the University of Calicut
for the award of the Degree of

DOCTOR OF PHILOSOPHY
IN
ZOOLOGY

By

NISHI ANN

Under the guidance of

Dr. V. J. Zacharias & Dr. Sabu K Thomas

DEPARTMENT OF ZOOLOGY
ST. JOSEPH'S COLLEGE
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DECLARATION

I, Nishi Ann, hereby declare that the thesis entitled "**ADAPTATIONS OF BIRDS IN THE SUB FAMILIES OF *TIMALIINAE* AND *SYLVIINAE***" submitted to the University of Calicut for the award of the degree of **DOCTOR OF PHILOSOPHY** in **ZOOLOGY** is my bonafide research work and this has not formed the basis for the award of any degree, diploma, associateship, fellowship or similar other titles before. It has not been submitted to any other University or Institutions for the award of any degree or diploma.

Calicut,
17-07-2007.

NISHI ANN

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CERTIFICATE

Certified that the thesis entitled "**ADAPTATIONS OF BIRDS IN THE SUB FAMILIES OF *TIMALIINAE* AND *SYLVIINAE*"** is a record of research work done by **Mrs. NISHI ANN** under our guidance and that the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or similar other titles and that it has not been published anywhere.

Dr. V.J.ZACHARIAS
Guide)

Calicut,
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As I wrote in the beginning there are many ...... I keep them all in my heart.

Nishi Ann

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CONTENTS

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LIST OF PLATES

Plate 8	*Garrulax cachinans*
	Macronous gularis
Plate 9	*Cisticola exilis erythrocephalus*
	Cisticola juncidis salimalii
	Prinia hodgsonii albogularis
Plate 10	*Prinia subflava franklini*
	Prinia sylvatica sylvatica
	Prinia socialis socialis
Plate 11	*Phragmaticola aedon aedon*
	Arcocephalus stentoreus brunnescens
	Arcocephalus dumetorum
Plate 12	*Arcocephalus agricola agricola*
	Hippolais caligata rama
	Phylloscopus trichiloides viridanus
Plate 13	*Phylloscopus occipitalis occipitalis*
	Phylloscopus trichiloides nitidus
Plate 14	*Phylloscopus affinis affinis*
	Phylloscopus magnirostrus
Plate 15	*Schoenicola platyura*
	Orthotomus sutorius guzuratus
Plate 16	*Locustella certhiola rubescens*
	Locustella naevia straminae

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LIST OF TABLES

TIMALIINAE

SYLVIINAE

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Dedicated to

My Dear Husband.....

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Chapter I

INTRODUCTION

Chapter 1

INTRODUCTION

The birds are best known of the large and adaptively diversified classes of animals. About 8600 living species are currently recognized and it is likely that more than a handful of additional species will be discovered. They are ideal subjects for comparative studies on the ecological and behavioural influences on the evolution of morphological and anatomical characters. Because of the abundance of basic empirical information on distribution, habitat requirements, life cycles, breeding habits etc, it has been relatively easier to use birds instead of other animals in the study of general aspects of ecomorphology.

The present study, is a discussion on the indices of adaptation of two sub-families, *Timaliinae* and *Sylviinae*, which share much in common in features and behavior. These two groups are regarded as sub families of the Family *Muscicapidae* together with *Muscicapinae* (flycatchers) and *Turdinae* (thrushes). The function of this foregoing investigation is obviously envisioned as two-fold. First, it digitally focuses on the frame of references of the similarities and contrasts. Second, it provides reasonable tendencies based on scientific observations on the pattern of their adaptations. This kind of exposition is relevant in the science of Ornithology and it requires a cross analysis of data and theory. The scientific deductions already made in the field are tested against the data and observations with regard to these sub families.

OBJECTIVES

Any discussion on the study of birds generates heterogeneous premise of theory and the facts. One of the main objectives of the study is to draw up the relation between niche and ecomorphology among the birds of the subfamilies *Timaliinae* and *Sylviinae*. It requires a space for discussion on inter and intra relationship of the variables that determine the fabric of the above relation. The present study operates with a set of well defined variables viz, Wing length, Bill length, Tarsal length, Tail length, Weight and Longest Toe. It also runs on the derived entities like index of roundness, aspect ratio and relative concepts.

The present study has identified as sample space of 322 specimens of *Timaliinae* and 271 specimens of *Sylviinae*. The species are chosen at random, though the present researcher has very consciously picked up the species that are widely seen in South India.

As the main objective of the present study is to bring out the points of correlation between niche and morphology, it requires detailed study on the course of the variables of ecomorphology and niche. A number of measurements are analysed to test the correlation with niche-group. The variables stated above are all compared with a number of parameters of niche of each species in order to evaluate the correlation between niche and morphology. Gaston (1969) has beautifully tried to carry out similar kind of exercises exclusively for that genus. It does not try to generalize the results and nor does it brings in findings for a rigorous comparative discussion. The present study is an attempt in the line in order to bring out meaningful findings.

Corollary to the above objective, a discussion is also made to bring out salient features of ecomorphological characteristics of these two sub families. An analysis on functional relations between the behavioural variables and composition of habitat obviously provides very interesting traits of adaptation process. The variables like bill, toe, tarsus, tail, weight and total length of the bird have analyzed in the context of its foraging behaviour, the potential to flight and identities of different niche groups. An attempt is also made to operate the hypothesis with derived results. It requires a statistical analysis of the data and observations.

Ecomorphological studies usually starts with a description of the correlation between ecological and morphological traits. An important goal of ecomorphological analysis is to predict ecological differences among organisms on the basis of morphological features. It is interesting to know that, formulation of hypothesis that explains this correlation speak of statements about behavior. The reason for this observation centres around the axiom that explains the relation between morphological trait and its physical and chemical properties.

Basically the present study tries to relate the degree of variation with (1) type of habitat and (2) body size. These two variables are well accepted to understand the dynamics of the adaptation process.

Studies of correspondence between measurements of ecological and morphological variables have shown that most of the variance among species in ecological measurements is associated with variance in morphological measurements; suggesting that morphology is a good predictor of ecology (Karr & James 1975, Miles & Ricklefs1984). The experiments have shown that habitat choice is influenced by an innate preference for suitable structure and exploratory behavior controlled by novelty. Leisler B., Ley & Winkler (1989) has demonstrated that learning leads to final adjustment of habitat choice. These ideas need further study.

The variation in wing length, bill length, tarsal length, tail length, weight, etc. contribute much to the changing pattern of behavior as well as ecomorphological features. Once relationship between morphology and performance has been determined, the latter may be related to the aspects of ecology. Bill length because of its ecological significance was chosen for study and analysed statistically (Hutchinson 1959, Lack 1947, Grant 1967). There is a relationship between food type, habitat and bill morphology. Long flat bills are typical for birds which have to catch mobile prey. The bill length differences reflect differences in the type of food exploited and that a greater variety of bill length in a population reflects a greater variety of types of food exploited. Gleaning of more sedentary prey favour shorter, slightly curved bills. Mobile prey is abundant in higher flooded vegetation of reed beds (marsh habitat) and less in shorter vegetation and undergrowth (Lederer 1975,1980). The tails of the birds have important aerodynamic functions; they produce lift, supplementing that created by the wings. The main function of the tarsus, together with other bone elements of the hindlimb is to support and transport the bird when it is not flying. Toe is a supporting factor for the birds to climb up. In vertical climbing, the toes are held in a near vertical direction on the trunk and they have to support the whole weight of the bird. Flight is a performance parameter about which much can be learnt through the study of ecomorphology. For almost all birds, flight is linked with a suite of ecomorphological habits, all of which are independent and relatively constrained. The wings have a share in evolving the behavior of the birds in its process of adaptation. Wings are more rounded in birds that manoeuvr through closed habitat than in birds that forage above the vegetation. Similarly, migrants and residents differ in their foraging strategies, food requirements, habitat use and they also develop corresponding morphologies.

The derived outputs like aspect ratio, index roundness and length of relative tail, tarsus, weight and toe also contribute much to the understanding of ecomorphology. A number of studies have been brought out to explain the correlation between ecomorphological features and adaptation process. The present study is an attempt to look at the comparison in the larger context of adaptation process that has taken place in the subfamilies of *Timaliinae* and *Sylviinae*.

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Chapter II

REVIEW OF LITERATURE

A number of literatures have been published on many of the issues raised in the discussion of the present researcher. As ornithology constitutes major share of knowledge in the realm of zoology, the topic under discussion could gather authentic findings on different aspects of ecomorphology and adaptation. During 1950-60's ecologists were analyzing a series of related questions on the concept of niche, habitat and community structure, diversity with taxa etc., by using simple morphological measures as tools. These studies led to the coining of the term "Ecomorphology" by Karr and James (1975). Several recent studies have attempted to describe pattern of organization within assemblages of species by using morphology as an index of ecological relationship (Karr & James1975, Gatz 1979b, Ricklefs & Travis 1980, Leisler & Winkler 1985, Neimi 1985).

Morphology does not completely reproduce the subtleties of ecological relationships based on behavior and physiology. However morphological measurements may reflect more accurately than samplings of foraging behavior, diet and habitat use of the ecological relationships of a population (Miles, Ricklefs & Travis 1987). The earliest work on studies relating to morphology to ecological niche within a group of closely related taxa were brought out by Dilger (1956), Kear (1962), and Newton (1967). They stressed the importance of behavior in determining the morphological adaptation. Lack (1949) and Guasse (1934) have expressed the idea that the two species with identical requirements for existence cannot exist together in the same ecological niche. Experimental studies such as those conducted by Park (1948) on two species of flour beetles (Tribolium) support this idea.

When a species becomes subdivided by geographical barriers a certain amount of genetic change takes place in the then isolated populations. The two populations can continue to live side by side in the same habitat. The degree of differentiation of this process has been discussed at length by Mayr (1942) and Lack (1949). They have brought out their findings with more statistical data. One of the central paradigm in ecomorphology focuses on the role of organismal performance as a crucial link between organism phenotype and its ecology (Arnold 1983, Emerson & Arnold 1989, Wain Wright 1991).

In fact Ecomorphology deals with covariation between morphological and ecological characteristics in a set of organisms. Meanwhile ecologist and evolutionary biologists have made various attempts to associate variation in the size of anatomical structures with ecological characteristics of organisms. Van Valen (1965 and1973), Wilson (1969), Grant (1971) and Rothstein (1973) have probed into the issues and come out with successful observations. Species of animals living on islands may have morphological characteristics not possessed by their mainland counterparts was recognized by Wallace(1881), Murphy & Chapin (1929) and Grant (1965) have brought out similar findings for the adaptations among the birds on island. The environmental factors which affect the morphology of birds are investigated by Grant (1965). He differentiates climatic and ecological factors which influenced the morphology of birds.

Morphology shapes ecological patterns by determining the behavioral capacity to exploit resources (Wain Wright 1991). The use of statistical method has given paradigm shift in the methodology of analysis. Univariate and multivariate correlative analysis are used to explore the relationship between morphology and performance among the species (Arnold & Bennette 1988, Losos, 1990). Ratios and proportions are very basic variables in morphological analysis, so their mathematical treatment is an important concern (Baldwin, 1931, Neimi et.al, 1985).

The recent studies in ecomorphological characters have shown very interesting observations on niche of birds. According to Leisler and Winkler (1985, 2003, 2006) the morphological differences between migrants and sedentary birds are related to flight performance or to other ecological factors that act differently in this group. Thomas (1996) has demonstrated that tail too is subjected to change when long distance migration evolves. Maybury and Rayner (2001) have discussed the role of the tail for flight performance. Fitzpatrick (1999), Leisler and Winkler (2003), Voelker (2001) have demonstrated that migrants and resident birds differ in their foraging strategies, food requirements and habitat use. Leisler (1990) concluded that both these groups develop corresponding morphologies. It has also been brought out by Leisler and Winkler (1985) and Voelker (2001) that the degree of intra specific polymorphism is lower in migrants.

It has been brought out that natural selection has acted either upon the parts of the birds directly or upon body size which has produced allometric effects on the size of the parts. Amadon (1943) agreed that body size is best indicated by weight, when a bird is not in fat condition. Grant (1964) has conducted that island birds have smaller weight but larger tarsus than in mainland birds. The wing length tends to become greater at higher altitudes for intra specific comparisons was established and documented (Rand 1936, Huxley 1942, , Traylor 1950, Mayr 1963).

Bill length because of its ecological significance was chosen for study and analysed statistically (, Lack 1947, Hutchinson 1959. Grant 1967).

There is a relationship between food type, habitat and bill morphology. Gleaning of more sedentary prey favour shorter, slightly curved bills. Leisler (1980a) have shown that many variables of feeding, wing and leg complexes have direct relationship with the habitat. Subtle morphological differences within genera are correlated with species specific foraging behavior. The bill length differences reflect differences in the type of food exploited and that a greater variety of bill length in a population reflects a greater variety of types of food exploited.

Kear (1962) and Watson (1962) have statistically shown the validity of the above assumption. Differences in external morphology among the species can reliably predict differences in habitat use and foraging behavior. This is true in the premise of ecomorphological analysis of bird communities (Karr & James 1975, Leisler 1980, Miles et. al. 1987, Weins 1989). This assumption is rarely tested with data on behavior and habitat. A few studies have attempted to clarify relationships among morphometry and the behavior of environment of species in question (Leisler et al 1989).

Wings are more rounded in birds that manoeuvr through closed habitat than in birds that forage above the vegetation. Savile (1957) has brought out very interesting observation on this pattern. A more pointed wing are found in long distance flyers and migrants, while a more rounded ones in whose flights are relatively infrequent and are of shorter duration. Stressmann raised the possibility that the adaptation for flight in thin air of higher altitudes might necessitate a relatively larger surface and length of wing. According to Rensch (1960) variation in the size of exposed parts of the birds can be explained partly as an allometric consequences of body size variation and partly as a result of selection of heat exchange. Huxley (1942) has pointed out that in semi-tropical regions where winter minimum temperatures are not extreme, selection should act most strongly in the summer months.

The difference in size between the bills and the tarsi of mainland and island birds may reflect a different usage of those structures in two environments. The tarsometatarsus (usually called tarsus) is relatively shorter in most birds that forage on tree trunks or hang from slender branches than in birds that forage on the ground or use rigid perches. The main function of the tarsus, together with other bone elements of the hindlimb is to support and transport the bird when it is not flying. The birds with long and stout legs are found to be active on the ground whereas short legged ones forage on trees and canopy. Toe is a supporting factor for the birds to climb up. In vertical climbing, the toes are held in a near vertical direction on the trunk and have to support the whole weight of the bird.

Hinde (1959) and Bowman (1969) have pointed out the variation in size and shape of bill can be correlated frequently with the nature of food taken. Baldwin found that there was a correlation between the length of bill of each species and the mean size of prey. According to the work of Kear (1962) birds of larger bill have an advantage over those with short bills, atleast among finches. Watson (1962) and Grant (1964) suggested that the long bill of many island birds is an advantage permitting the exploitation of a large range of food sizes. Palmgren showed that in birds which feed in hanging position from slender perches not only is the leg musculature different from those which feed in more upright position, but also the tarsus is the shorter member of the limb. The tarsometatarsus is shorter in those species exploiting vertical surfaces (Spring 1965, Winkler and Bock 1976, Norberg 1979 James 1982 Lederer 1984).

Davis (1957) concluded that a long tarsus is presumably advantageous in bipedal locomotion. He concluded that the length of tarsus is correlated with the nature of perch and the way in which it is used. The behavior of animal specie is influenced by the presence or absence of the other. Lack and Southern (1949) have correlated the habitat extension displayed by some species of birds, Tenerife with the absence of clearly related species. Similarly it is known that two closely related species are often more similar, ecologically and morphologically when in allopatry and most dissimilar when in sympatry. The proponents of this theory Chapman (1940), Brown & Wilson (1956), and Watson (1962) have drawn attention to the fact that large bills are characteristics of birds living on both mountain tops and islands, two environments which are ecologically similar.

The morphological difference between migrants and sedentary birds may be related to flight performances or to other ecological features that act differently in these groups. The interdisciplinary studies have brought out a new canvas with new concepts and ideas. The derived results through the statistical analysis have shown new areas of research and enquiry. Although there is no consistent difference in wing-loading between migrants and residents, the migrants in most families have higher aspect ratio and also the wings are frequently more pointed (Leisler & Winkler 1985, 1992, 2003, Voelker 2001, Lockwood *et al* 1998). The tails of the birds have important aerodynamic functions; they produce lift, supplementing that created by the wings (Thomas 1993, Norberg 1994), influence flight manoeuvrability and agility and are particularly useful at low flight speed. However the tail also affects aerodynamic costs by decreasing drag- The longer the tail, the greater the drag. Natural selection for aerodynamically efficient flight, commensurate with the ecological requirements of the species, should therefore act on tail length and shape. The tail too is subjected to change, when long distance migration evolves. The role of tail in flight performance has been studied in detail only recently (Thomas 1996, Maybury & Rayner 2001). It is also true that birds with shorter tail prefer ground and the longer tailed ones are seen in dense understory. Comparative studies of song birds have shown that migrants tend to have squarer and shorter tails as opposed to the often long and graduated tails found in non-migrants (Fitzpatrick 1999, Leisler & Winkler 2003, Voelker 2001). Migrants and residents differ in their foraging strategies, food requirements, habitat use and they also develop corresponding morphologies. Migration physiology and the tight seasonal schedule that migrants have to follow also may constrain the development of certain morphological features and thus contribute to consistence differences between migrants and residents.

The relict hypothesis proposed by Barrett-Hamilton and Hinton (1914) tries to explain this feature with more statistical data but it has been contested by Mayr (1982), Steven (1953) and Cook (1961). Mayor warned that climatic adaptation would be expected to occur as an additive, adaptive response with opportunity for more than one selection force to contribute to the process. Falconer (1953) has concluded that large size may be disadvantageous on the mainland in the face of heavy predator pressure. Snow (1954) noted that the variation of some population of several species is an apparent exception of Bergmann's Rule. Warham (1996) presented data for sexual procellariform species that revealed how wing morphology reflected ecology. Birds having wings with high aspect ratio and high wing loading reflects more pelagic life style, while the ones having low aspect ratio and high wing loading reflects their pursuits plunging behavior. Hamilton (1958) speculated that the increase in wing length in warm, arid regions is an indication of size increase that facilitate conservation of metabolic water and the decreases of wing length in warm humid regions is indicative of size decreases, that facilitate effective heat dissipation. Moreau (1960) has conducted a partial regression analysis of variation in wing length in the Zosterops complex of Africa. Mayr (1963) and Vaurie (1951) have warned that migratory populations of a species may have wing lengths modified in comparison to resident populations. Lederer (1984), Winkler (1989) and Wain Wright (1991) have shown that there is a link between resources, performance and morphology, which obviously requires a deeper understanding of the relationship between the design of the birds and their environment.

In short the studies on the issues discussed at length in the foregoing chapters are rich in its form and content. The studies on adaptation have brought new theories, concepts and findings which obviously help the researcher in the field explore new information in different context.

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18

Chapter III

METHOD OF STUDY

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METHOD OF STUDY

The present study employs the methodologies which can be operated on the museum specimen available in Peninsular India. The sample space for the present study has 322 specimens of *Timaliinae* and 271 specimens of *Sylviinae*. Out of the 271 *Sylviinae* specimens, 159 are drawn from migratory birds. The sample space is evidently operated on the museum specimens for two reasons. First, the scope of the present study is more concerned about the adaptation, rather than the details of behavior. The secondary studies on behavior of the birds are taken for granted to corroborate the evidences derived through the data on museum specimens. Therefore the present researcher uses the methodology that can be operated on museum specimens only. Second, as a random analysis, the present researcher has tried to compare the data used in the foregoing study, with the data on live specimen. It has significantly brought out an interesting equalence between the data on live and museum specimen. It explains the rationale of the present researcher to depend exclusively on museum specimen.

As the two subfamilies do have more differences than commonalities, two mutually exclusive frameworks are adopted to find out the dimensions of adaptation.

The methodologies adopted in the present study, centres around a simple concept of ecological niches. They are defined on the basis of the differences and distinctiveness of types of the habitat. Gaston (1974), in his 'Adaptation in the Genus *Phylloscopus*', has developed a different type of classification of niches based on the height of foraging above ground and the type of foliage preferred. This methodology fails to give reasonable results in the present study for a simple reason that all of the birds, in his discussion, are used to ground feeding only. Consequently the present researcher employs a more practical concept for possible deductions. The niche concept employed for the subfamily *Timaliinae*, herein after called group I, has five categories which are shown below. The sample space carries the following species and the number shown against the niche group refers to the order of the birds in the following list.

1. *Pellorneum ruficeps olivaeceum*
2. *Pellorneum ruficeps ruficeps*
3. *Pomatorhinus horsfeldi horsfeldi*
4. *Pomatorhinus horsfeldi travencoreinsis*
5. *Pomatorhinus horsfeldi madrepatensis*
6. *Dumetia hypoerythra albogularis*
7. *Rhophocichla atriceps atriceps*
8. *Rhophocichla atriceps bourdilloni*

9. *Turdoides subrufus subrufus*

10. *Turdoides subrufus hyperythrus*

11. *Turdoides striatus orientalis*

12. *Turdoides striatus malabaricus*

13. *Turdoides affinis affinis*

14. *Turdoides striatus somervillei*

15. *Turdoides malcolmi*

16. *Turdoides caudatus caudatus*

17. *Turdoides striatus orissae*

18. *Alcippe poioicephala*

19. *Garrulax jerdoni fairbankii*

20. *Garrulax delesserti delesserti*

21. *Garrulax cachinans*

22. *Garrulax jerdoni meridionale*

23. *Macronous gularis*

GROUP I

A1	Evergreen	7, 8, 9, 19, 22
B1	Evergreen & Sholas	1, 2, 20, 21
C1	Deciduous	3, 4, 5, 11, 13, 14, 15, 16, 17
D1	Deciduous & Evergreen	10, 18, 23
E1	Deciduous & Avoids evergreen	6, 12

Similarly, group II deals with the characteristics of subfamily *Sylviinae*. The niche groups for the subfamily of *Sylviinae* are defined on the basis of foraging strata. This classification is necessarily tentative and obviously it does not have any taxonomical significance. The following table defines the niche groups and lists the species included in each. The sample space carries the following species and the number shown against the niche group refers to the order of the birds in the following list.

1. *Cisticola exilis erythrocephalus*
2. *Cisticola juncidis salimalii*
3. *Prinia hodgsonii albogularis*
4. *Prinia subflava franklini*
5. *Prinia sylvatica sylvatica*
6. *Prinia socialis socialis*
7. *Phragmaticola aedon aedon*
8. *Arcocephalus stentoreus brunnescens*
9. *Arcocephalus dumetorum*
10. *Arcocephalus agricola agricola*
11. *Hippolais caligata rama*
12. *Phylloscopus trichiloides viridanus*
13. *Phylloscopus occipitalis occipitalis*

14. *Phylloscopus trichiloides nitidus*

15. *Phylloscopus affinis affinis*

16. *Phylloscopus magnirostrus*

17. *Schoenicola platyura*

18. *Orthotomus sutorius guzuratus*

19. *Locustella certhiola rubescens*

20. *Locustella naevia straminae*

GROUP II

A2	Terrestrial	2, 4, 5, 9, 15, 18, 19
B2	Terrestrial & Arboreal	3, 10, 12, 14
C2	Open Grasslands	6, 17
D2	Arboreal	1, 11, 13, 16, 20
E2	Marshy & Mangrove	7, 8

The data for the classification are drawn from the information given in the work, Handbook of the Birds of India & Pakistan, written by Salim Ali & Ripley (1989). Graphical and mathematical methods are applied to explore the properties of avifaunas and the extent of convergence among them. The data on different variables are listed against the theories and concepts in the field of study and the derived results are found out in order to explore more reasonable meanings.

MORPHOMETRIC ANALYSIS

External morphological measurements were taken from the museum specimens at Zoological Survey of India, Kolkatta and Bombay Natural History Society, Mumbai. The measurements included that of the wing length, wing span, bill, bill from culmen, tail, tarsus, longest toe, length of the bird and weight. The Handbook of the birds of India & Pakistan written by Salim Ali & Ripley has been consulted for the measurement of weight in addition to data collected through specimen observation. Measurements in different variables constitute the crux of the statistical investigation. The measurements were taken to the nearest 0.1mm using a digital vernier calipers. The dividers are also used to measure the distance, when vernier calipers is not found fit to measure. The biometrical variables were standardized by dividing values by the cube root of body weight (Baldwin 1931 Amadon 1943). Seasonal variation in the below mentioned variables are omitted. Measurements used are shown under different heads, the details of which are given below.

(1) Weight

Data on weight are not available for all species under study. The mean weight of the largest series is used for deduction, wherever direct data on weight is not available. The data on weight is secondary information as the present researchers depended completely on the information provided on the tags of the museum specimens. The data is independent of sex, age and season.

(2) Wing Length

It is the distance from the humero-scapular joint to the wing tip (the tip of the longest primary feather), when the wing is moderately outstretched laterally on a horizontal plane. The square of mean wing length for the species against $\log_{10}$ weight is plotted for greater accuracy of possible deduction in the context of adaptation. The overall relationship of W^2 to $\log_{10}$ weight in the species under study has been calculated from the means of the largest and smallest thirds of each set of ranked data (in the line of best fit). The comparisons of species of different niche groups are discussed at length. Migratory and non-migratory species are compared to bring out the relationship between wing length and distance of migration.

(3) Wing shape & wing span

The difference in wing shape among birds to the differences in flight performances have been discussed at length by many. The index of wing shape, also called the index of roundness is calculated on the basis of the length of first primary relative to the total wing length. The first primary gives the measure of the wing width, while the wing length relates to wing span. The index of roundness is calculated by subtracting the distance of the closed wing from the tip of the length of the longest primary to the tip of the first primary from the wing length. This figure is then divided by the wing length to give the index. This index of roundness is related to aspect ratio. Aspect ratio is calculated for making more significant observation. It is the ratio of wing span to the mean width of the wing and is calculated as the ratio of the wing span squared to the total wing area. Wing span is the distance between the two wing tips, when the wings are moderately outstretched laterally.

(4) Tail length

It gives direct measurement of the tail of the bird under study. The tail performs two functions: as an aerodynamic structure, acting as brake and rudder and as a balancing organ, when the bird is perched. It is difficult to assess the relative contribution of these two functions in the evolution of tail length. In the present study it is taken as relative tail length, measured as the ratio of tail length to wing length (T/W).

(5) Bill length & bill length from culmen

It is measured from anterior edge of nostril to the tip. In taxa without clearly defined anterior nostril edges, total culmen is preferred. It extends to bill tip from the notch on forehead, where base of culmen meets skull.

(6) Tarsal length

The data taken on tarsal length shows its ratio to the cube root of the weight of the body.

(7) Longest toe

The data on above variables are appended and used for parametric estimation.

Statistical Analysis

The statistical analysis was operated on Statistical Analysis Software (Statistical Analysis Institute, INC.). Plots were created using version 8.0, SPSS. An unbalanced ANOVA and Test were used to test the significant differences. The GLM Pro Student – Newman – Keul Multiple Range Test was used in the forgoing discussion. This method has been used mostly to bring out the features of Morphological differentiation. Karl Pearson's correlation co-efficient has also been used to understand the one to one correspondence as well as the relation among the variables. It is to be noted that the statistical analysis is not conceived to be a better substitute for explanatory notes. Rather the idea of the present researcher is to threat it as a complementary and/or supportive component in the discussion.

ADAPTATIONS OF BIRDS IN THE SUB FAMILIES OF *TIMALIINAE* AND *SYLVIINAE*

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Chapter IV

SUB FAMILY TIMALIINAE: A REVIEW

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SUB-FAMILY TIMALIINAE: A REVIEW

The present analysis has well defined focus on the similarities and contrast between two subfamilies, *Timaliinae* and *Sylviinae*. Babbler is the substantive name of many species of the subfamily *Timaliinae*. In fact the Old World insect eaters assembled under the general name of babblers. Babblers belong to different groups that are a little more closely related to one another than they are to others. They have sometimes been considered as making up a family *Timalidae*, but they are better considered as a subfamily of the large family of the Old World insect eater *Muscicapidae*. It includes the thrushes, the flycatchers, the warblers and others.

Babblers have characteristically short rounded wings and are poor flyers. They are thick in shape; the tail often fairly long, hangs loosely and the folded wings are not held close to the body. The bills and legs are strong. The birds live usually in the undergrowth, sometimes on the ground, among thick under bush, fallen branches, ascending vines and evergreen trees. They possess a loud and varied voice, to which they owe their name. They generally keep to thick woods, forests, bushes and fallen grass. Except during the breeding season, they go in small flocks, often mixing with other birds and forming those composite hunting parties, so characteristic of tropical jungles.

Majority of babblers make a large cup shaped nests, but a number of them build domed structures; most of the nests are placed on trees and bushes, some on ground and clumps of grass. The eggs vary much in colour, some being plain white or blue, while others are spotted and blotched. The babblers are found throughout oriental region. And they extend to the Celebes, New Guinea, Australia and Africa. At least six tribes can be recognized; The jungle babbler (*Pellorneini*), the scimitar babbler & wren babbler (*Pomatorhinini*), the tit babbler (*Timalini*), the wren tit & allies (*Chamaeini*), the song babblers (*Turdoidini*) and the rock fowl (*Picathartini*). (Please see the plates for the photographs of the museum specimens).

Practically all babblers occur during most of the year in small parties, numbering 3 to 30 birds. Solitary babblers are rare, pairs are uncommon, and so are flocks of more than 30 birds of the same species. Although cooperative breeding is evidently widespread among the babblers, the details of the social systems involved differ considerably. Observation of adult babbler feeding one another outside the breeding season may also relate to dominance within the group.

The present investigation, though deals with *Timaliinae* subfamily, has a limited focus with regard to different tribes of this family. *Pellorneum*, one of the genera of the tribe *Pellorneini* is considered for discussion. It falls under the tribe of jungle babblers and share much in common with the birds of other four genera of this. They feed mostly on insects. Their eggs are spotted. They have uniform brown above nearly white and sometimes spotted underneath; with a slender bill, long legs and short tail. Invariably, the tail is shorter than wings for all birds coming under this genus.

Pomatorhinus another genera under discussion comes under the tribe *Pomatorhinini*. They are generally ground dwelling birds that live under low bushes, less often on low trees and creepers. They are insectivores and feed mostly on ground. They build covered wall like nests. Their plumage is brown, more or less strongly marked with white, black, grey, chestnut or some shades of red. The genus *Pomatorhinus* differ much in their living and nesting habits with the Australian and New Guinea scimitar babblers.

Three different genera viz, *Dumetia, Rhophocichla* and *Macronous* are selected from the tribe *Timalini* for analysis. The tribe Timalini is composed of six genera and 35 species of small birds with rather short pointed bills and with tails of moderate length. The plumage is soft and fluffy. Brown, chestnut, grey, yellow, white and black are the dominant colours. *Dumetia* and *Rhophocichla* are the two Indian monotypic genera and they are mostly brown in colour. *Macronous* is also brown in colour and has much in common with the other two genera.

The tribe *Turdoidini* is the largest with 17 genera and 140 species distributed throughout Africa and South Asia. The bill, legs and feet of the birds are strong. The wing is rounded and held loosely and is often adorned with beautiful colours. The tail is broad. They go about in flocks. They feed on berries and insects. *Turdoides* the most primitive is included in the present sampling. These birds are uniform brown, fairly large, with long tail, and bills slightly curved. Another genus *Garrulax* also comes under the analysis. It is a large genus of 50 species with thicker, straighter bills and more elaborate plumage. They live in moisture country and most of them are found only in forest. Many are brown with black, chestnut, grey and white marking, but some are beautifully adorned with yellow, crimson or olive green on wings and tail. *Alcippe* which comes under this tribe is also seen in south India. They are small or very small and have a shorter bill. It is to be noted that the present study does not cover the two tribes, *Chamaeini* and *Picathartini*, as the birds of these kind are not found in peninsular India.

The present researcher has selected 322 specimens of the subfamily *Timaliinae* that are abundantly found in Indian peninsular region. The specimens belong to 8 different genera and they come under 14 different species. Their subspecies are also considered. The sampling is arbitrary and does not follow any theoretical stipulation. The ongoing hypothesis does not require any finer classification for selection birds for analysis. Their abundance, proximity and diversity are roughly considered for selection. The following discussion focuses more on the characteristics and the differentiation of different species of birds selected. The data furnished for the study are exclusively drawn through direct observation of specimens preserved in Bombay Natural History Society, Mumbai and Zoological Survey of India, Kolkatta. And the accuracy of the readings is well taken care of and the present writer is responsible for any error in data.

1) *Pellorneum ruficeps olivaeceum*, is found in Trichur, Cochin and central parts of Kerala. It is commonly known as Kerala spotted babbler. It is resident and found in evergreen and shola forest. It lives in shrubs and is used to ground feeding. Insects constitute the set of food. The bird is about 15.4cm long with brown colour all over the body. The head has darker shades of brown, and the beak is long. (see Plate 1).

2) *Pellorneum ruficeps ruficeps* is commonly known as Peninsular spotted babbler and is found largely in Nilgris and Coonoor. It is 17.4 cm long and has a brown colour over the upper parts of the body. Darker head marks it conspicuous and the long beak adds to its beauty. It is resident and is found in evergreen and shola habitat. Il insects come under their

Plate:1

Pellorneum ruficeps olivaeceum

Pellorneum ruficeps ruficeps

Pomatorhinus horsfeldi horsfeldi

food pattern. They are used to ground feeding. They are restless in the shrubs, which makes their movements fast. (Plate 1).

3) *Pomatorhinus horsfeldi horsfeldi* is commonly known as Deccan scimitar babbler and is found in Mahabaleshwar and Western ghats. It is 22cm long and the whole body is blackish brown and the throat is white colour. It is resident and found largely in deciduous forest. It feeds on insects, small seeds, berries, spiders and flower nectar. It is used to ground feeding and does live on shrubs. (Plate 1).

4) *Pomatorhinus horsfeldii travencorensis* commonly known as Kerala scimitar babbler. It is found in Goa, Mysore and Kerala, and is a common resident. It has 22cm length, the body blackish brown colour and white on the throat. It lives on shrubs and used to ground feeding. (Plate 2).

5) *Pomatorhinus horsfeldii madrepatensis* known as Tamil Nadu scimitar babbler and found largely in Tamilnad, Eastern ghats and Andhra Pradesh. It is also resident and found in deciduous forest. Tarsus is long and has a length of 22cm. It lives on shrubs and is used to ground feeding. It eats insects, small seeds, berries, grubs, spiders and flower nectar. (Plate 2).

Plate:2

Pomatorhinus horsfeldi madrapatensis

Pomatorhinus horsfeldi travencoreinsis

Dumetia hypoerythra albogularis

6) *Dumetia hypoerythra albogularis*, White throated babbler is the common name of this specie and is found largely in South India. It is 14.2cm long and has a long tarsus of 2.3cm. Olive green colour keeps wing and other parts of the body impressive. The throat and other parts are ochreous. It lives in grassland and scrub areas and are used to ground feeding. Insects and flower nectar constitute its food. Though it is resident and found in deciduous forests, it's never found in evergreen forests. (Plate 2).

7) *Rhophocichla atriceps atriceps*, it's commonly known as Black headed babbler and largely found in Western Ghats. Its habitat is abundantly found in the belt from Belgaum to Palakkad gap. It is resident and found in evergreen forest. It lives in shrubs, and is mostly confined to ground. Olive green colour is so significant on the upper parts of the body and the wings too. The head is black and whitish grey covers the under parts of the bird. It is 14.3cm long. It feeds on insects. (Plate 3).

8) *Rhophocicla atriceps bourdilloni*, its common name is Kerala blackheaded babbler. It is found in Kerala and Western Tamilnadu. It is resident and found in evergreen forest. It is 11.3cm long and has olive green colour on the upper parts of the body. The head is black and

Plate:3

Rhophocichla atricpes atriceps

Rhophocichla atriceps bourdilloni

Turdoides subrufus subrufus

whitish grey colour is seen on the underneath. It lives on shrubs and feeds on insects. (Plate 3).

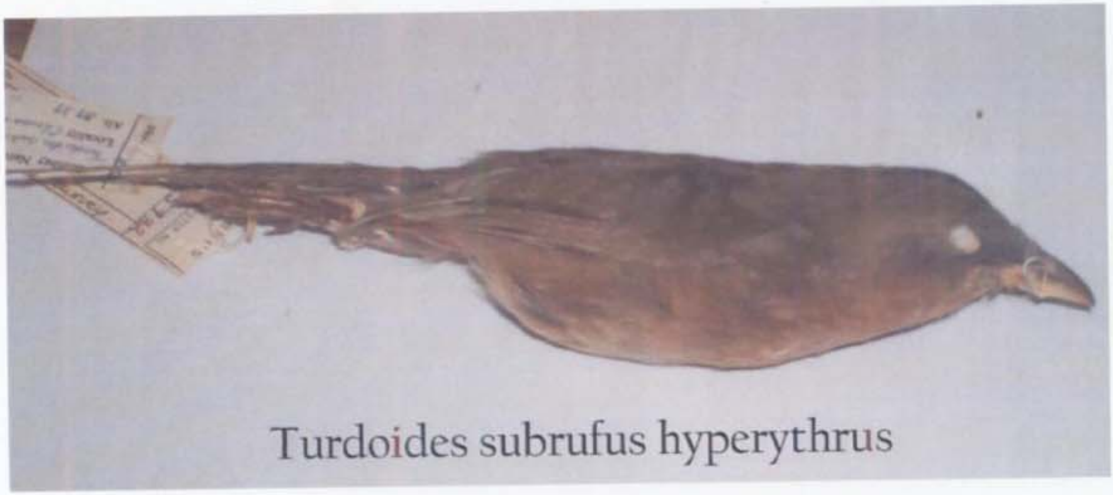
9) *Turdoides subrufus subrufus* commonly known as *Rufous* babbler and found largely in Mananthavady region. It is resident and lives in shrubs. It has light brown colour on the upper part and orangish brown covers the under parts. It is 17.4cm long. (Plate 3).

10) *Turdoides subrufus hyperythrus* commonly known as Kerala rufous babbler and is found in Palakkad district. It is resident and seen in evergreen and moist deciduous forest. It lives in shrubs and eats insects and berries. Dark olive brown covers the upper parts of the body but orangish brown is the colour of underparts. It is 21.2cm long. (Plate 4).

11) *Turdoides striatus orientalis* commonly known as Peninsular jungle babbler and is largely found in the Eastern Ghats. It is resident and mostly confined to deciduous forest. It lives in shrubs and feeds on insects, grains, berries and seeds. Brown is the colour of the bird and spotted throat with the same colour is its common character. It is 24cm long. (Plate 4).

12) *Turdoides striatus malabaricus*, its common name is Malabar jungle babbler and is found largely in all parts of Kerala. It is resident and is found in deciduous forest and significantly avoids evergreen forests. It

Plate:4

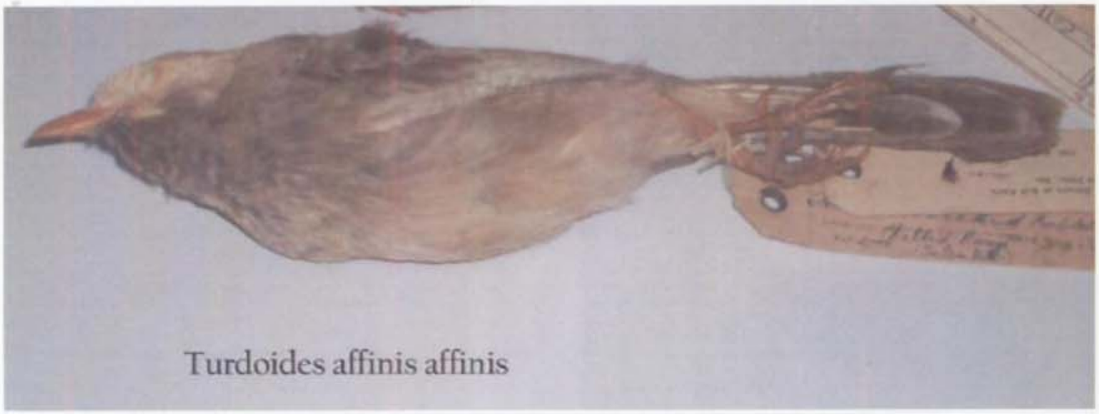


Turdoides subrufus hyperythrus

Turdoides striatus orientalis

Turdoides striatus malabaricus

Plate:5



Turdoides affinis affinis

Turdoides striatus somervelli

Turdoides malcolmi

lives in shrubs. Spotted throat with brown colour is visible on the brown body. The under parts has light brown colour. It is 24cm long. It feeds on insects, seeds, grains and berries. (Plate 4).

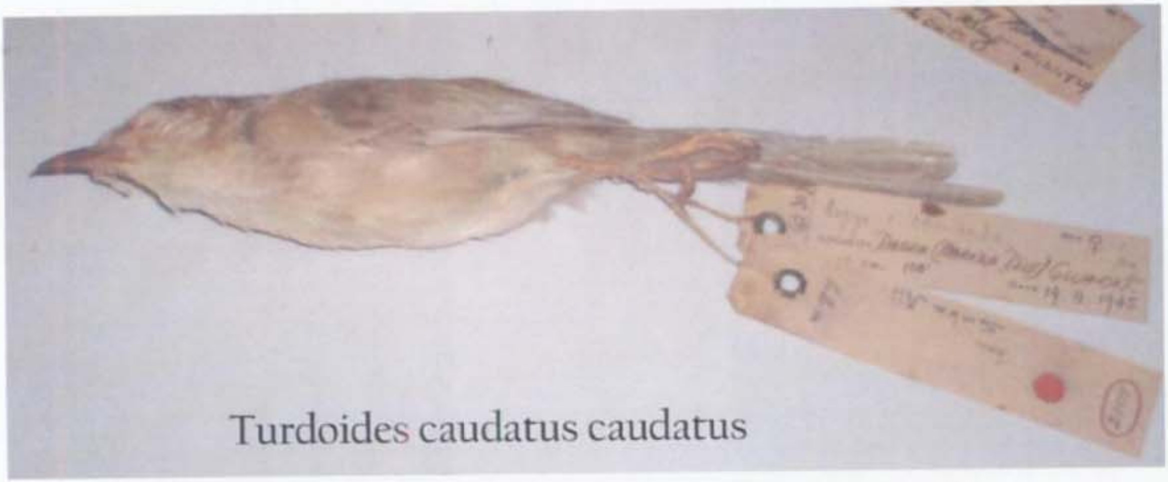
13) *Turdoides affinis affinis*, its commonly known as White headed babbler. It is widely seen in Kerala, Tamilnadu and Mysore. It is resident and found in deciduous forest. Brown is seen on the upper parts of the body with spotted throat, but the head is white. It feeds on insects and vegetable matter and is 22cm long. (Plate 5).

14) *Turdoides striatus somervillei*, is commonly known as Bombay jungle babbler and seen in Maharashtra and Goa. It is resident and found in moist deciduous forest. Brown covers the upper parts of the body but under parts are light brown. Spotted throat are significantly seen. It feeds on insects, grains, seeds and berries. It is 24cm long. (Plate 5).

15) *Turdoides malcolmi* is commonly known as Large grey babbler and found largely in Maharashtra, Goa, Nilgris and Kerala. It lives in shrubs and is resident. Light grey colour covers the upper parts of the body. But the lower parts are white. It eats insects, grains, seeds and berries. It is 26.2cm long. (Plate 5).

16) *Turdoides caudatus caudatus*, it's known as Common babbler and largely found in South Indian peninsular region. It is resident and lives

Plate:6



Turdoides caudatus caudatus

Turdoides striatus orissae

Alcippe poioicephala

in shrubs. Light grey with stripes on head are seen on upper part. But the lower parts are white. It has a long tail of same colour. It feeds on insects, seeds, grains and berries. It is 20cm long. (Plate 6).

17) *Turdoides striatus orissae* commonly known as Orissa jungle babbler. It is found in Godavari River belt. It is resident and lives in shrubs. Light brown covers the upper parts of the body and lower parts are with white stripes. It feeds on insects, seeds, grains and berries. It is 22.1cm long. (Plate 6).

18) *Alcippe poioicephala* commonly known as Quaker babbler. It is found in Peninsular India though not largely. It is resident and found in deciduous forest. It lives in shrubs and feeds on insects. The upper parts of the body is with mud colour, whereas white covers the under parts. It has a long wing of 7.1cm and a tail of 7.7cm. It has a length of 15.5cm. (Plate 6).

19) *Garrulax delesserti delesserti* is commonly known as Wynad laughing thrush. It is resident and locally common. It is found in southwest India, particularly in Goa, Belgaum, Western Karnataka, Kerala and Western Tamilnad. Head is black. The upper parts of the body are dark brown in colour, chest is grey, belly is orange and white colour is seen

Plate:7

Garrulax jerdoni fairbankii

Garrulax delesserti delesserti

below throat. It feeds mostly on the ground and it eats insects, berries and seeds. It has a length of 23cm. (Plate 7).

20) *Garrulax jerdoni fairbankii* commonly known as Travancore laughing thrush. It is resident and largely found in Kerala and Western Tamilnad. The bird is dark brown in colour with light grey throat. Belly has orange shade. It lives on low bushes and occasionally descends to the ground. It eats insects, berries and fruits. It is 22cm long with long tail of 9.3cm. (Plate 7).

21) *Garrulax cachinans* commonly known as Nilgris laughing thrush. It is resident and found only in Nilgiri hills. It feeds on ground and also on low bushes. Dark greenish brown is seen in the upper parts of the body. Head is black, the under parts are orange in colour. Orange shade I seen below the eyes. It is 18.5cm long. It eats insects and berries, esp. raspberries. (Plate 8).

22) *Garrulax jerdoni meridionale* commonly known as Kerala laughing thrush. It is resident and commonly found in southern parts of Kerala. The bird is dark brown in colour with greyish throat. Belly is orange in colour. It lives among bushes and feeds mainly on insects and berries. It is 22.3cm in length.

Plate:8

Garrulax cachinans

Macronous gularis

23) *Macronous gularis* commonly known as yellow breasted babbler. It is resident and largely found seen in Peninsular India. It lives on shrubs and feeds mainly on insects. Dark brown covers the upper parts of the body, whereas yellow is the colour of the under parts. It is 11.8cm long and has a very dark brown head. (Plate 8).`

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Chapter V

SUB FAMILY SYLVIINAE: A REVIEW

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SUBFAMILY SYLVIINAE: A REVIEW

The second category of sampling for analysis is drawn from the subfamily *Sylviinae* of the family *Muscicpinae.* Warbler is the substantive name of the most species of this subfamily. Generally warblers are of small or very small size, are plainly coloured, usually greenish, or brownish or pale greyish; and they have fine narrowly pointed beaks. They are mostly insectivores and arboreal. In most species there is no difference in plumage between males and females. Many species of warblers resemble each other closely. They differ from flycatchers and thrushes in having an unspotted juvenile plumage, resembling the adult plumage.

Warblers inhabit trees, shrubs, lower scrubs and sometimes even grass; they live mostly solitarily or in pairs, the males usually having striking territorial songs. The nest is commonly placed among thick foliage in trees and shrubs. The eggs are almost white, buffish, greenish or pinkish, usually with fine spots. In view of the mainly insect diet, the warblers living in cold and temperate regions are conspicuously migratory.

The subfamily *Sylviinae* comprises of more than 300 species. They are distributed throughout the Old World. 39 species are known to breed in Europe, at least 150 species in Africa, 25 species in south East Asia and 21 species in Australia. The diversity of the family facilitate grouping based on broad similarities in ecology and habitat preferences. It necessarily implies no taxonomic contextualization. The grouping of warblers broadly falls under different heads like reed and bush warblers, scrub and woodland warblers, leaf warblers, grass warblers, ground warblers and fern warblers, kinglets and tit warblers.

Acrocephalus, one of the genera under discussion comes under reed and bush warblers. It has 28 species spread throughout Eurasia, Australia and Africa. In general they are robustly built warbler with prominent bills and large feet, able to clamper about in reed and other vertically growing marsh vegetation. Most of them are uniform brown colour. The genus *Locustella*, another member of the present sample is characteristic of low dense vegetation in Eurasia. *Locustella* warblers are morphologically distinctive with long under tail coverts, very narrow beaks, lacking rectal bristles and large feet. They are chiefly terrestrial, creeping readily on the ground under and through the densest vegetation.

The genus *Hippolais* is also included in the sample for its presence in south India. It falls under the group of scrub and woodland warblers. They are found in broad range of vegetation types from very low scrubs to mature deciduous woodland. Most are distinctively patterned black or grey above with contrasting pale. The genus *Hippolais* is close to *Acrocephalus* and like them, they have large bills. The tail of *Hippolais* is square ended and, although the species are largely plainly coloured, some are brightly yellow.

The genus *Phylloscopus*, another member of the sample comes under the group of leaf warblers. The genus has a confusing assemblage of about 40 species of small, short-billed warblers. Most are arboreal in broad leaved trees, but some also frequent the canopy of coniferous forests. *Phylloscopus* contain small birds of greenish and yellowish colouration, living among the twigs and branches of bushes and tree tops. They are mainly *paleartic* and oriental in their distribution.

The genus *Cisticola*, another member under study falls under the group of grass warblers. It has 75 species. The birds occur in dry scrub, swampy bush, grass fields and reed beds. The genus *Orthotomus* chosen for analysis comes under the group of tailor-birds. These birds are generally somewhat brighter in colour with yellow, brown, rufuous and black. Several species of this genus are well known garden birds. They have long straight bills and long tails. The members of the genus *Prinia* are included in the group of wren warblers. They occur in tropical zones and, their open purse shaped nests are ingeniously woven among twigs and plant stalks. Some wren warblers resemble grass warblers in habits, although not in colour pattern.

The present sample confines itself to the different genera of birds of the subfamily *Sylviinae*, which are distributed in the southern peninsular India. It obviously includes other groups of warblers like ground warblers and fern birds, kinglets and tit warblers from the preview of discussion. The data derived are used for possible causative deduction. The variables and its figures are included in the appendix for detailed reference. The following discussion centres on the characteristics of birds included in the sample.

The present study has selected 271 specimens of the subfamily *Sylviinae* that are widely found in south Indian peninsular region. They belong to 9 different genera and there are 20 different species of them. As noted earlier the sampling is arbitrary without any theoretical prejudice. The abundance, proximity and diversity and availability are roughly considered for selection. The following narrative focuses more on the characteristics and differentiation of different species of bird selected.

1) *Cisticola exilis erythrocephala* has a common name, Red headed fantail warbler. It is widely found in high range of Kerala. It is resident. The upper parts of the body are black, with black and brown lines, whereas underneath is yellowish. It lives among tall coarse grass and bracken scrub. Also open spaces alternating with sholas. It feeds on insects mainly ants. It has a length of 12 cm. (Plate 9).

Plate:9

Cisticola exilis erythrocephala

Cisticola juncitis salimalii

Prinia hodgsonii albogularis

2) *Cisticola juncitis salimalii* is commonly known as Kerala streaked fantail warbler. It is found in paddy fields of Kerala and is a common resident. It generally skulks among grass and herbage making short flights and quickly perching on to stem. It feeds near ground and insects are the main food. It has black and brown lines on the upper parts and yellowish underneath. It is 10.2cm long. (Plate 9).

3) *Prinia hodgsonii albogularis*, its common name is Southern ashy grey wren warbler. It is found in Mysore, Kerala and Tamil Nadu. It is common a resident. It lives in thorn scrubs, lantana brakes, deciduous jungles with tall grass and bushes. It feeds on insects. It has a dark ash colour on the upper part of the body and whitish underneath. It is 11.5cm long. (Plate 9).

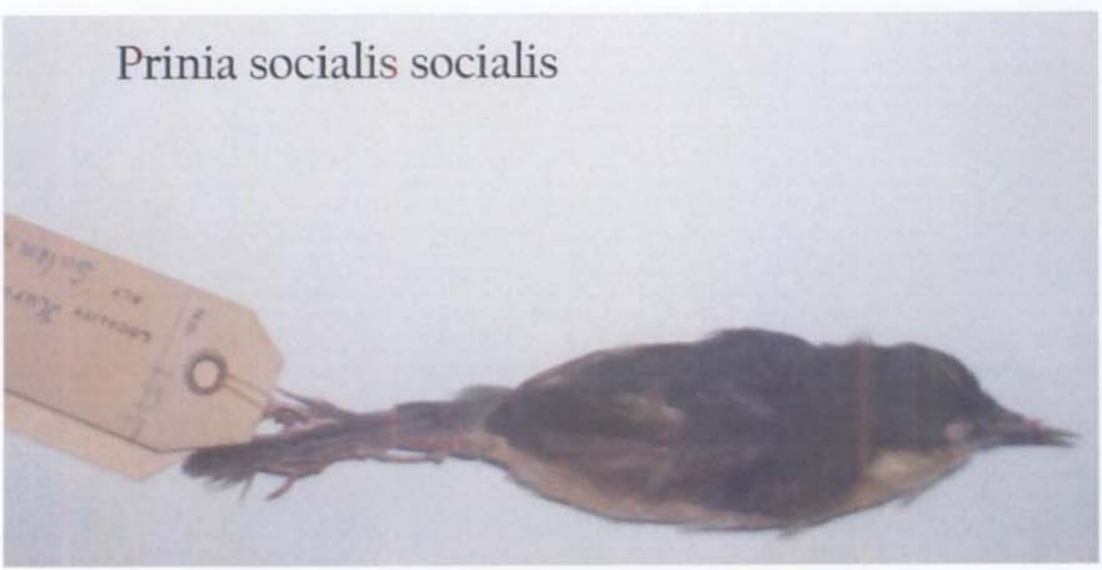
4) *Prinia subflava franklini* commonly known as Nilgris plain wren warbler. It is found in Kerala and western Tamil Nadu. It is resident and lives in scrubs, thorn, thickets mixed with high grass, wild cane in damp situation. It is also seen in mangroves and open cultivation. Dark ash colour is on the upper part of the body and white covers the underneath. It has 11.5 cm length. (Plate 10).

5) *Prinia sylvatica sylvatica*, its commonly known as Peninsular jungle wren warbler and found in whole of South India. It is resident. It hops

Plate:10

Prinia subflava franklini

Prinia sylvatica sylvatica



Prinia socialis socialis

and flits about jerkily in grass and thorn scrub. It affects low shrub jungles. Upper parts are dark ash colour and underneath is white. Its length is 15.2cm. (Plate 10).

6) *Prinia socialis socialis* commonly known as Southern ashy wren warbler. It is found in south India and is a common resident. It lives in grasslands and scrubs in deciduous forests, reed beds, mangrove and grassy hill sides. It has blackish brown head. Wing is brown and lower parts are white in colour. It has 11.5cm length. (Plate 10).

7) *Phragmaticola aedon aedon*, has a common name thick billed warbler and is found in Mysore, Kerala and Tamil Nadu. It is migratory. It lives in marshy places covered with reeds and bushes, patches of tall grass and weeds, bracken bushes on water logged grounds and undergrowths in light forests. The upper parts of the body are greenish brown colour, whereas the underneath is yellowish. It is 18cm long. (Plate 11).

8) *Acrocephalus stentoreus brunnescens* is commonly known as Indian great reed warbler. It is found in Kerala and Madhurai. It is migratory and affects reed beds, tall bushes around water and mangrove swamps. It feeds on insects, particularly grasshopper. It is greenish in

Plate:11

Phragmaticola aedon aedon

Acrocephalus stentoreus Brunnescens

Acrocephalus dumetorum

colour on the upper parts of the body and white is on underneath. It is 17.6cm long. (Plate 11).

9) *Acrocephalus dumetorum* is commonly known as Blyth's reed warbler and found largely in Peninsular India. It is a migratory bird and seen in bushes away from water. It hops and creeps through bushes and undergrowths. It feeds on insects. It has greenish brown colour on the upper parts of the body and white underneath. It is 17.6cm long. (Plate 11).

10)*Acrocephalus agricola agricola*, its known as Indian paddy field warbler and found in Peninsular India. It is migratory and lives within thick cover hopping from stem to stem, close to ground or water. Brown colour covers the upper parts, whereas white is on the underneath. It is 11.5 cm long. (Plate 12).

11)*Hippolais caligata rama* is commonly known as Indian Booted tree warbler. It is migratory bird and is widely found in the belt from Madhya Pradesh to Kanya Kumari. It flocks up to 10 birds. It fly out from extends of a twig to take insects on the wing. Light brown colour on the upper parts of the body and white shade is on the underneath. It is 10.2cm long. (Plate 12).

Plate:12

Acrocephalus agricola agricola

Hippolais caligata rama

Phylloscopus trichiloides viridanus

12)*Phylloscopus trichiloides viridanus*, is commonly known as Western greenish leaf warbler and is found in belt from Madhya Pradesh to South Kerala. It is a migratory bird and found mostly in foliage canopy, undergrowth and bustling among leaves. Olive green colour is seen on the upper parts, with whitish underneath. It is 11cm long. (Plate 12).

13)*Phylloscopus occipitalis occipitalis* is commonly known as Large Crowned leaf warbler. It is found in southern part of India and is a migratory bird. It flits among branches and shrubs, and hunts mostly on canopy. Upper parts has olive green colour and white shade is seen on lower parts. It is 11cm long. (Plate 13).

14)*Phylloscopus trichiloides nitidus* is commonly known as Bright green leaf warbler and found in Kerala, Tamil Nadu and Eastern Ghats. It is a migratory bird and affects heavy forests and cultivation. It has olive green colour on upper parts and white shades on the underneath. It is 10.5cm long. (Plate 13).

15)*Phylloscopus affinis affinis* has a common name Tickell's leaf warbler. It is found in Peninsular India and is a migratory bird. It affects scrubs and low bushes. It has olive green colour on the upper

Plate:13

Phylloscopus ocipitalis ocipitalis

Phylloscopus trichiloides nitidus

parts and yellowish green on the underneath. It feeds on beetles, weevils and other insects. Its length is 10.4cm. (Plate 14).

16)*Phylloscopus magnirostrus*, commonly known as large billed leaf warbler. It is common in Kerala but rare in other parts of the country. It is a migratory bird and lives on crown of medium sized trees and lower canopy of all trees. The upper parts of the body are olive green in colour and lower parts are yellowish green. It eats insects and has a length of 12.7cm. (Plate 14).

17)*Schoenicola platyura* commonly known as Broad tailed grass warbler. It is found largely in South Kerala. It is resident. It has dark brown upper parts and whitish lower parts. It feeds on insects. It has a length of 14cm. (Plate 15)

18)*Orthotomus sutorius guzuratus* commonly known as Indian tailor bird and is found largely in Peninsular India. It affects herbaceous gardens, deciduous jungles, cultivations, low herbage or undergrowth. It is resident. The body is greenish in colour. The head is pleasant brown, wings are slate colour, the under parts are whitish cream. It feeds on insect larvae and flower nectar. It is 10.5cm long. (Plate 15).

19)*Locustella certhiola rubescens*, is commonly known as Palla's grasshopper warbler. It is found in south Kerala. It is a migratory bird

Plate:14

Phylloscopus affinis affinis

Phylloscopus magnirostris

Plate:15

Schoenicola platyura

Orthotomus sutorius guzuratus

and lives on low herbage and undergrowths. It has dark brown colour with lines all over the body. Belly is blackish brown, legs are brownish. It feeds on insects. It keeps well hidden in the fields. It has a length of 12.9 cm. (Plate 16).

20)*Locustella naevia straminae* is commonly known as Eastern grasshopper warbler. It is migratory bird found largely in Kerala. The upper parts of the body are brown in colour, with spotted head and body. White covers underneath. The spots around the neck make the bird conspicuous. It lives in low herbage and undergrowth, and move with jerky flights. It feeds on insects. It has a length of 12.5cm. (Plate 16).

ADAPTATIONS OF BIRDS IN THE SUB FAMILIES OF *TIMALIINAE* AND *SYLVIINAE*

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Chapter VI

DISCUSSION ON TIMALIINAE

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The birds grouped under different niche exhibit certain commonalities as well as differences. As discussed in the earlier chapter the foregoing analysis centres around the significant commonalities as well as differences of the birds coming under the subfamily of *Timaliinae.*

BODY LENGTH

The evergreen niche group has birds of varying sizes ranging from, on an average, 115mm to 230mm. The graphical representation of the length of the birds under study is shown in fig 1. Corresponding range of difference is also seen in their body weight and to be precise, it is proportional to the range in size.

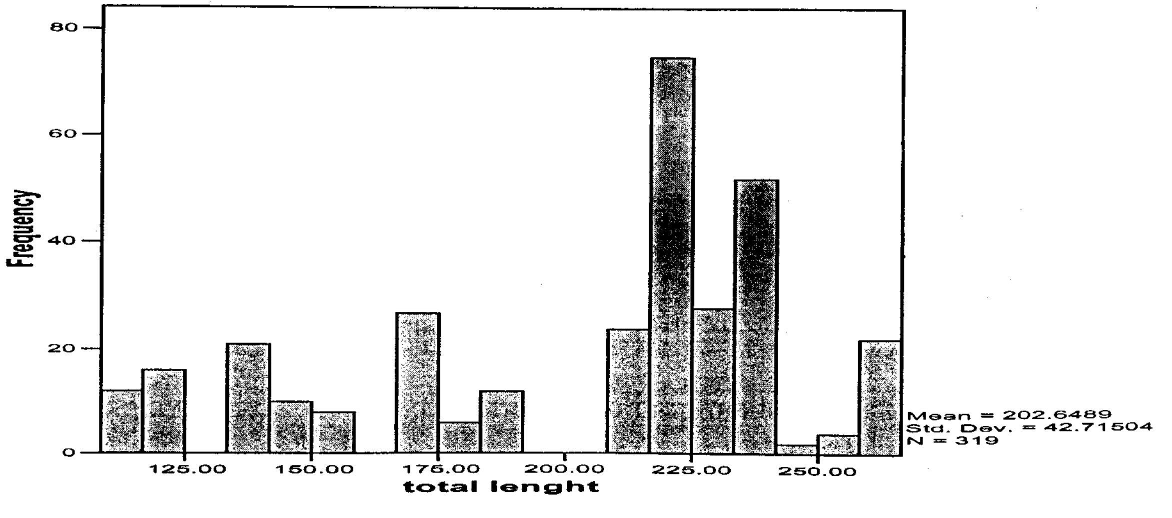

Figure 1: Distribution of total length for all birds

A good number of birds from the given sample population of the niche group A1, fall under the upper side of the range. It signifies the predominance of the birds with longer size in the niche group. The significant range of 170mm to 230mm is to be treated as a supporting argument for the above deduction. The lower limit of the size of the birds of the niche group B1, starts from 150mm and ranges up to 258mm, spanning a range of 100mm. Interestingly enough more than 70% of the birds of this group have lengths of more than 200mm. This is a striking feature of this group which keeps it different from other groups. It is to be noted that corresponding increase in the weight of these birds is also seen significantly in the data. It is not clear whether the birds of longer size are confined to either sholas or evergreen habitat. Logically it can be argued that they intercept the habitat with regard to its size.

Interestingly enough all sample points of the population of the niche group C1 have higher values for their lengths. It ranges from 218mm to 222mm. The short interval of 4mm or the length size of the birds of this niche group is significant. It explains the homogeneity of the birds of this group with regard to its size. Consequent increase in the weight is also significant. 142mm is the lower limit of the lengths for the species in the D1 niche group. It ranges upto 240mm. More than 60% of the birds of this niche group fall under lower side of the range. It is interesting to note that the lower limit of its size overlaps with the size of the evergreen niche group. In fact, this feature to a certain extent justifies the grouping under different niche. The size is proportional to its weight at all levels.

It is interesting to note that the lower limit of its size overlaps with the size of the evergreen niche group. In fact, this feature to a certain extent justifies the grouping under different niche. The size is proportional to the weight at all levels. The sample space is not abundant in the case of the niche group E1. The lengths of this group have two extremes, 140mm and 230mm, generating a span of 90mm difference. It is worth noting that the lower limit and the upper limit share both the niche group viz, evergreen and deciduous. The fig 2 shows the frequency of the length of the birds under study on the basis of niche group. Corresponding increase in the weight is also noted.

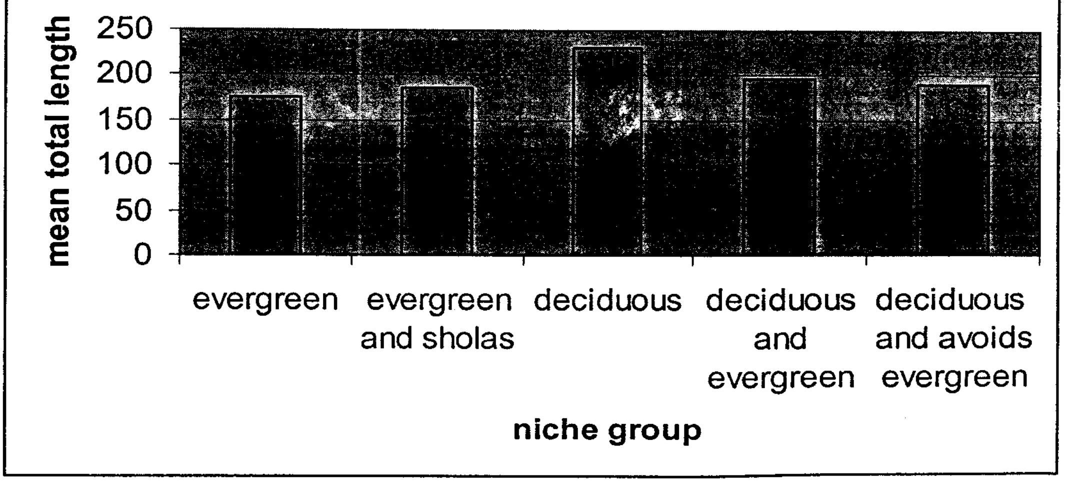

Figure 2: Distribution of total length based on niche group

TARSUS LENGTH

Tarsus of the bird is one of the strongest indices of adaptation process, as it has an organic relation with the behavioral pattern of the birds in the given habitat. This presumption is employed in the present discussion and the details given in the foregoing part span basically from this inter and intra relationships.

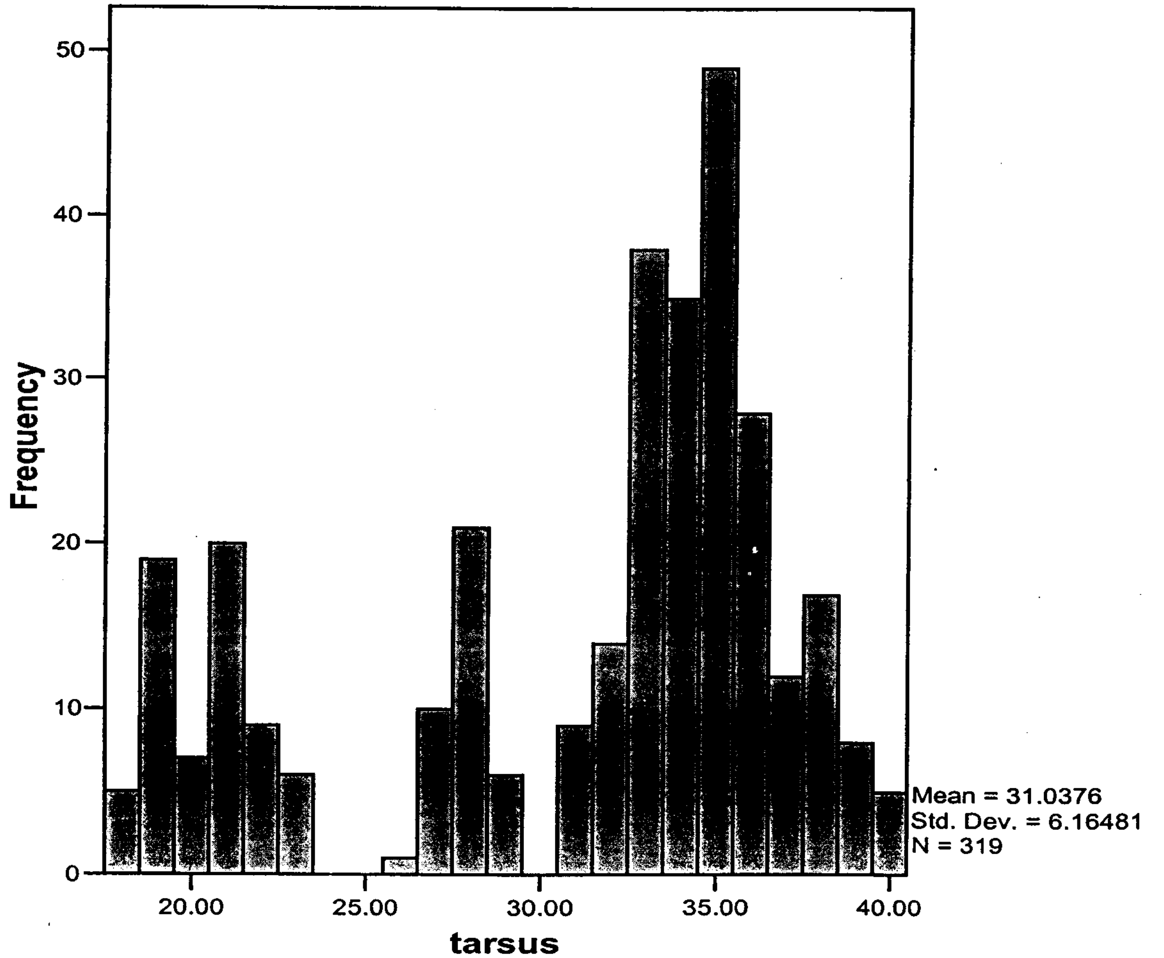

Figure 3: Distribution of tarsus length for all birds

The fig 3 gives a vivid picture on the distribution of length of tarsus. The birds of the niche group A1 has a range of length, on an average of 21-38mm, but major part of the sample space of this group have longer tarsus. In fact it is >35 which is the upper limit of the length of the tarsus of all birds in the subfamily. The birds of the niche group B1 in general have longer tarsus with an exception of two (28,27mm). All other birds have an average length of 35mm which is significantly the upper limit of the birds of the evergreen niche groups. The space of interception between evergreen sholas explains the reasons for commonalities. All the birds of niche group C1 have longer tarsus and it invariably crosses 33mm and does not show significant variation.

The niche group D1 has a unique range of 19mm- 38mm. This range can be well explained with the fact that the niche group D1 shares the features of both deciduous and evergreen. The niche group E1 has only two points, with length 20mm and 35 mm. The big range of length can also be explained as the given niche group has the combined characters of deciduous that avoids evergreen habitats.

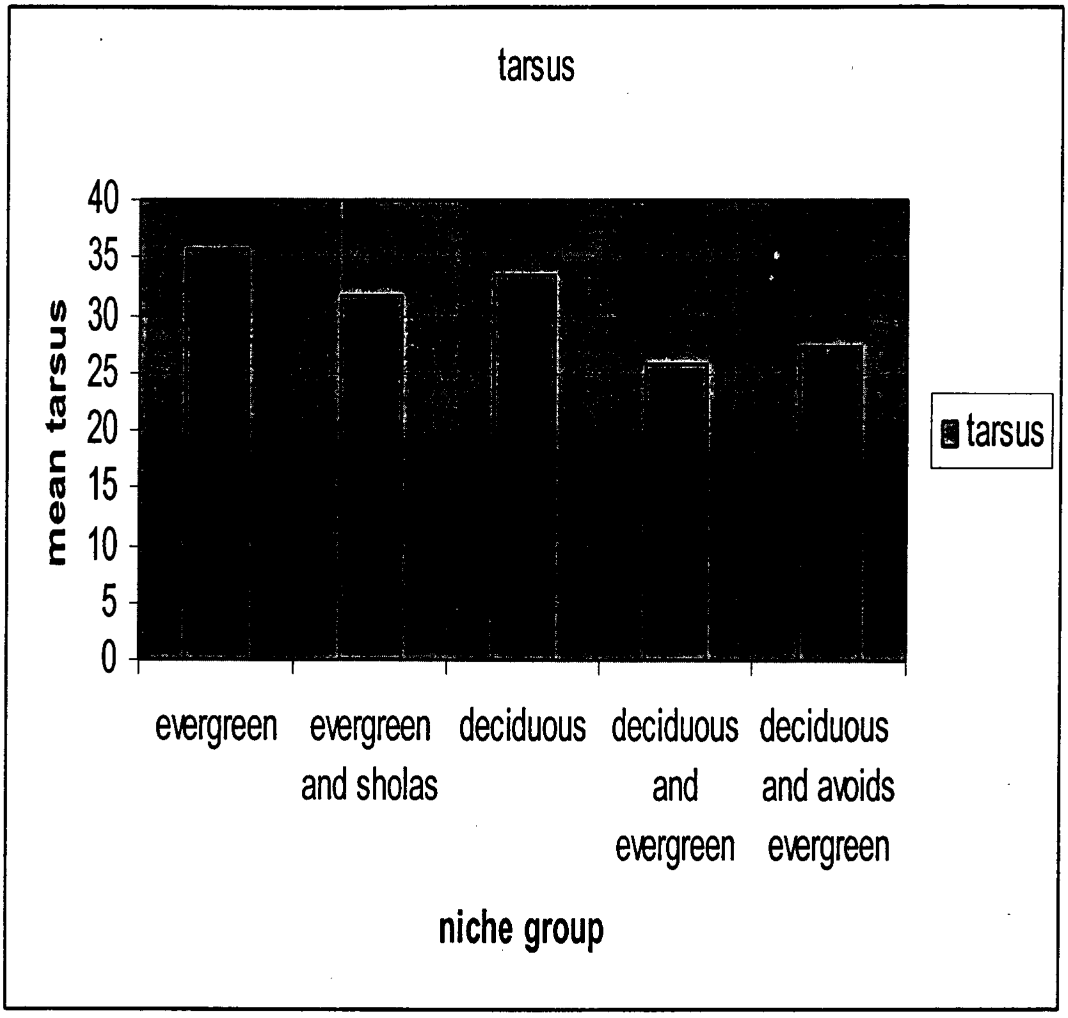

Figure 4: Distribution of tarsus length for all niche group

The figure 4 speaks on the distribution of the length of tarsus on the basis of niche group .The above discussions points out the validity of the general rule that ground living species tend to have longer and stouter tarsi which are one of the indices of morphological adaptation. All the forms considered here are primarily adapted for ground foraging and their proportion and length of their legs are consistent with this mode of feeding.

BILL LENGTH

The length of the bill is a good indicator to understand the size of the prey as well as the feeding methods most frequently employed. The bill morphology has been correlated with the structure of feeding substrates. The value of the length of the bill for all species of Timaliinae spans a range from 15mm to 34 mm. It is shown in fig 5. The significant interval in the values is to be analysed in the context of heterogeneity of the behavioral pattern of bird under study.

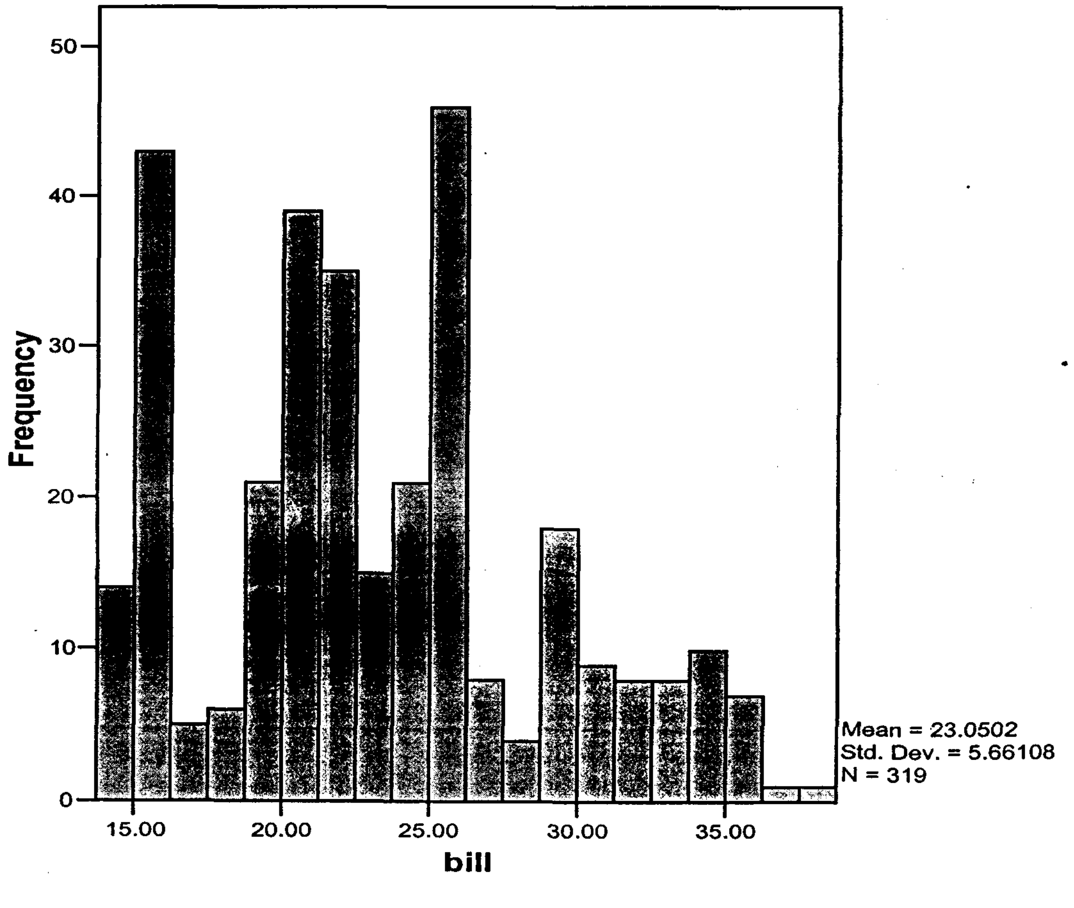

Figure 5: Distribution of bill length for all birds

The species of niche group A1 has a range from 15mm to 23mm. A good number of this sample space has length of more than 20mm.

The niche group B1 has nine members and it has a range of length from 19-33mm except for two. All the birds of this group have a value more than 20mm. The longest among the lot has 33mm, which is the upper limit of the length of the bill of all species of this subfamily *Timaliinae.*

The niche group C1 completely falls in the upper side of the range of the values of all species of the family. The birds of this group are noted for its extra long beak. The high variation in the length of the bill for the birds of the niche group C1, may be understood in the context of the grouping of niche habitat. It has a combination of evergreen and sholas. This kind of range is seen consistently among these groups for different variables. The niche group D1 has also significant range of 16-22mm which has also the same rational on the niche grouping. This niche combines many of the characters of deciduous and evergreen. The niche group E1 has two values 15mm and 24mm. The fig 6 shows the distribution on the basis of niche group.

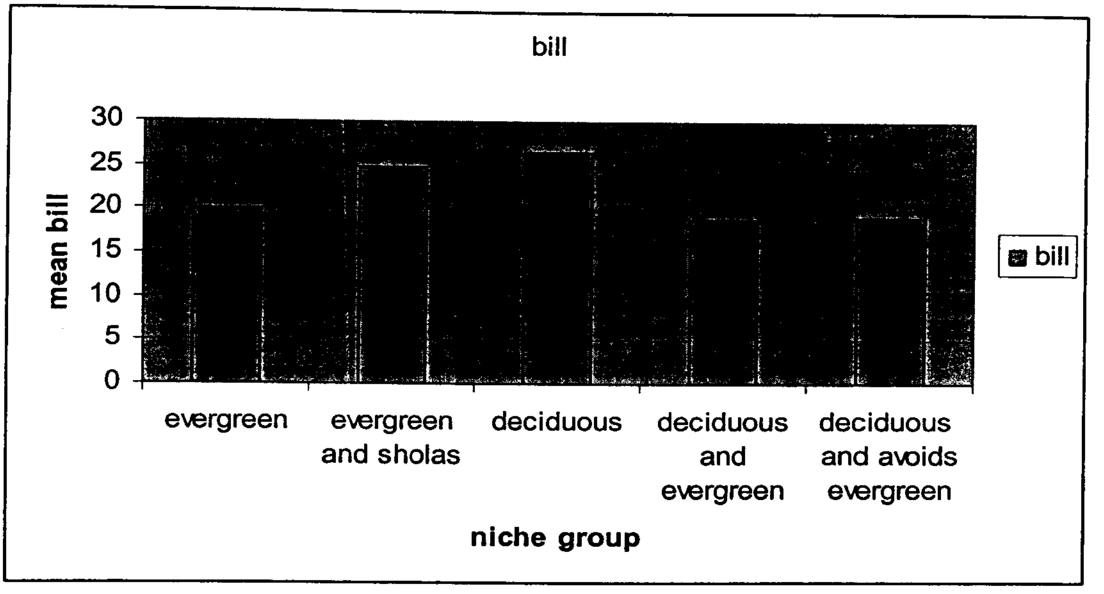

Figure 6: Distribution of bill lengths for all niche groups

Pomatorhinus schisticeps travencorensis has comparatively longer bill whereas *Dumetia hyperythra* has a slender and small bill. Invariably the birds of this subfamily feed mostly on insects, caterpillars, grains, berries, flower nectar etc.

TAIL LENGTH

Tail length of the birds has direct relation to tail shape and flight ecology. The birds under study have interesting observations on the tail factor. In general the data on tail length spans a range from 44mm to 139mm. The figure 7 describes the distribution of the data for all birds under study.

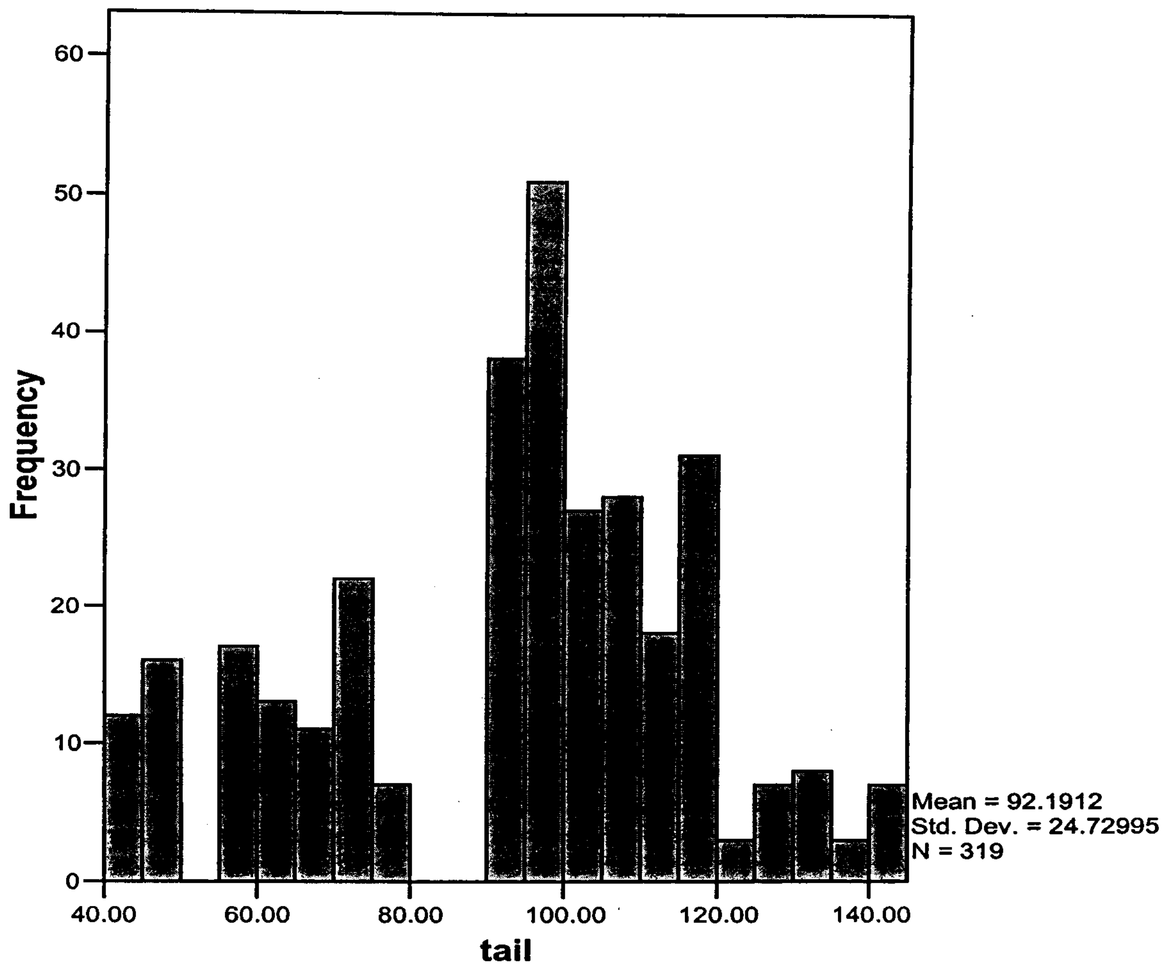

Figure 7: Distribution of tail length for all birds

The niche group A1 has a conspicuous range from 44mm to 96mm. It is worth noting that the specie *Rhophocichla atriceps* have comparatively shorter tail against their body length. On an average its tail length constitutes a value less than 1/3rd of its body length, whereas other species of the niche group have longer tail. Interestingly enough, *Rhophocichla* has its tail length shorter than its wing length. The values for niche group B1 ranges from

70mm to 113mm. On an average the tail length of this group also tend to 1/3rd of body length. *Pellorneum ruficeps ruficeps*, of this niche group has a shorter tail than wing. The niche group C1 has a range from 95mm to 139mm. The *Turdoides malcolmi*, of this niche group has 139mm against the body length of 250mm. The values for the niche group D1, has 55mm in the lower limit and 117 in the upper limit. It is to be noted that all these values tend to 1/3rd of body length. The niche group E1 has two values, 60mm and 105mm against their body length of 140mm and 230mm respectively. In general the tail length of this subfamily is comparatively shorter.

The distribution of the values of tail length, on the basis of niche grouping is shown in figure 8.

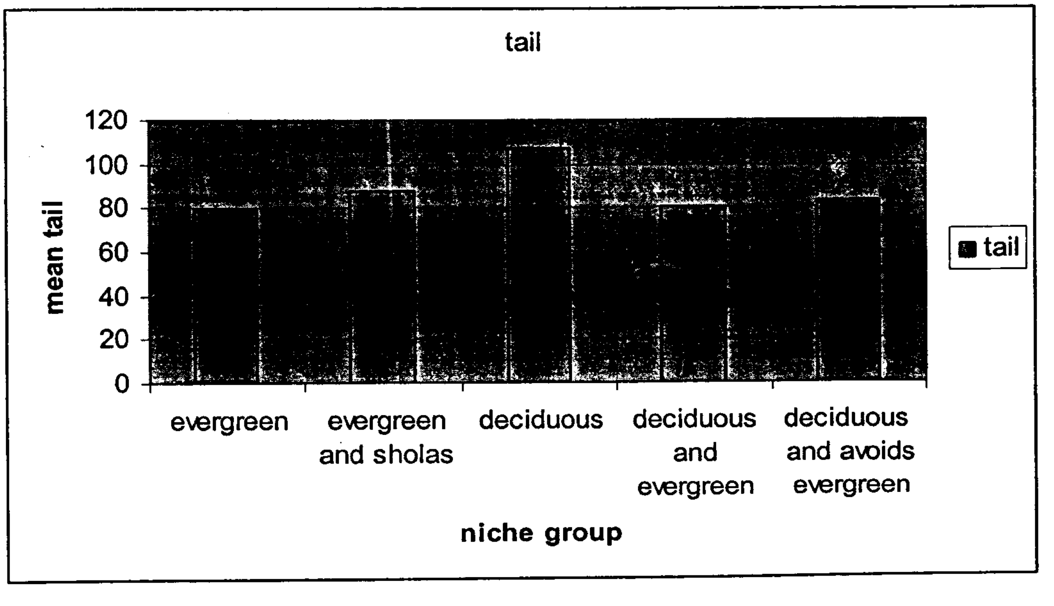

Figure 8: Distribution of tail length for all niche groups

LONG TOE

Long toes support the bird in climbing. The values of long toe for all the birds under study ranges from 16mm to 37mm, which is shown in fig. 9.

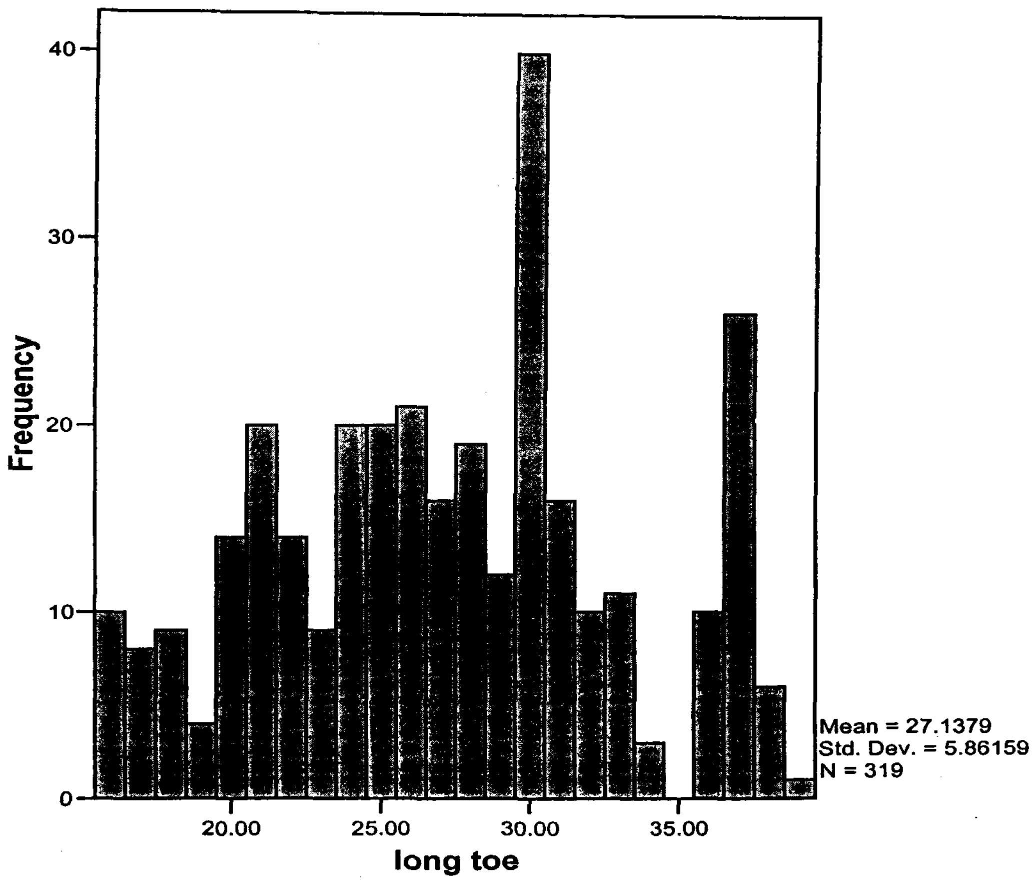

Figure 9: Distribution of length of long toe for all birds

The niche group A1 has 21 mm and 32 mm as its lower and upper limit respectively. As in the case of tail factor the species *Turdoides subrufus subrufus, Garrulax jerdoni Fairbankii* and *Garrulax jerdoni meridionale* have comparatively longer toe among this group. The niche group B1 and C1 has the range from 22mm to 32mm, but with different variations. It is interesting to note that species *Turdoides malcolmi* has a long toe. The niche group C1 is heterogeneous with regard to toe length/ body length ratio. The niche group D1 has a range from 16mm to 38mm. It is interesting to note that *Turdoides subrufus hyperythrus* has longest toe among the lot and significantly its relative toe length to the body length is also high. The niche group E1 has two values 18m and 28mm. The data on longest toe for all species are shown in the figure 10.

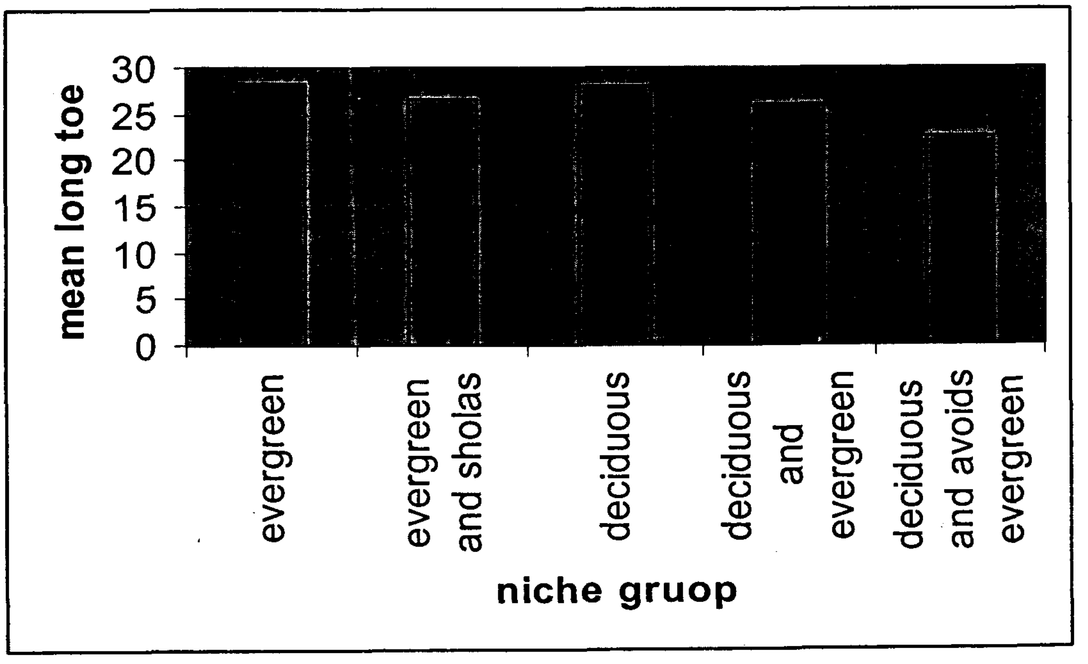

Figure 10: Distribution of length of long toe for all niche groups

WING LENGTH

Wing is a powerful indicator of morphological adaptation. The size, form and its span are the basic parameters of the study on wings. It is worth noting that on an average the ratio to wing to body length for the species of the subfamily *Timaliinae* centres around an interval of 2 to 2.5. Fig 11 shows the frequency of wing length.

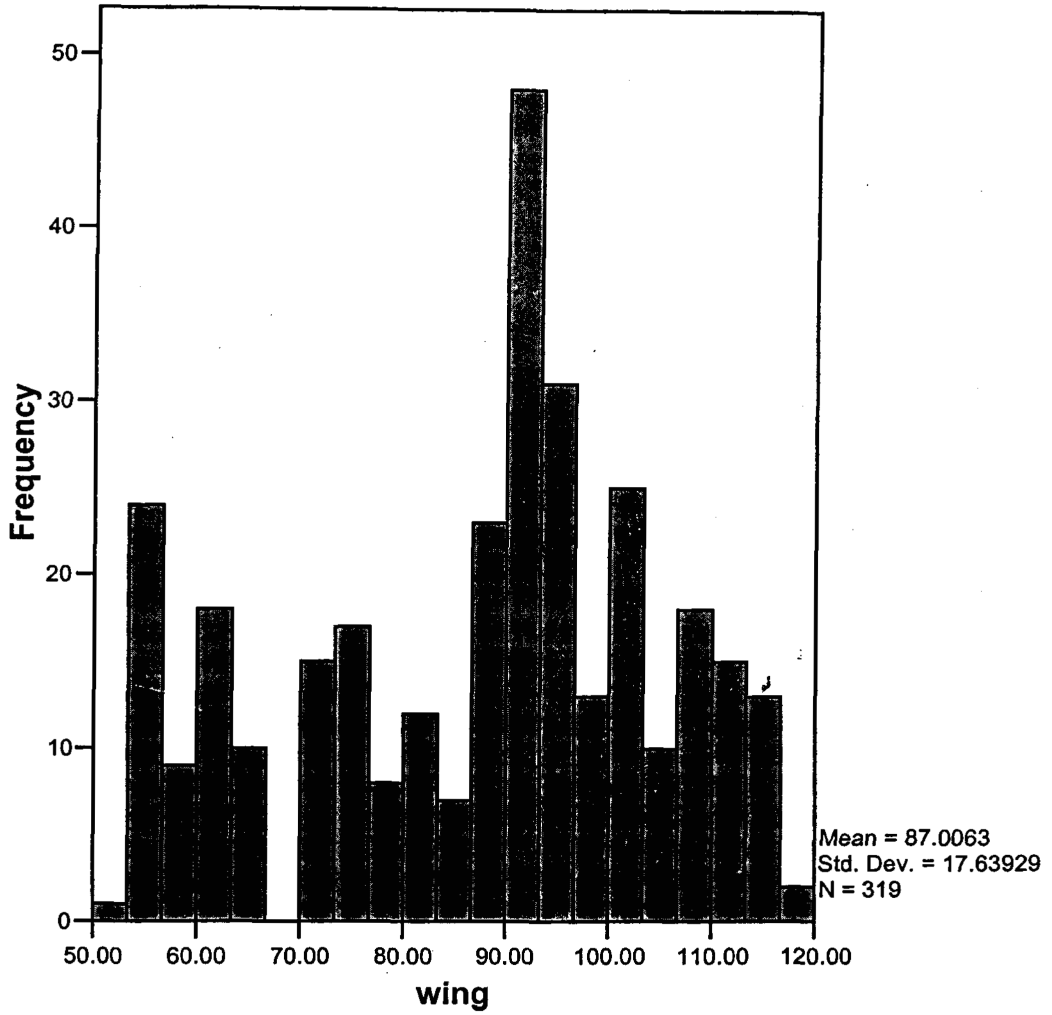

Figure 11: Distribution of wing length for all birds

The length of the wings of the niche group A1 invariably tends to a value of 2.5 in W/L ratio. This consistency becomes more meaningful when we look at the value from the upper limit of the interval of the value of all species of the subfamily. The values of the wing for the species of this niche group ranges from 57mm to 92mm and most of the points of the sample space fall in the upper side of the range. The *Garrulax jerdoni* has an average 92mm wing length and interestingly it has 230mm body length.

The values of the species of niche group B1 ranges from 69mm to 108mm, with a heterogeneous distribution. It is to be noted that the ratio of W/L of the species of this family spans significant interval from 2.3 to 2.5. But more than 70% of the birds of this niche group, tends to 2.4 in the value of W/L ratio. The *Turdoides striatus* invariably shows a value closer to 2.5 . *Turdoides malcolmi* has mean wing length of 112mm, which is highest among the lot. *Garrulax delesserti* also has the same value for the wing length.

The values of wing length for the niche group D1 have a significant range from 64mm to 93mm. Consequently the ratio also moves from 2.1 to 2.5. The overlapping of the value of the upper limit among the niche group C1 and D1, is understandable in the context of combination of niche groups. The niche group E1, has two divergent values of the wing length viz, 59mm and 103mm. but interestingly enough both of them have the same W/L ratio. The fig 12 describes the length of the wing on the basis of niche group.

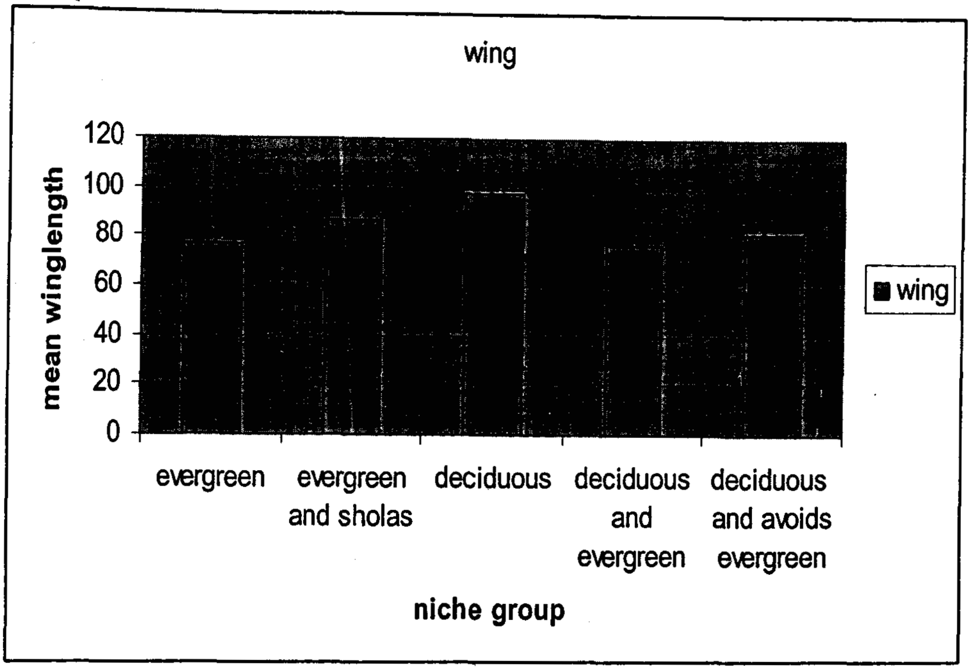

Figure 12: Distribution of wing length for all niche groups

The consistency in the values of ratio W/L should be related to the kind of exploitation of the vegetation of the habitat. It can safely be deduced that the species of this subfamily invariably have longer wings enabling them to forage in where vegetation is comparatively thin. If geometric similarity prevails, then wing length would be proportional to (body size)$^{0.417}$. The fig 13 explains the correlation between wing length and the body size for all birds of *Timaliinae* under study.

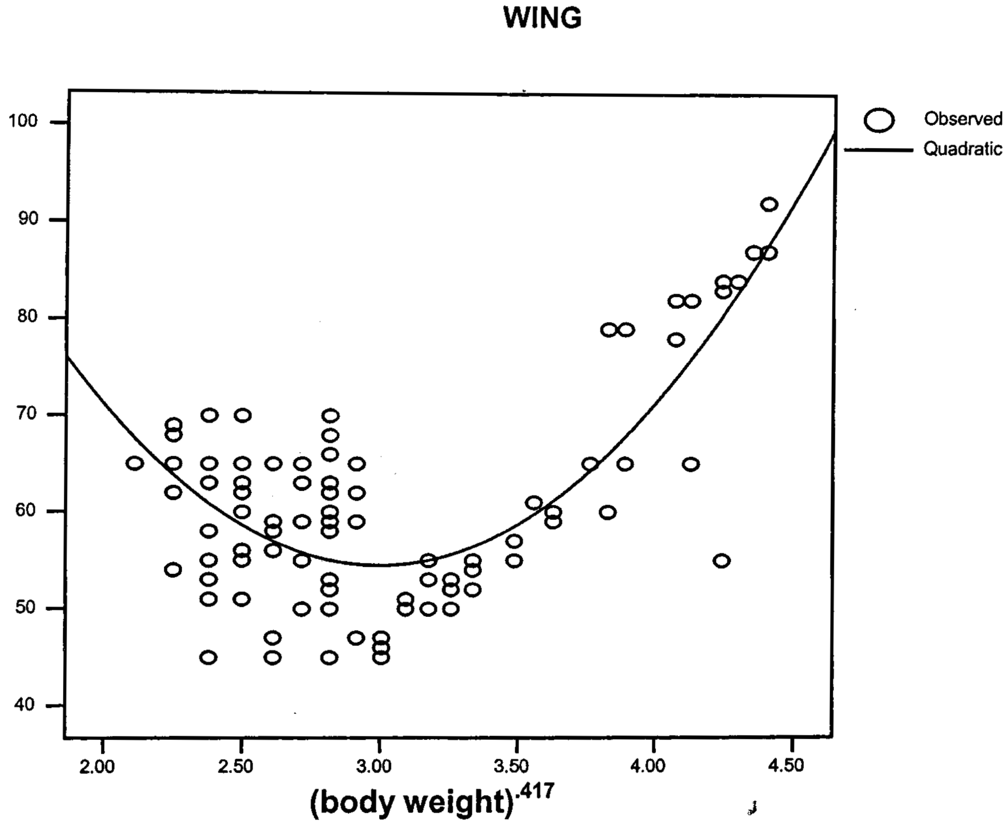

Figure 13: Ratio of wing length body size

Table 1: Correlation analysis of winglength to (body weight)$^{0.417}$

		WING	(body weight).417
WING	Pearson Correlation	1	.496(**)
	Sig. (2-tailed)	.	.000
	N	271	100
(body weight).417	Pearson Correlation	.496(**)	1
	Sig. (2-tailed)	.000	.
	N	100	100

It indicates that body weight almost increases with wing length.

WING SHAPE

(A) INDEX OF ROUNDNESS

The values of index of roundness for all species have a range from 0.8 to 0.9. The fig 14 shows the distribution of values of index of roundness. Theoretically index of roundness can assume a value between 0 and 1. Rounded wings are seen in birds of Timaliinae. The presence of rounded wings implies its behavior of short distance flying. The ecogeographical rule implies that a relatively shorter wing facilitates flight in or about dense vegetation. It should be noted that exploitation of dense vegetation may result in reduce body size as well as in reduced length of wing.

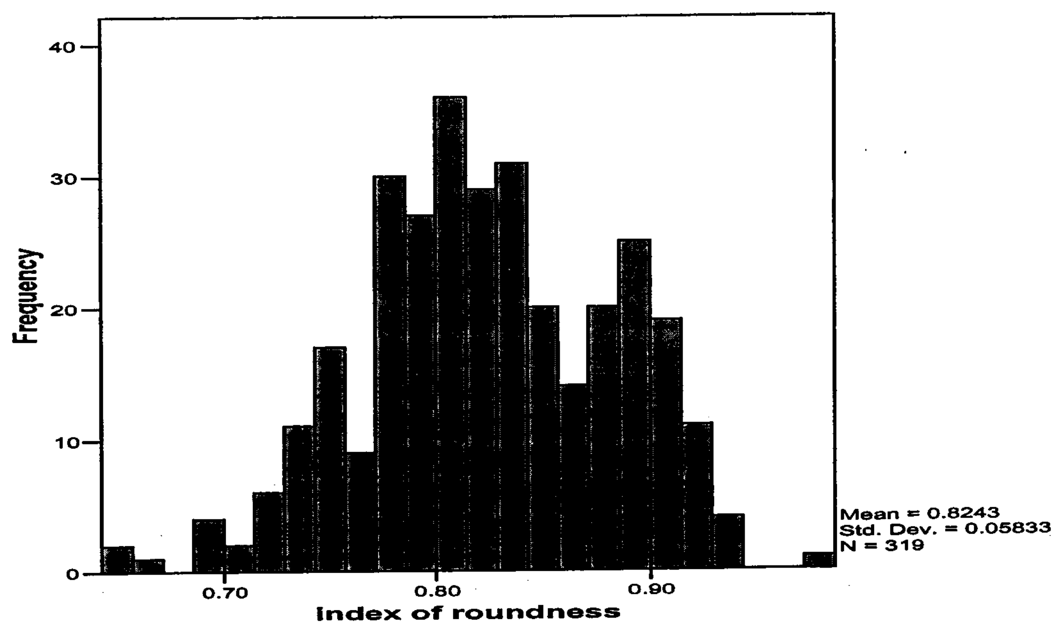

Figure 14: Distribution of index of roundness for all birds

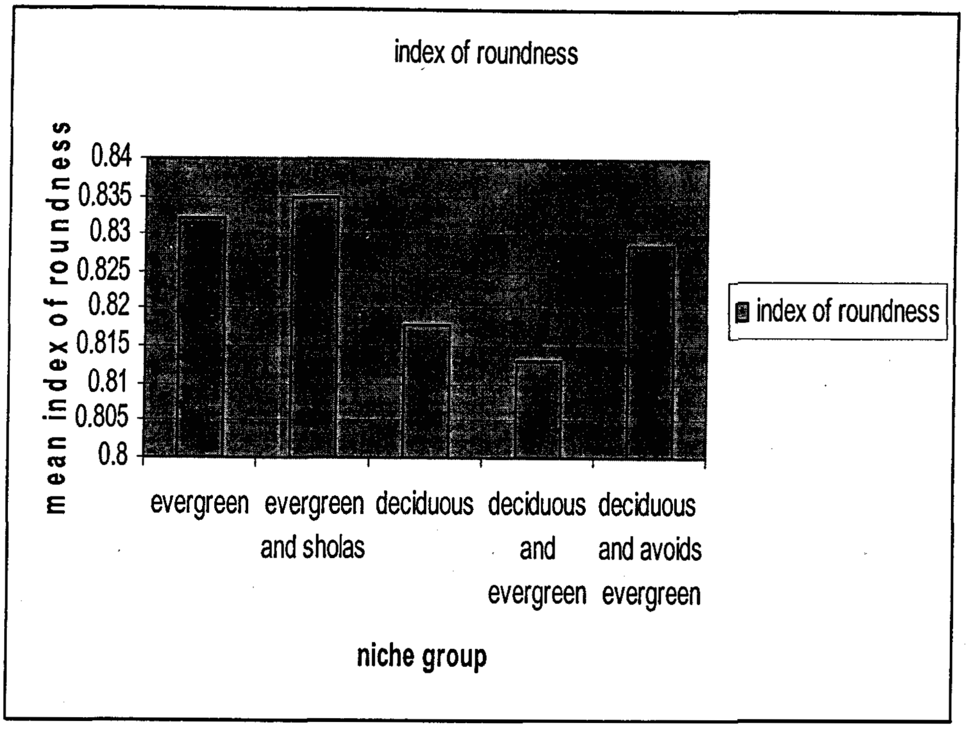

Figure14 (a): Distribution of index of roundness for all niche groups

(B) WING SPAN & ASPECT RATIO

The two variables are determinants to understand the capacity of flying. Different types of flight are associated with different shapes of the wing. All the species under study have relatively short and broad wings, although some differences occur among the species. In general the drag on the bird is very small because of the low relative air speed of the body. The geometric similarity requires that wing span should be proportional to (body size)$^{0.33}$. The fig. 15 shows the relation between wing span and body size for all the birds under study.

Table 2: Correlation analysis of wing span and (body weight)$^{1/3}$

		Wing span	Cub root weight
Wing span	Pearson Correlation	1	-.069
	Sig. (2-tailed)	.	.218
	N	319	319
Cub root weight	Pearson Correlation	-.069	1
	Sig. (2-tailed)	.218	.
	N	319	319

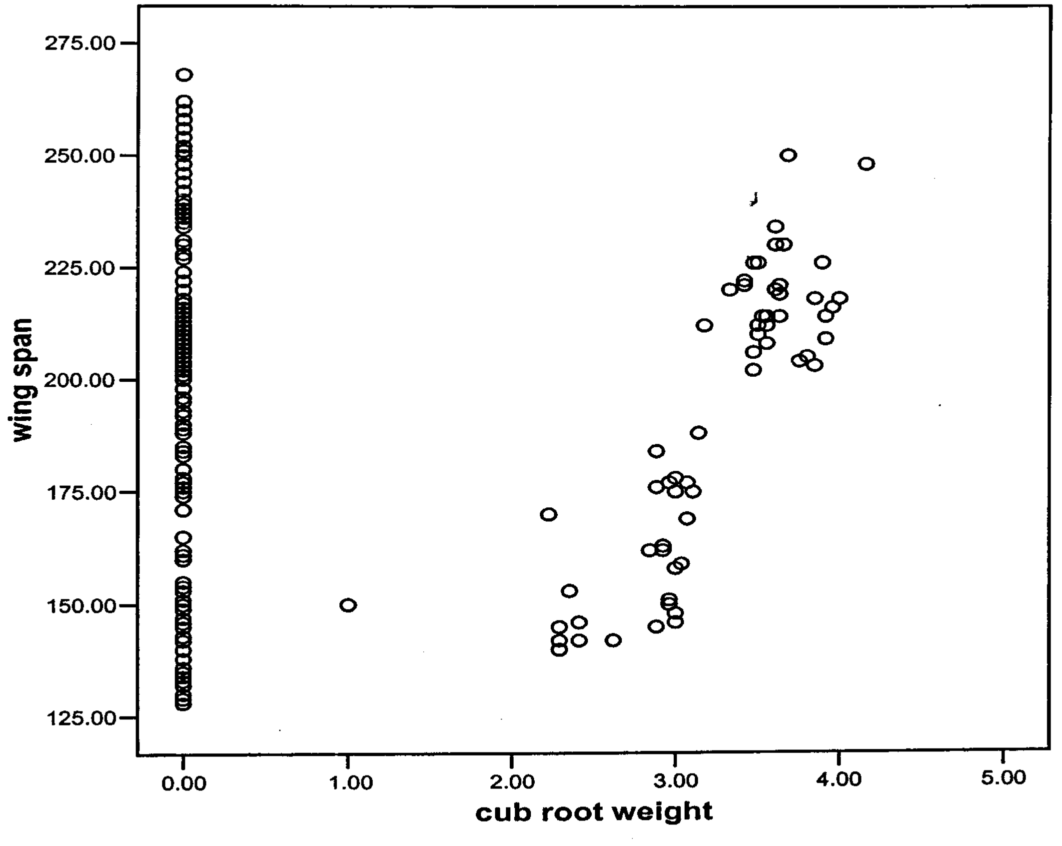

Figure 15: Ratio of cube root weight to wing span

The aspect ratio explains more about the functional dimensions of wing and wing span. Wings of most birds of *Timaliinae* have relatively low aspect ratio and high wing loading. Wing loading enables the bird to produce the required lift to fly. These birds invariably hop on branches or on the ground to a greater extent in search of food. The Fig 16 gives interesting relation between aspect ratio and wing length of all birds of *Timaliinae* under study.

Table 3: Correlation analysis of wing length and aspect ratio

		wing	Aspectratio
Wing	Pearson Correlation	1	.073
	Sig. (2-tailed)	.	.196
	N	319	318
Aspectratio	Pearson Correlation	.073	1
	Sig. (2-tailed)	.196	.
	N	318	318

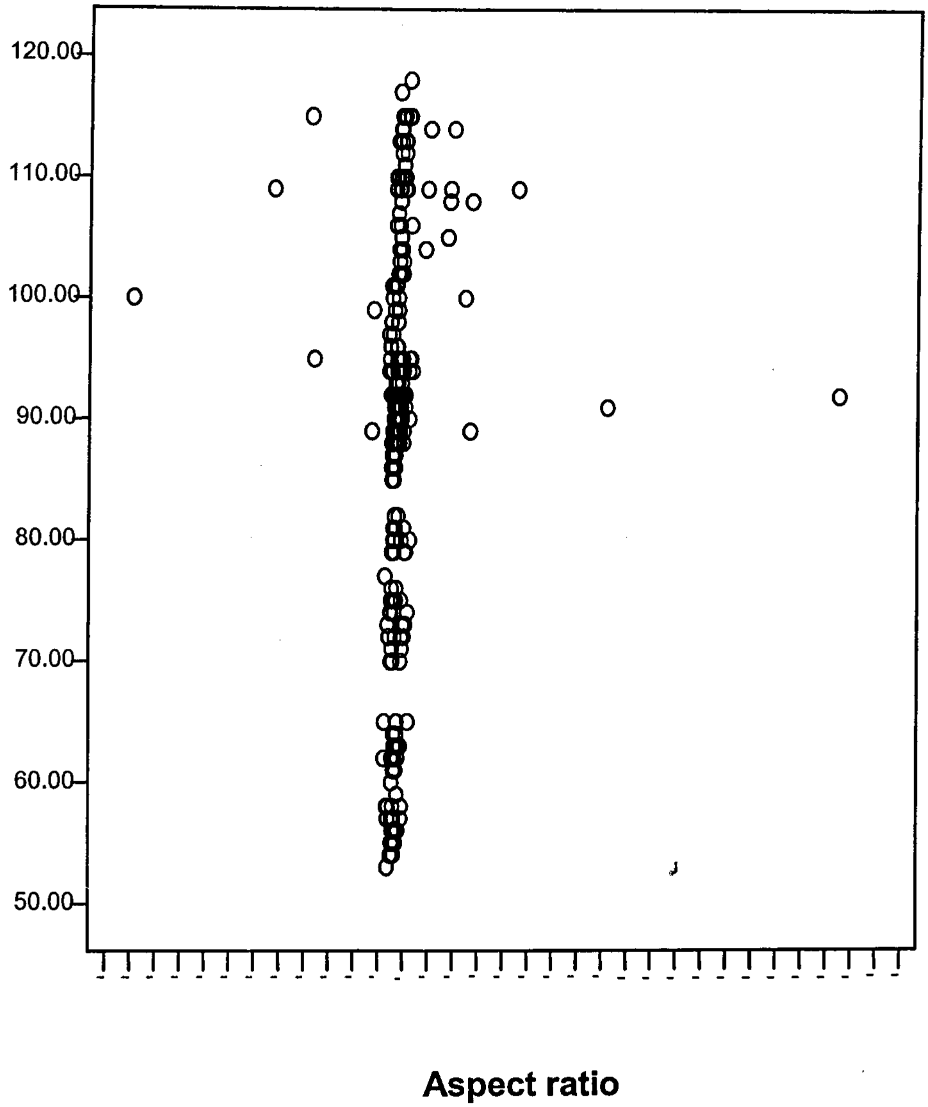

Figure 16: Relationship between aspect ratio and wing length

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Chapter VII

SUMMARY ON TIMALIINAE

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An analysis on the different variables of morphological adaptation. A case study on the subfamily *Timaliinae*.

The literatures on morphological adaptation of birds have stressed (Dilger 1956, Kear 1962, Newton 1967) the importance of behavior in determining morphological adaptation. Obviously, it has lacked a discussion on the inter and intra relationship among the behavioral variables and the morphological characters. The present discussion runs with a hypothesis that there is a vivid relationship between the morphological characters and the behavioral pattern for which they are adapted. The validity of this hypothesis is being tested with a statistical enquiry into its form and content. The present study is an attempt in this line.

The line of best fit explains the overall relationship of the square of mean wing length (W^2) to log weight in the subfamily. It is calculated from the mean of the largest and smallest values of each set of ranked data. The following figure depicts the line of best fit.

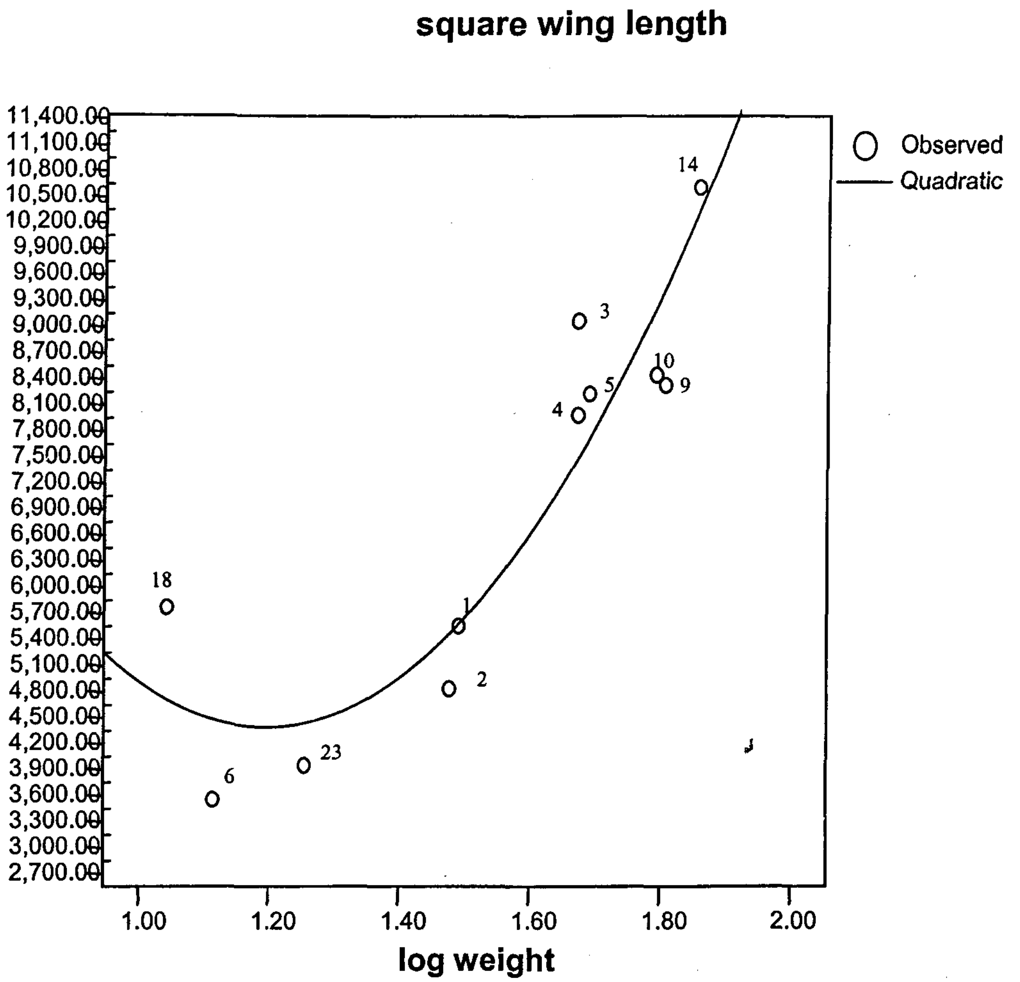

Figure 17: Ratio of log weight to square of wing length

The figure depicts a curve drawn on a quadratic equation. It shows moderately related relation between weight and wing length. The relation is positive correlation between log weight and square wing length. The quadratic curve and the plotted values do not show significant variance. The following values speak of its analysis of variance.

	DF	Sum of squares	Mean Square
Regression	2	4569414.1	22847070.6
Residuals	8	7637421.2	954677.6

F = 23.93171 Significant F = 0.0004

The quadratic curve and the plotted values shows a high degree of correlation at all points except one. It does not weaken the deduction of correlation as the analysis of variants does not show significant values to prove otherwise. Scientifically, it would explain limited movements of birds with regard to its flying capacity, which require them to confine themselves in closed habitats. Consequently they do not migrate and they do not change their niche breadth. The figure 18 describes the magnitude of deviation of each observation to the line of best fit, which is shown in mm. The figure shows very small deviation, which gives the accuracy of the curve. The regression line signifies the prediction and it allows us to go for the observation and deduction that have been detailed above.

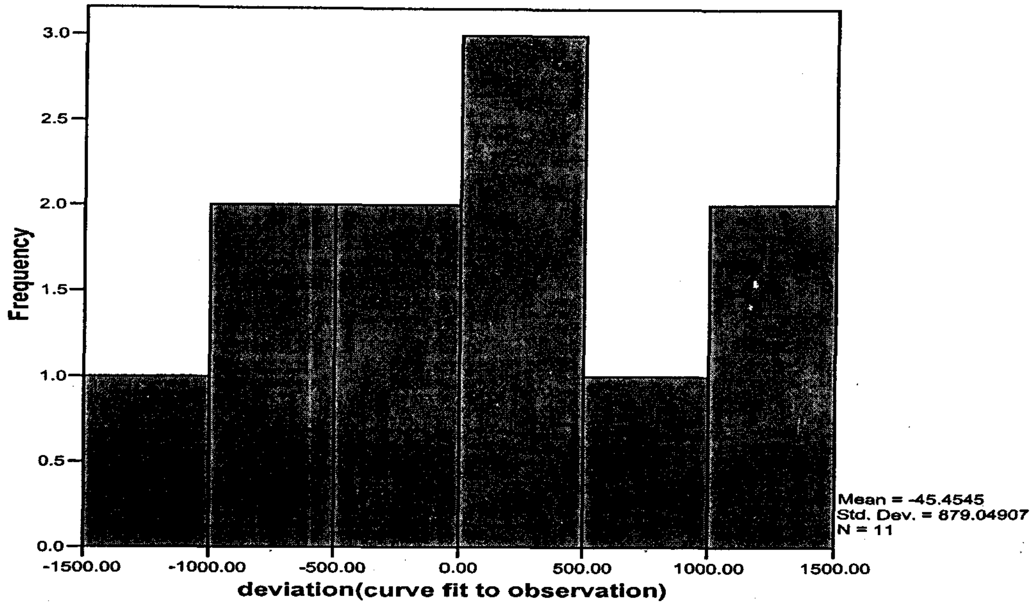

Figure 18: Magnitude of deviation

The graphical representation of mean weight of each niche group explains more about morphological adaptation. The figures 19a, 19b, and 19c are drawn with mean weight on X-axis and its frequency on Y-axis. The graph shows a number of species included in each interval. Graphically, it is very clear that the first two sets in the niche group have more weight than the rest. The species inhabiting deciduous and deciduous-evergreen sholas have significantly higher values for weight. They are *Pomatorhinus horsfeldi horsfeldi, Pomatorhinus horsfeldi travencoreinsis, Pomatorhinus horsfeldi madrepatensis, Turdoides striatus malabaricus, Turdoides striatus somervelli, Turdoides striatus orissae, Turdoides striatus orientalis, Turdoides malcolmi, Turdoides affinis affinis,* *Turdoides caudatus caudatus, Turdoides subrufus subrufus, Alcippe poioicephala and Macronous gularis.*

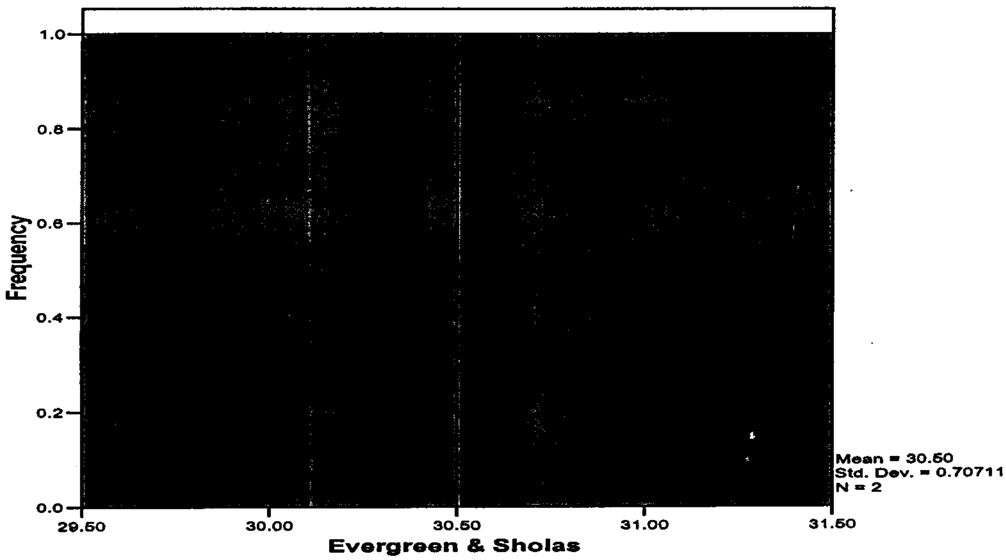

Figure 19a: Mean weight

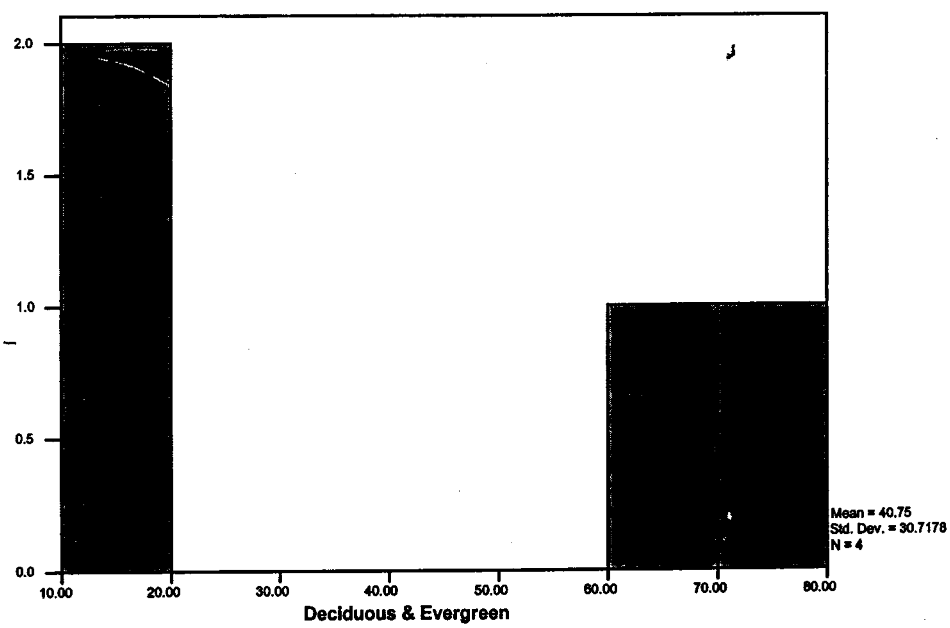

Figure 19b: Mean weight

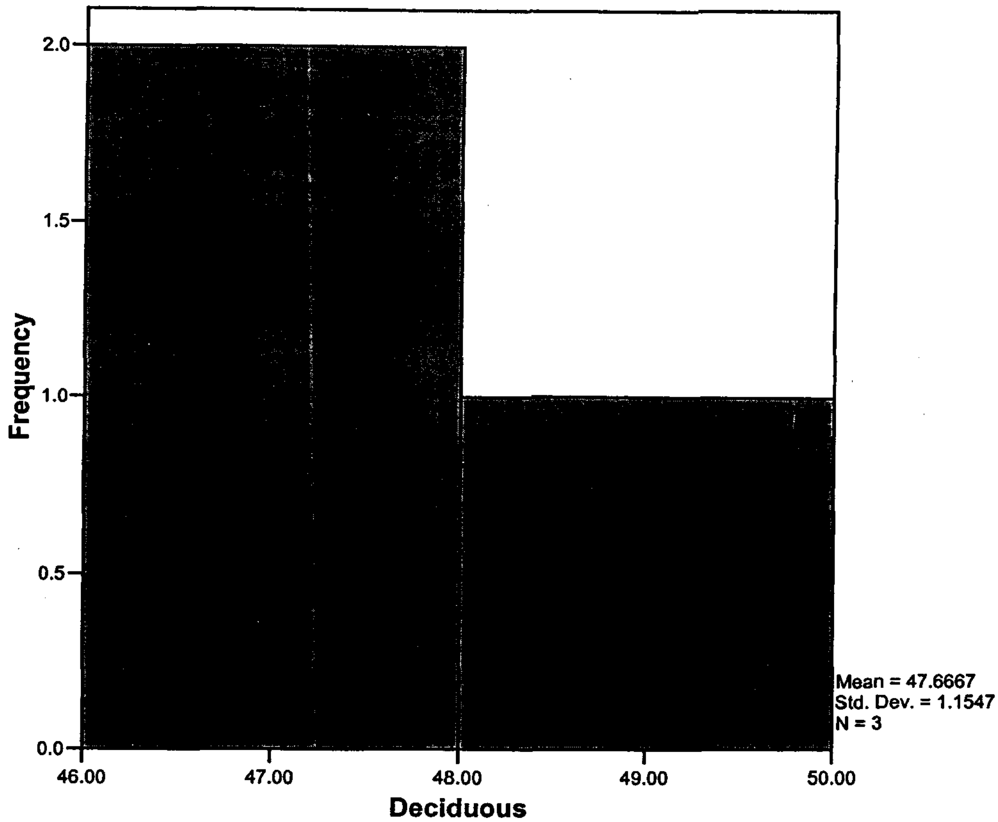

Figure 19 c: Mean weight

It is interesting to note that the increase in weight of the birds show corresponding increase in the body length. The correlation between weight and the body length in proportion to wing span is indication of resident character of these birds. This adaptation is a significant feature of its morphology.

The relationship of index of roundness to T/W ratio among the species is worth noting. The figure 20 depicts this relationship. Here the index of roundness is plotted against relative tail length for all species of *Timaliinae*. The functions are expressed as percentages of species means. The niche groups which show considerable separation when plotted are shown in the figure 21. It is worth noting that the correlation between the variable is seen strong in the evergreen and deciduous niche group. The figure shows the points of interception and exclusivity, which are well explained in the context of the behavioral pattern.

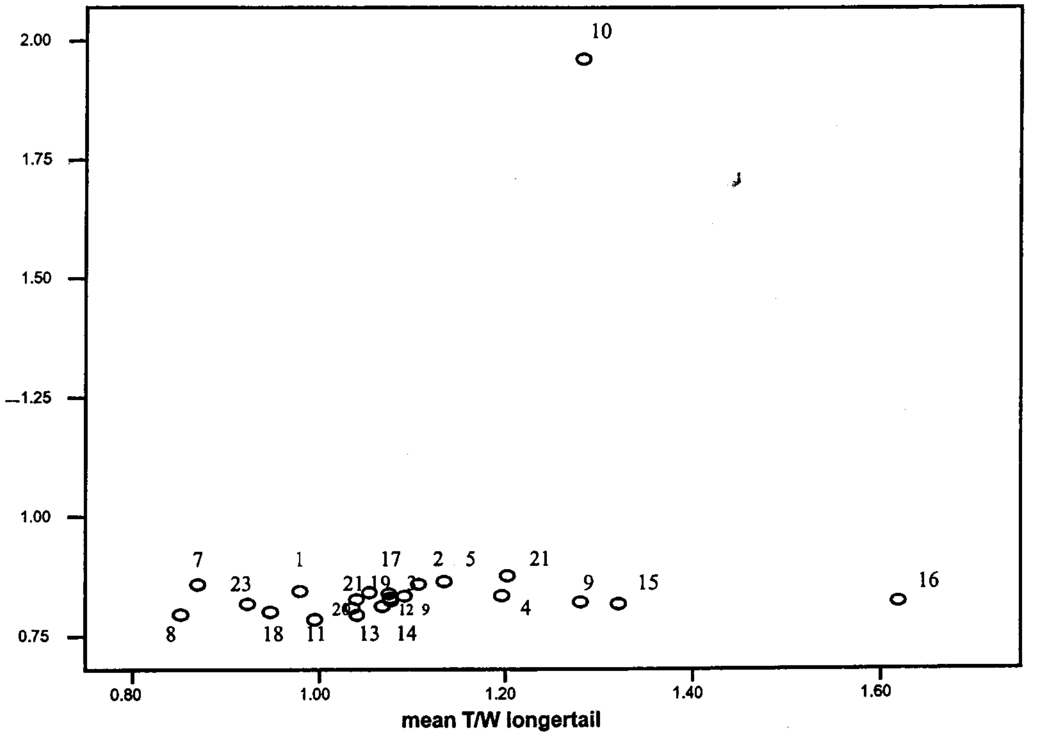

Figure 20: The relationship of index of roundness to T/W ratio

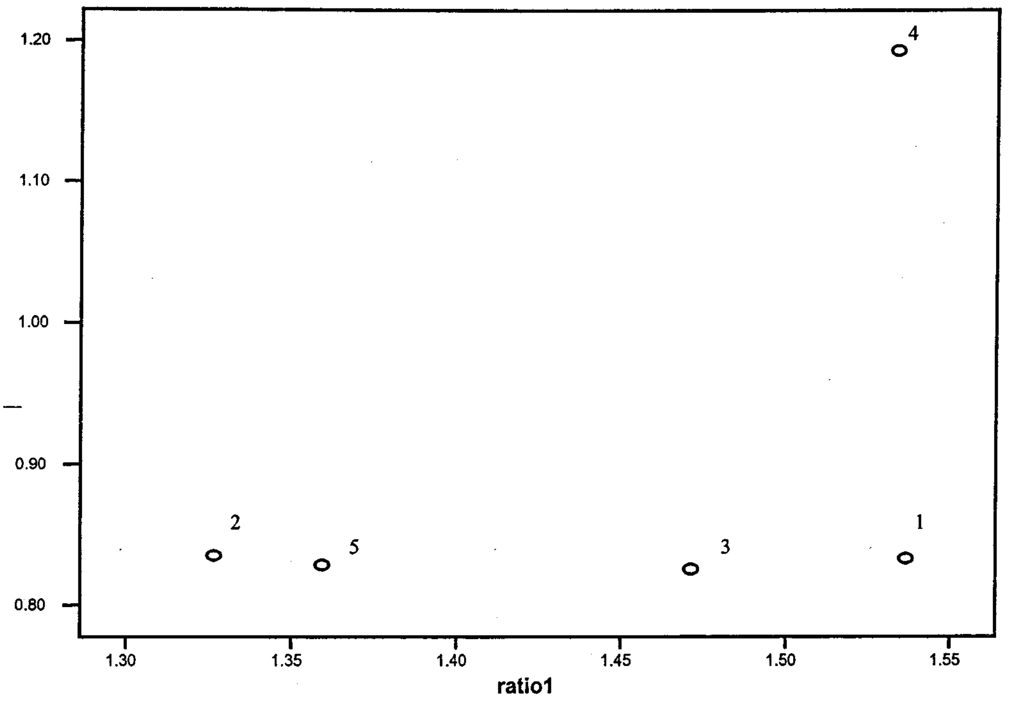

Figure 21: Mean index of niche

The values of index of roundness can be analysed against different variables in different context. The figures 22a, 22b, 22c, 22d, & 22e are drawn to explain the relationship between wing tip to index of roundness among species of different niche groups. X-axis carries index of roundness and Y-axis shows the frequency plotted against wing tip. The figures are self explanatory and it shows the distribution of index of roundness for each niche group.

The figure 22a explains the relationship for niche group A1. The graph shows a mean of 0.832 and standard deviation 0.03701. Similarly the graph 22b is drawn for niche group B1 with a mean value of 0.83 and std. deviation 0.02986. The graph 22c shows the niche group C1with a mea value 0.822 and std. deviation of 0.02279. The graph 22d shows the niche group D1 with a mean value of 1.19 and std. deviation of 0.6674. The graph 22e shows the niche group E1 with a mean value 0.82 and std. deviation 0.01.

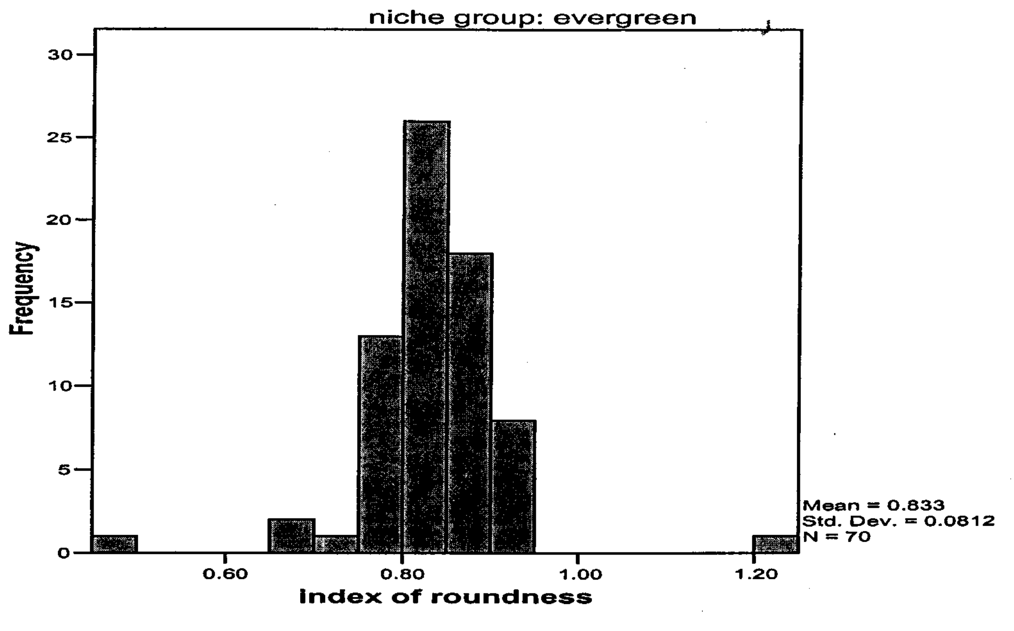

Figure 22a: Index of roundness

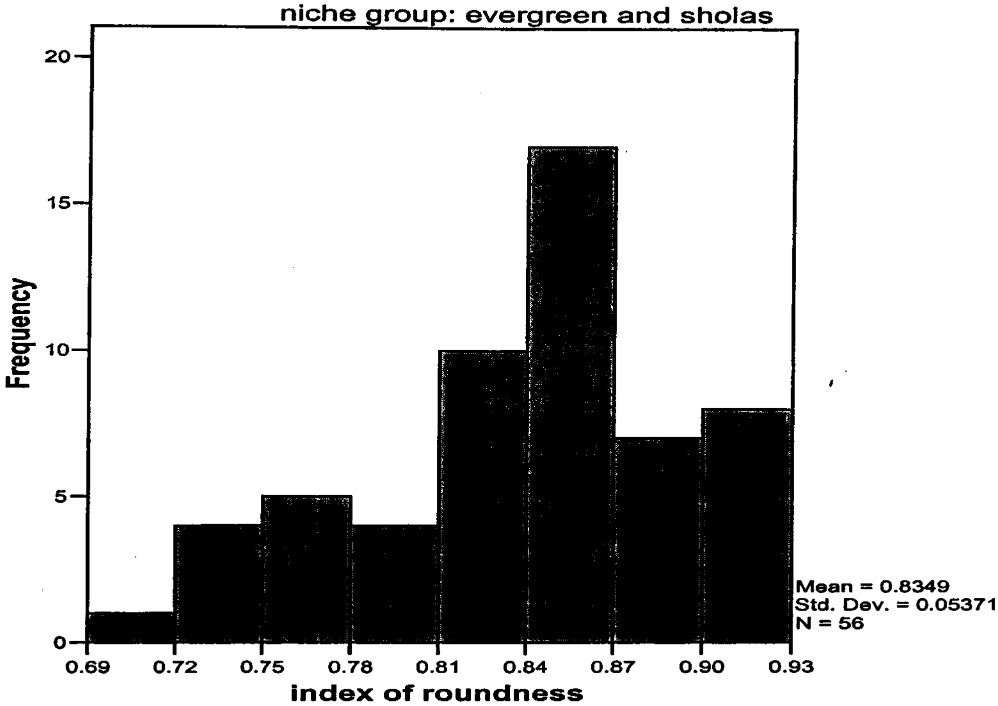

Figure 22b: Index of roundness

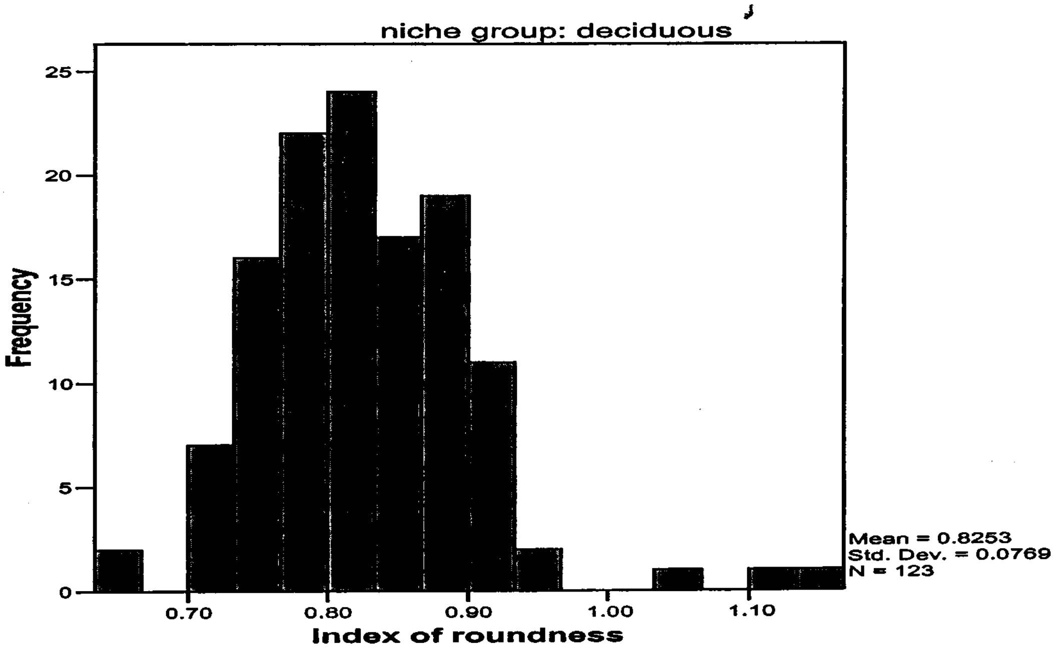

Figure 22c: Index of roundness

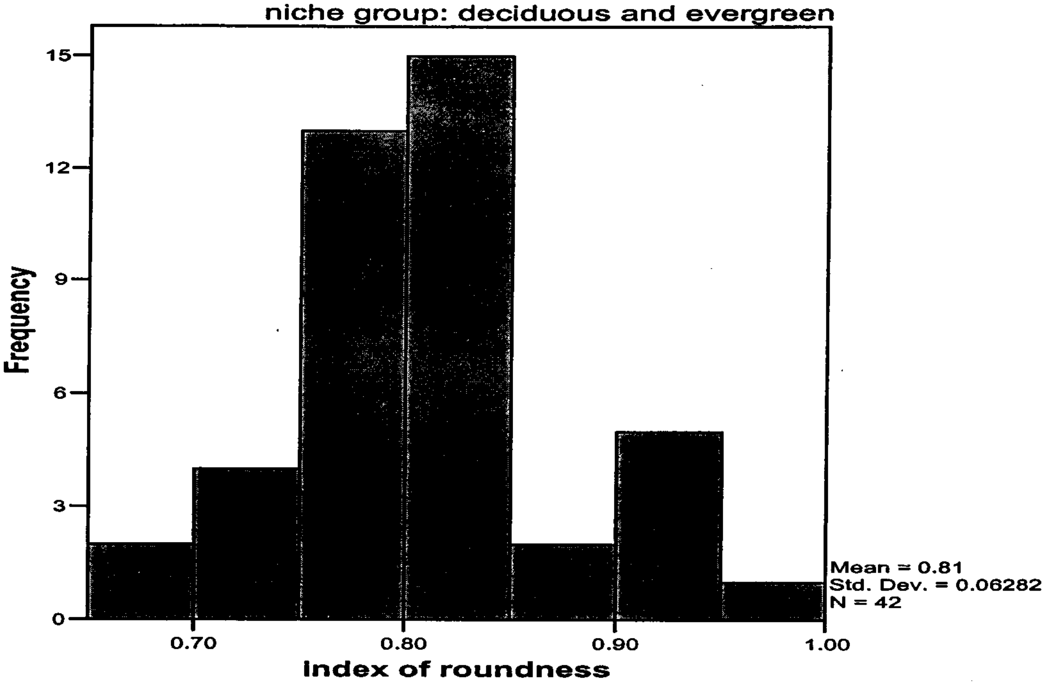

Figure 22d: Index of roundness

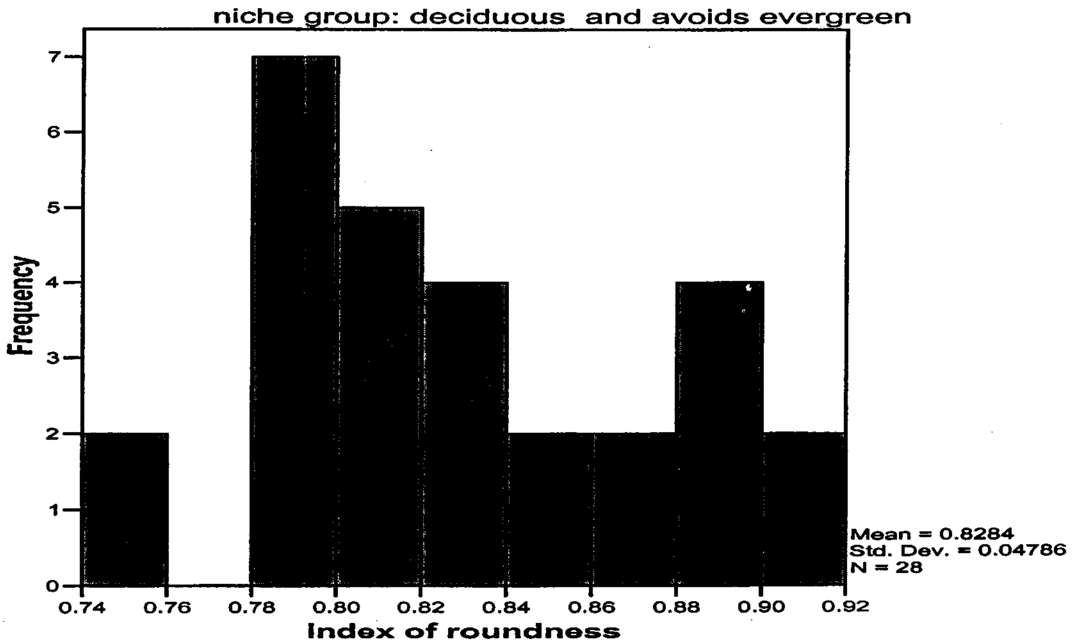

Figure 22e: Index of roundness

The distribution of tarsus/cube root weight indices for the birds of combined niche groups in the figure 23. There is a considerable overlap between groups in this index. However it does not seem to be as closely correlated with niche groups as the relative tail length or index of roundness. The figure shows the niche groups B1 and E1 have significantly higher indices than species of other three groups, hence relatively longer legs. They include *Pellorneum ruficeps olivaeceum, Pellorneum ruficeps ruficeps, Dumetia hyperythra albogularis, Turdoides striatus malabaricus, Turdoides affinis affinis, Garrulax delesserti delesserti* and *Garrulax cachinans*. The group A1 and C1 overlap with regard to its values.

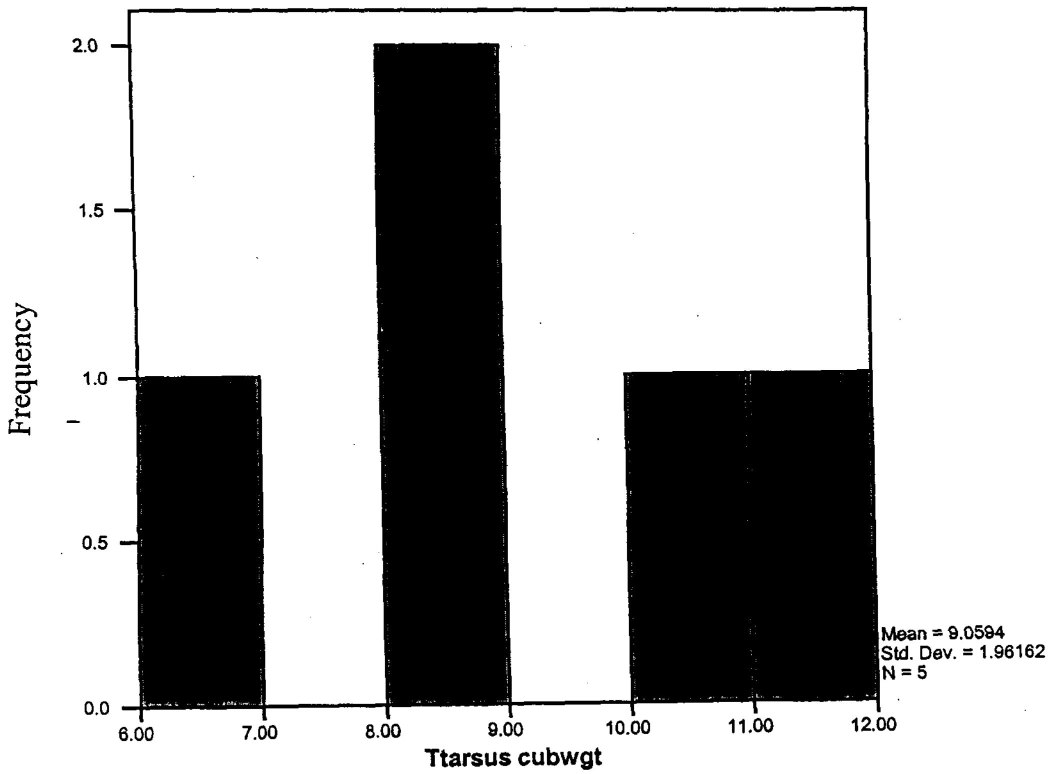

Figure 23: Distribution of cube weight of tarsus

The distribution of bill/cube root weight ratio's for the birds of combined niche groups is shown in figure 24. The niche groups A1and D1, which overlap with each other shows low indices which indicates relatively shorter bill length. The niche group B1 and E1 have higher indices of which lies between 7.5 and 8.5. It is indicative of relatively longer bill length.

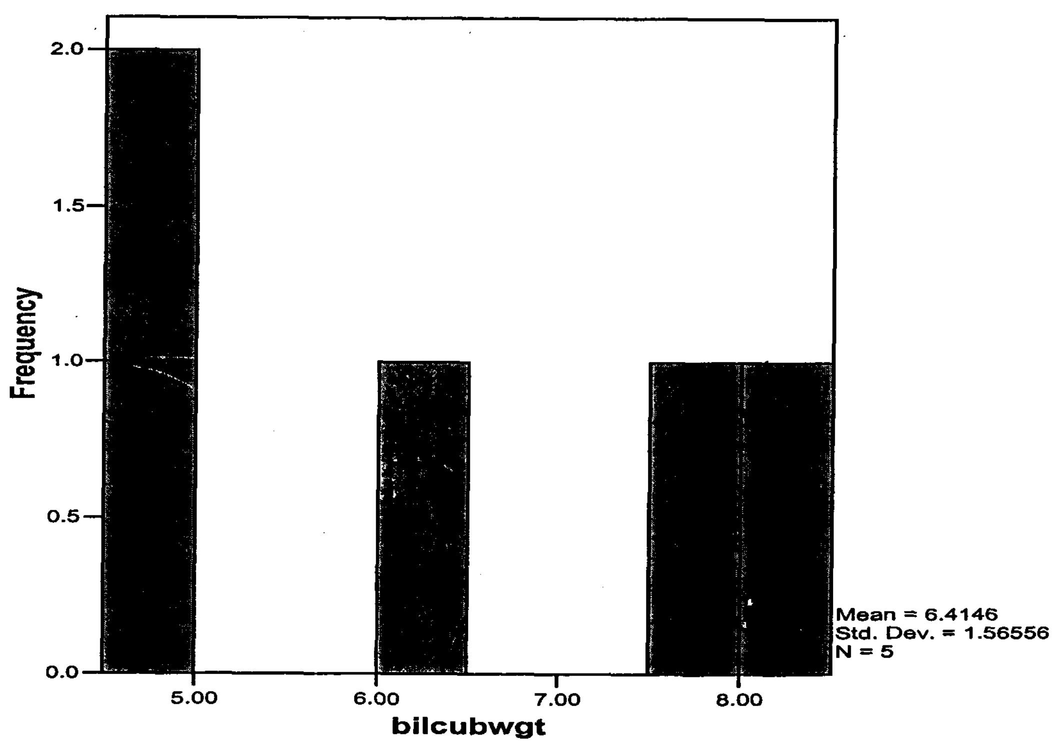

Figure 24: Distribution of cube weight of bill

The above discussions on the functional relationship among the different variables of morphological adaptations seen in subfamily *Timaliinae* underline a set of vivid deductions. It has been discussed at the appropriate places in the preceding chapters. The statistical analysis goes well with theoretical postulates on ecomorphological adaptation. The give sample space is potent enough to generate as well as substantiate many of the well known correlation.

The Anova results given below, in Table 4 sums up the significance of the operation employed by the researcher in the present study. Strongly enough, the three variables wing, bill and tarsus of all specimens under study have shown different levels of relation among the different species in the ecomorphological context. It also shows the level of adaptation that has taken place.

Table 4: The Anova results of bill, wing and tarsus length

ANOVA

WING

	Sum of squares	Df	Mean square	F	Sig
Between groups	27382.630	4	6845.657	30.038	.000
Within groups	71561.358	314	227.902		
Total	98943.988	318			

There is a significant difference in the case of wing length.

ANOVA

BILL

	Sum of squares	Df	Mean square	F	Sig
Between groups	3458.151	4	864.538	40.318	.000
Within groups	6733.047	314	21.443		
Total	10191.198	318			

There is a significant difference in the case of bill length.

ANOVA

TARSUS

	Sum of squares	Df	Mean square	F	Sig
Between groups	3426.438	4	856.610	1.883	.000
Within groups	142865.800	314	454.986		
Total	146292.238	318			

There is no significant difference in the case of tarsus.

Table 4: The Anova results of bill, wing and tarsus length.

Descriptive Statistics

	N	Mean	Std Deviation
Bill	322	15.17	7.361
Tarsus	322	21.51	6.371

Coefficient of variation of bill =48.52

Coefficient of variation of tarsus =29.37

Tarsus is more consistent or more uniform or more stable then bill.

Table 5: Descriptive statistics of bill and tarsus.

The coefficient of variation for mean bill length among species of *Timaliinae* is significantly higher than the coefficient of variation for mean tarsus length. This suggests the evolution of different behavioral strategies for obtaining different types and sizes of prey items. Consequently this lead to the selection of different morphological traits, while the leg apparatus for foraging the prey remained substantially the same. The significant difference in bill length may be well explained with the fact that as a whole they must have gone adaptive radiation from a seed-eating finch-like ancestor into fruit-, nectar- and insect-eating forms.

The significant coefficient of variation in the wing length reinforces the postulate that the length of the wing is necessary and sufficient condition for evolving foraging strategies. The statistics seen through the data for *Timaliinae* associate the wing length with ground foraging.

ADAPTATIONS OF BIRDS IN THE SUB FAMILIES OF *TIMALIINAE* AND *SYLVIINAE*

Thesis
submitted to the University of Calicut
for the award of the Degree of

DOCTOR OF PHILOSOPHY
IN
ZOOLOGY

By

NISHI ANN

Under the guidance of

Dr. V. J. Zacharias & Dr. Sabu K Thomas

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Devagiri, Calicut
UNIVERSITY OF CALICUT
2007

Chapter VIII

DISCUSSION ON SYLVIINAE

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DISCUSSION ON SYLVIINAE

As discussed in the earlier chapter the foregoing analysis centres around the significant commonalities as well as differences of the birds come under the subfamily of Sylviinae. The grouping under the different niche groups are treated as a separate block for discussion.

BODY LENGTH

The fig 1 describes the distribution of body length among the birds under study. More than 30% of the sample of the given population is significantly seen in the niche group A2.

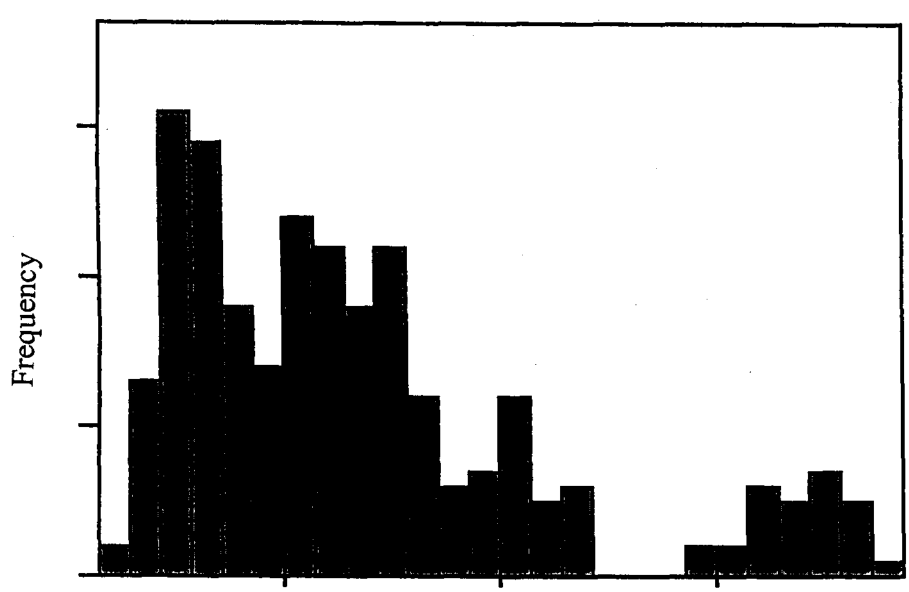

Figure 1 : Distribution of total length for all birds

The length of the birds of this group, A2 has a range of 102mm to 148mm.The interval is of 46mm, which is likely to span significant variation in the lengths of the birds of this group. It is to be noted that more than 60% of the birds of this group falls in the upper segment of the range. To be precise it clusters around the interval of 120mm to 135mm. The weights of the birds have also the proportional increment. The birds of the group B2 have a range in their lengths of 102mm to 140mm. It is interesting to note that majority of the birds are seen in the lower side if this range. Moreover the lower limit of this group is identical to that of the birds in the A2 niche group. It explains again the space of interception between the two groups. The upper limit 140mm stands alone in the range as sample space does not carry more birds of this size in this niche group.

The open grassland niche group C2 is comparatively weak in terms of the sample points. The two points generates a range of 14mm from 124mm to 138mm. The values in the weight reflect corresponding changes. The birds of the niche group D2 have a smaller interval range with regard to its length. It ranges from 110mm to 126mm. More than 64% of the birds of this group belong to upper side of the range. The changes in the weight are also seen in the data.

The birds of the niche group E2, marshy & mangrove, are also weak with regard to the number of sample space. The range in the length is reflected with an interval of 13mm. But it is conspicuous by its longer size. The two points of this space has a longer dimension compared to the rest of the niche group. The lengths of the birds of this niche group 188mm and 195mm, certainly makes this group totally different from the birds of other niche groups. It can safely be argued that birds of this niche group are significantly longer in comparison with the rest of the niche groups. The fig 2 describes the data on the basis of niche groups.

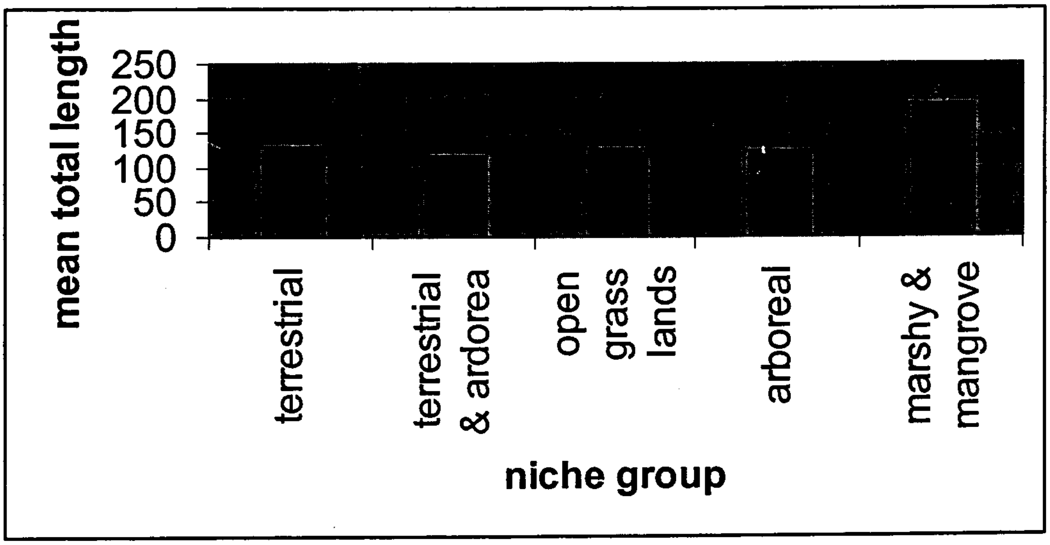

Figure 2: Distribution of total length based on niche group

TARSUS LENGTH

Interestingly enough, the length of the tarsi of the birds of *Sylviinae* do not cross the value 30mm, as is it seen in *Timaliinae*. In general it ranges from 19mm to 29 mm for all the birds of the subfamily. The fig 3 explains the distribution of the values.

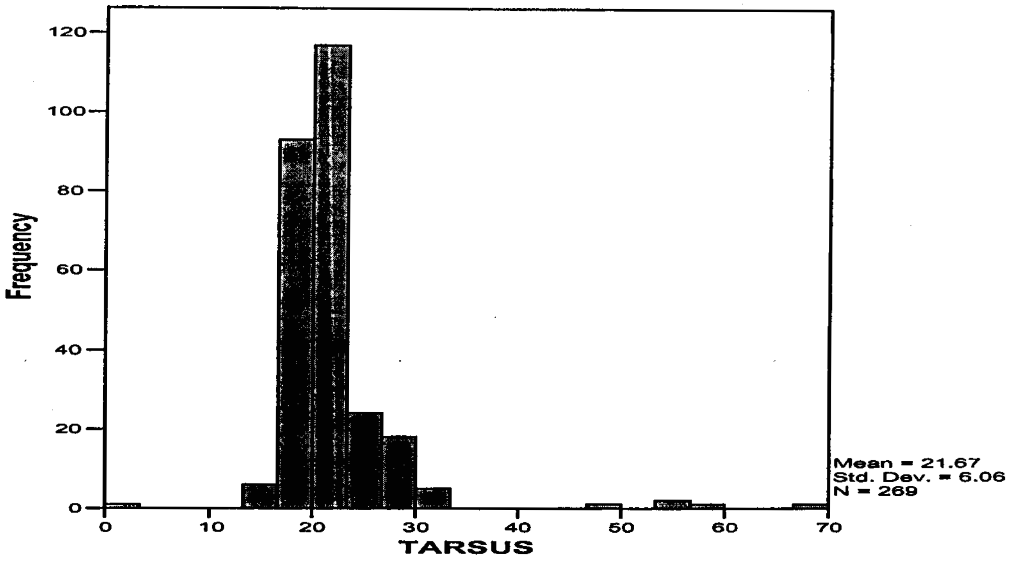

Figure 3: Distribution of tarsus length for all birds

The niche group A2 has a range from 19mm to 24mm of tarsus length. Except two species all other points of the sample space have a length more than 20mm. As the interval has small width, the difference becomes insignificant and does not show any abbreviation or oddities in the generality of tarsus length. The birds of niche group B2 is also similar to that of A2 with regard to the range of length of tarsi. But it is worth noting that most of the species of this niche group centres around 20mm of length. The combination of two, in this niche group does not show significant variation in the length of tarsi, in a way it provides justification for the methodology employed in the grouping

As noted earlier the sample space for open grass, niche group C2 is weak, as it has only two points. But interestingly the variation is almost nil in case of lengths of tarsus. It is, on an average, 23mm. The birds of niche group D2, has array of values from 19mm to 21mm. The small magnitude of interval for a larger number of species of *Sylviinae* clearly signifies similarities of morphological adaptation, at least in the context of length of tarsus, which is one of the strongest determinants of the adaptation. The birds coming under niche group E2 have values 27mm and 29mm, which also do not call for any unusual explanation. Fig 4 shows the distribution on the basis of niche groups. To sum up the length of tarsus of the species of Sylviinae do not show significant level of variation.

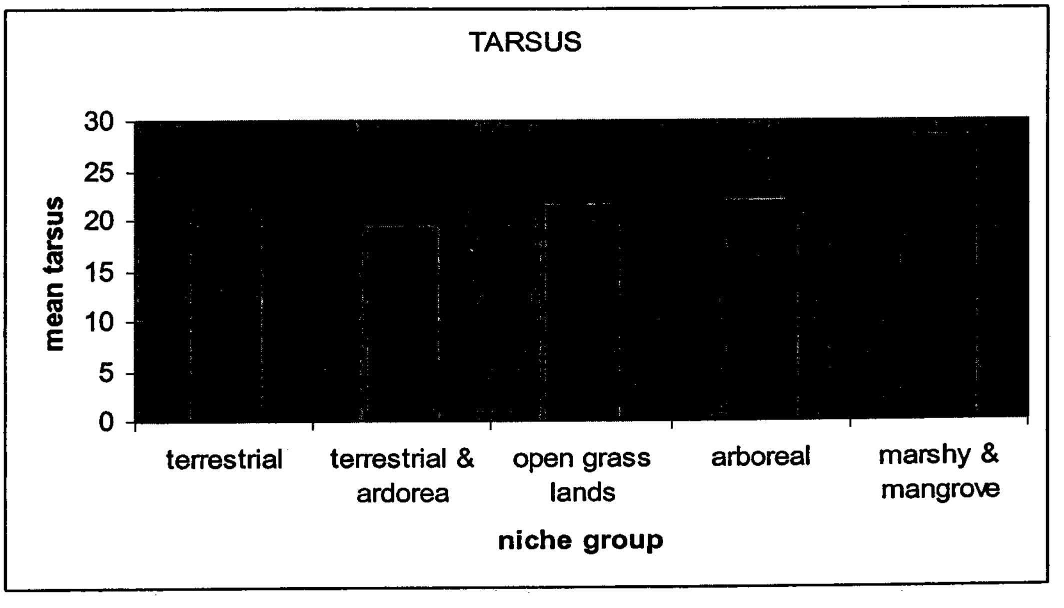

Figure 4: Distribution of tarsus length for all niche group

BILL LENGTH

The values of length of bill of species of *Sylviinae* also follow similar trend as in the case of *Timaliinae*. It shows heterogeneous pattern and output. The value of bill length of this subfamily ranges from 11mm to 19mm, which is shown in fig 5.

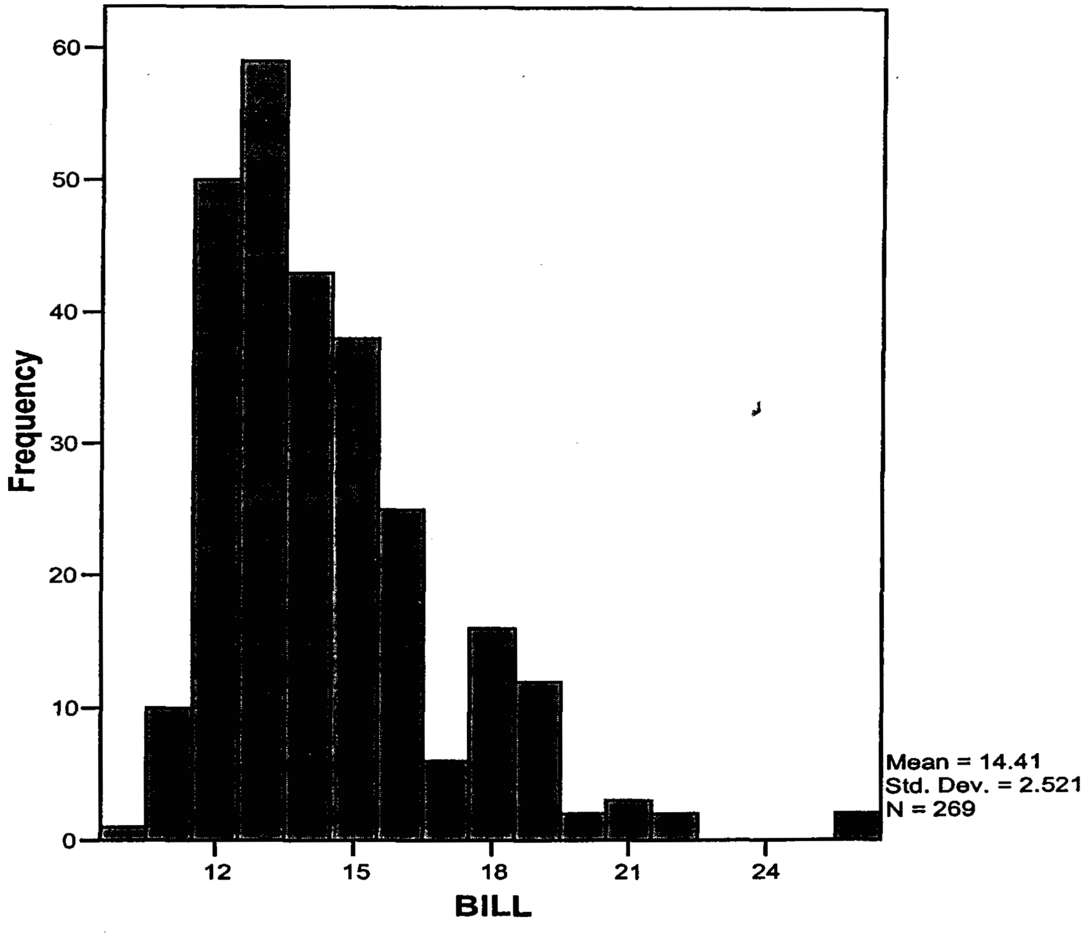

Figure 5: Distribution of bill length for all birds

The niche group A2 has an interval from 11mm to 18mm. The values of all other points of sample space do not show any identical results.The niche group B2 has a small interval of vales from 13mm to 15mm. It is interesting to note that the value 13 and 15 do not cross the limit of the earlier niche group. This feature is also consistent with the values of other variables. The niche group C2 has two points 14 and 15, whereas the values of niche D2 has a range from 12mm to 15 mm. 19 and17 are the values of the bill for the niche group E2. The fig 6 explains the frequency on the basis of niche groups. It is to be noted that these two species has a longer beak compared to other species of the subfamily. They are *Phragmaticola aedon aedon* and *Acrocephalus stentoreus brunnesens, Cisticola exilis erythrocephala* has a slender and pointed bill. *Acrocephalus stentoreus brunnesens* has a long slender bill which is long as its head. *Hippolais caligata rama* has a flattened and wide bill. *Locustella naevia straminae* has a slender bill whose length is almost half of its head. *Phragmaticola* is noted for its strong wide and thick bill, and its popular name thick billed warbler carries the specialty.

The birds of this subfamily mostly feed on insects, including beetles and weevils and their larvae, grains, berries, flower nectar etc. The presence of large beak of a few species of this subfamily should be understood in the premise of the type of insects they feed on. They feed mostly on beetles, weevils and bugs.

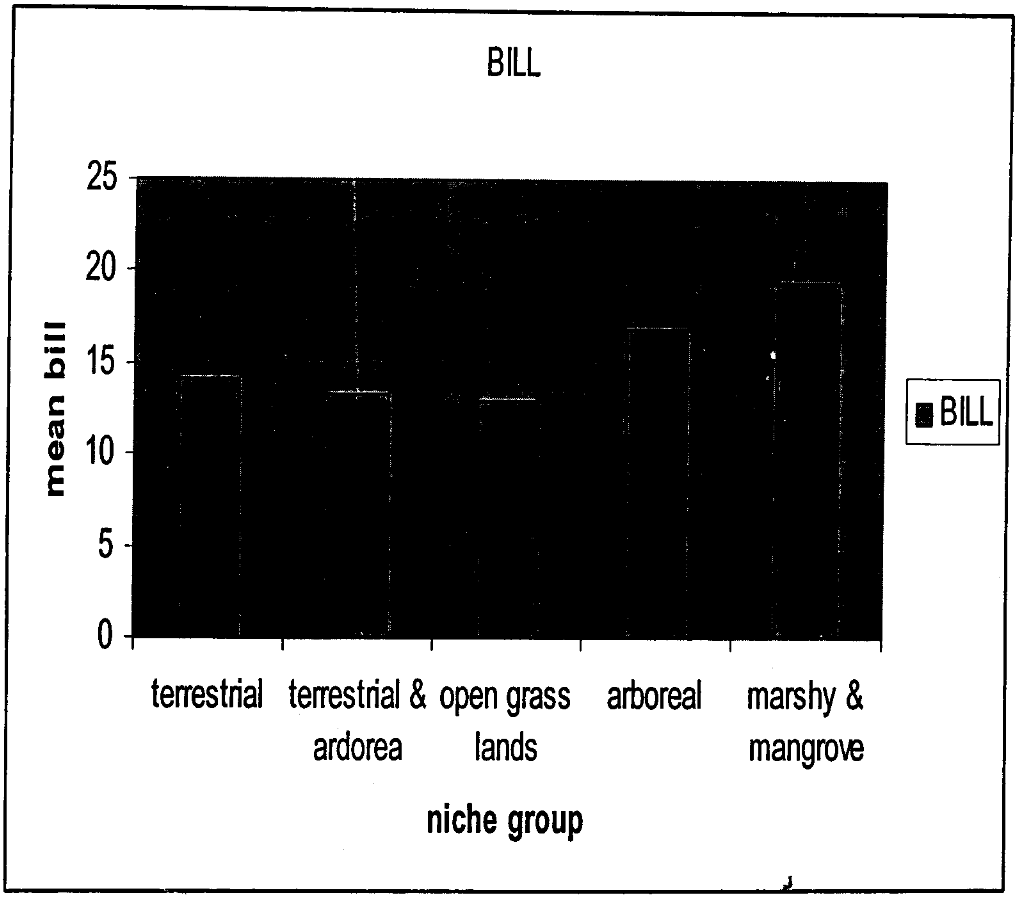

Figure 6: Distribution of bill lengths for all niche groups

TAIL LENGTH

The values of tail length for all the birds under this subfamily show a consistent pattern. The relative tail length against the body length is indicative of its functional relation in the process of morphological adaptation. All the values on average tend to half of the body length. The values range from 35mm to 88mm, which is shown in figure 7.

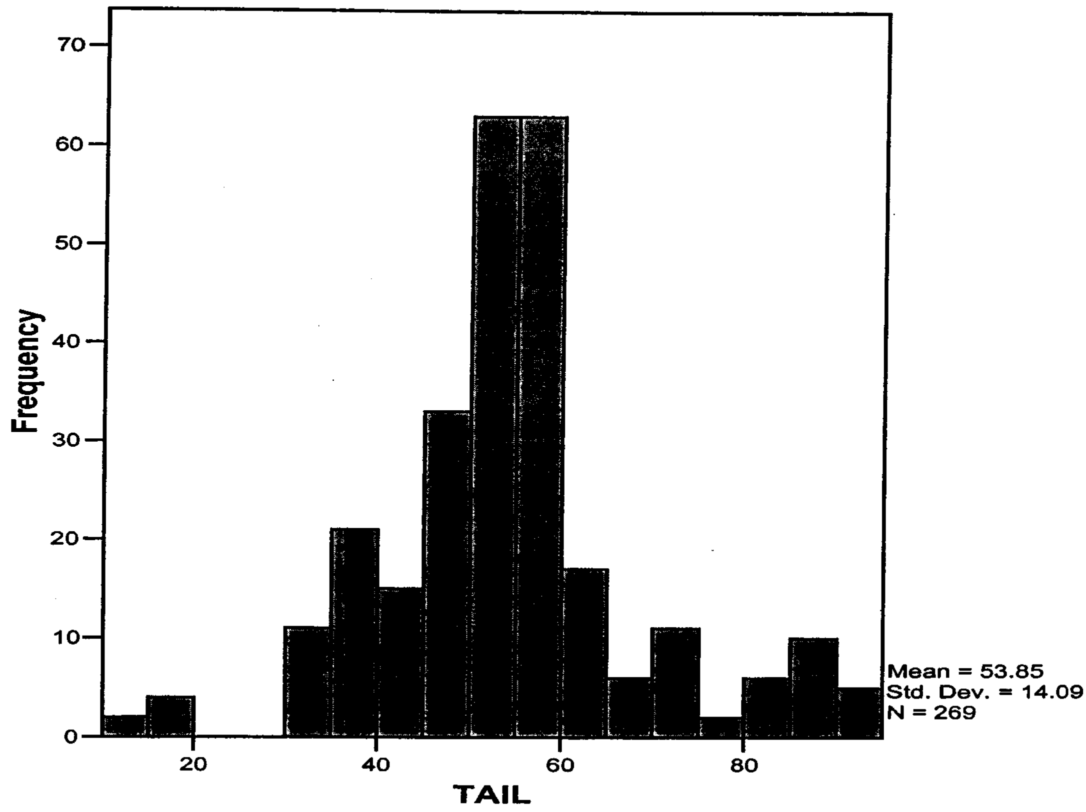

Figure 7: Distribution of tail length for all birds

The niche group A2 has a significant range of values from 35mm to 67mm. Invariably all these values crosses 1/3rd of body length and move closer to its half. *Prinia sylvatica sylvatica* has the longest tail in this niche group. The values of niche group B2 ranges from 45mm to 55mm. The corresponding differences could be found in the bill length also. The niche group C2 is with two points 60mm and 69mm, which shows comparatively longer tail. The values of niche group D2 ranges from 50mm to 60mm. It is interesting to note that most of the values of this group fall in the upper side of the range of the subfamily. *Hippolais caligata rama* has the same value of

Phylloscopus occipitalis occipitalis. Niche group E2 has higher values viz, 88mm and 79mm. It is to be noted that these birds, *Phragmaticola aedon aedon* and *Acrocephalus stentoreus brunnescens* with long tail are migratory. The distribution of the values for each niche group is shown in the figure 8.

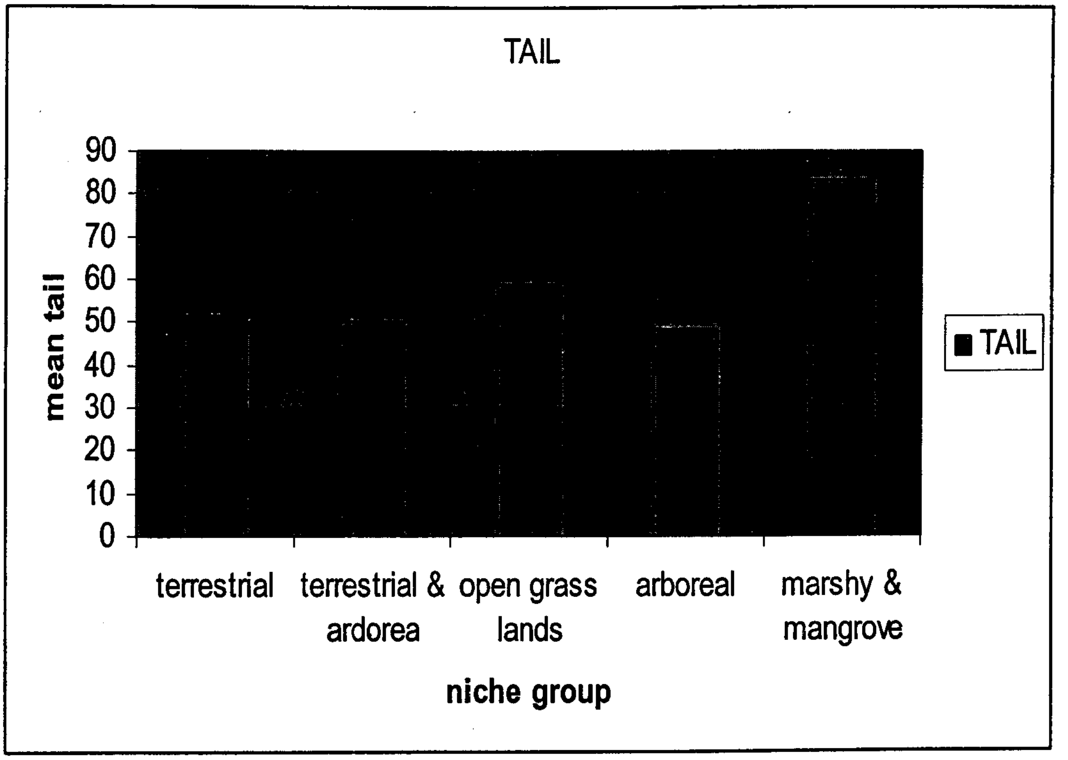

Figure 8: Distribution of tail length for all niche groups

LONG TOE

The length of the toe is a significant determinant in the morphology of the subfamily of *Sylviinae*. Its values ranges from 13mm to 26mm and it is shown in figure 9.

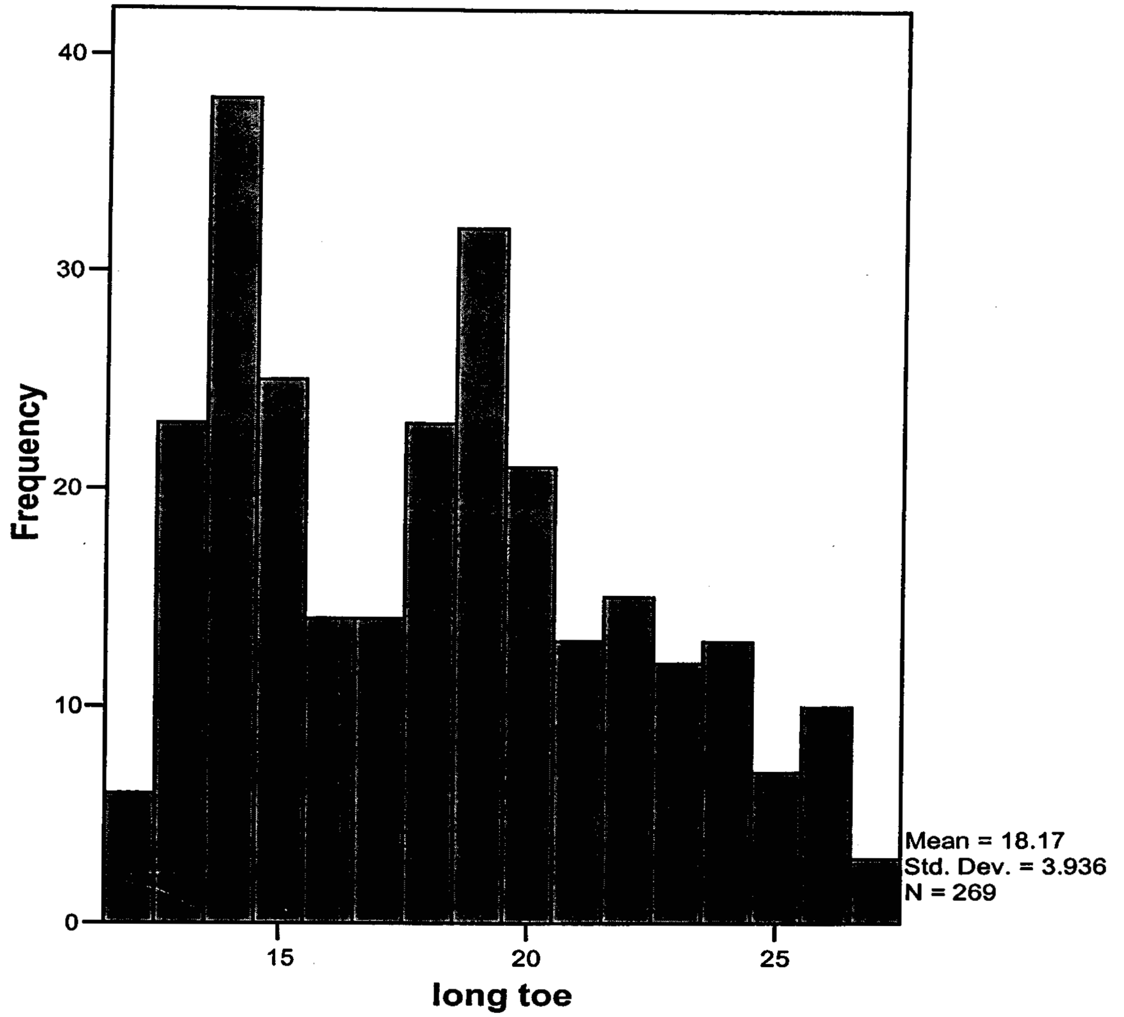

Figure 9: Distribution of length of long toe for all birds

The values of niche group A2 has a range from 14mm to 23mm. Most of the values of this group fall in the first half of the range. Interestingly enough, *Cisticola juncidis salimalii* and *Orthotomus sutorius guzuratus* have the same value for tail and toe lengths. The niche group B2 has a range from 13mm to 22mm. The values of niche group C2 are 22mm and 23mm, which are higher values in the range. The niche group D2 ranges from 14mm to

20mm. As in the case of tail length, the length of long toe for E2 has two extreme values, 26mm and 25mm. The graphical representation of the values for all niche groups are shown in figure 10.

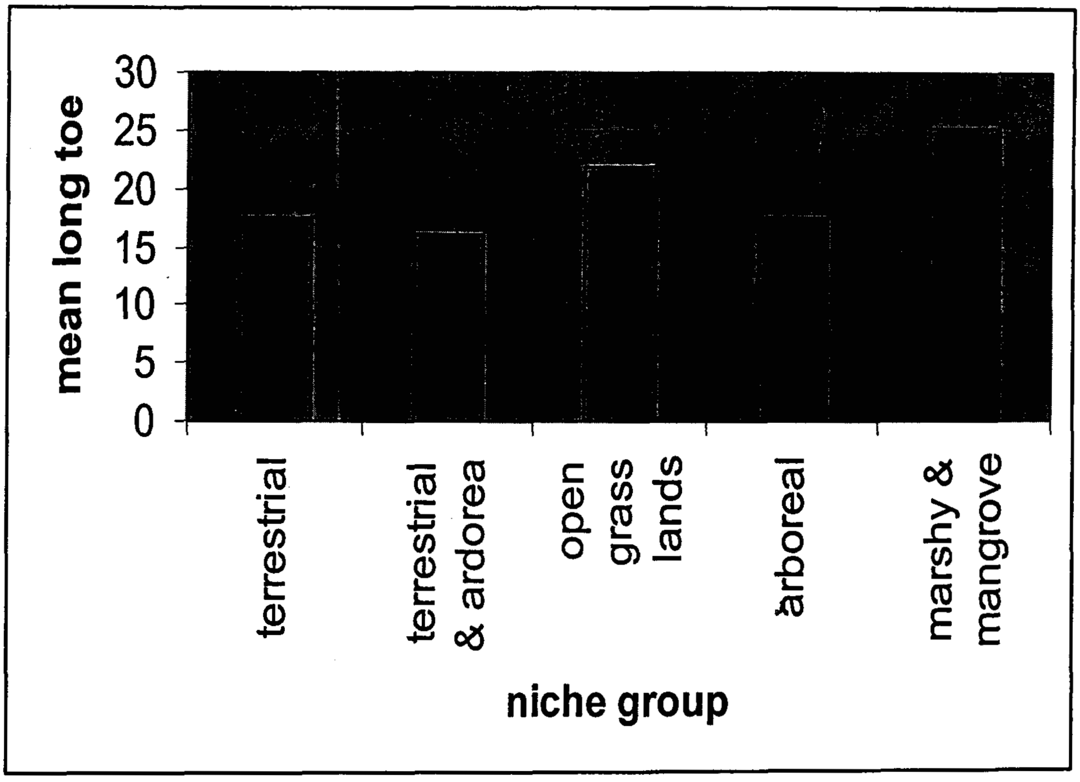

Figure 10: Distribution of length of long toe for all niche groups

WING LENGTH

The values of wing length for all species of the subfamily *Sylviinae* ranges from 48mm to 88mm, which is shown in figure 11. The ratio of W/L moves from 2 to 2.5. But more than 80% of the sample space tend to move within a range to 2 to 2.3.

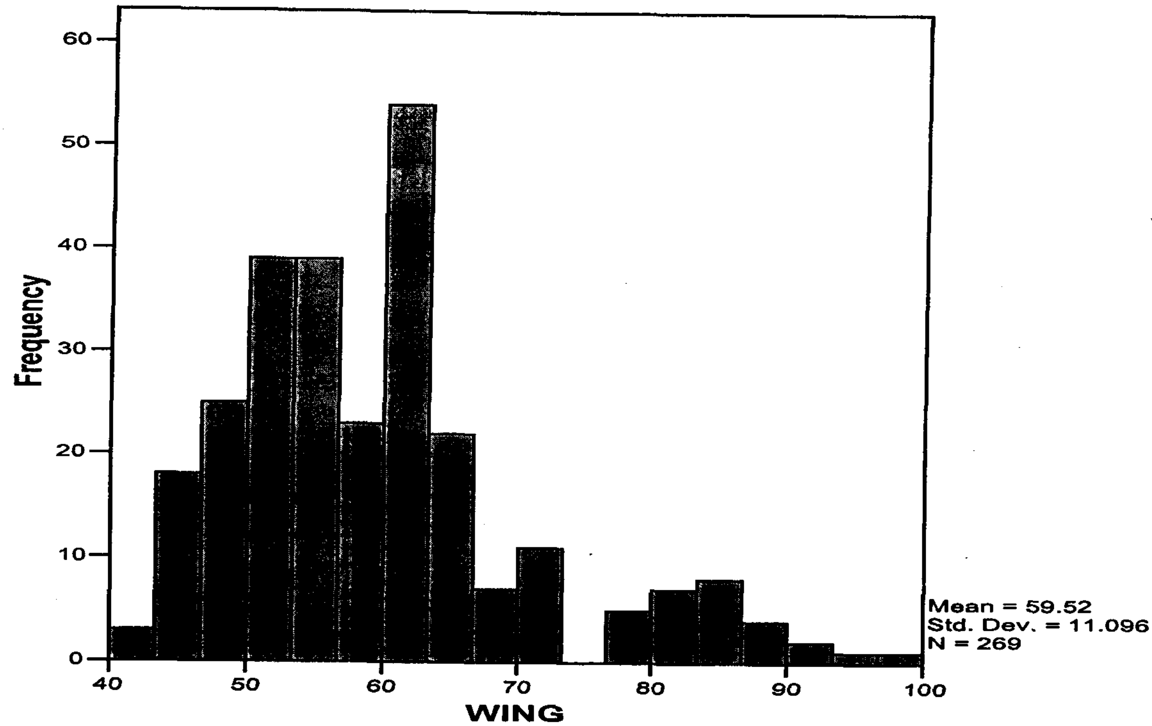

Figure 11: Distribution of wing length for all birds

The value of the ratio W/L for all the species of the niche group A2 tends to 2.2 with an exception for *Prinia sylvatica sylvatica.* It has 62mm wing length and 148mm body length. The values of the wing length for all species of B2 moves within a range from 48mm to 65mm. Significantly its W/L ratio remains the same for all species, 2.3.The values of wing length for niche group, C2 are 49 and 69. The ratio of W/L for all species of D2, tend to move to2.1, with an exception of *Cisticola exilis*, which is resident bird. It is interesting to note that all other species of this group are migratory and their value tends to 2.1. The ratio of W/L for E2 is 2.3, which is the mean value of the ratios for all the birds of this subfamily. The frequency of the values for all birds is shown in fig 12. It is to be noted that these two species, *Phragmaticola* and *Acrocephalus* has the highest values for wing length and body length, among the species of the whole subfamily. But interestingly enough their W/L ratio is equivalent to the mean value of W/L ratio of the whole subfamily.

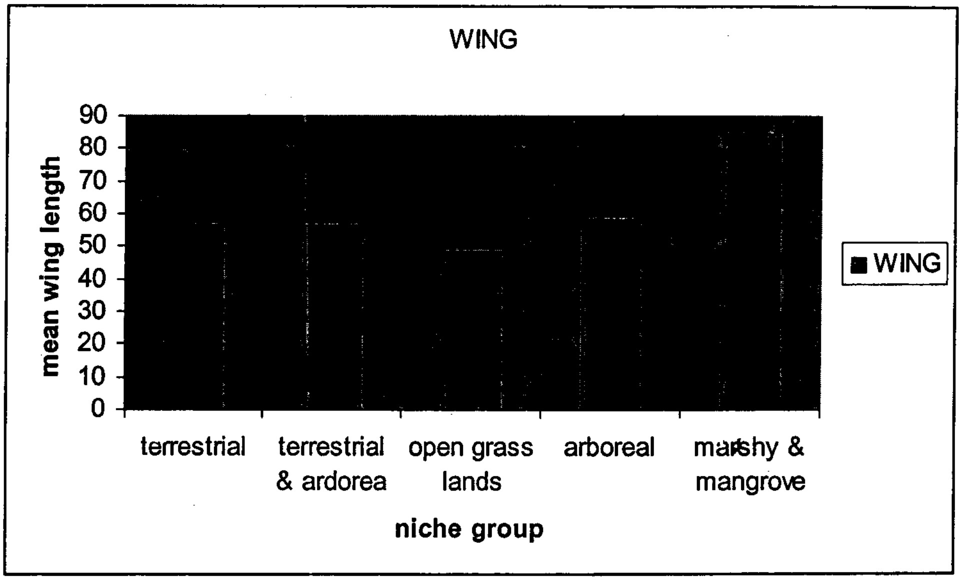

Figure 12: Distribution of wing length for all niche groups

It is clear from the discussion that the wing size of the birds of this subfamily fall under the label of short winged and obviously it is a built in mechanism of the adaptation process, as invariably warblers forage among undergrowth and low bushes. As the vegetation in these areas are denser the shorter wings enables the birds for more manoeuvrability. The migratory birds of *Sylviinae* invariably have longer wing length. But their W/L ratio remains the same. It is well taken that a longer wing is an adaptation for increased flight activities, in regions of open vegetation. If geometric similarity prevails, then wing length would be proportional to (body size)$^{0.417}$. The fig 13 explains the correlation between wing length and the body size for all birds of *Sylviinae* under study. This figure shows a positive correlation which indicates that body weight almost increases with wing length.

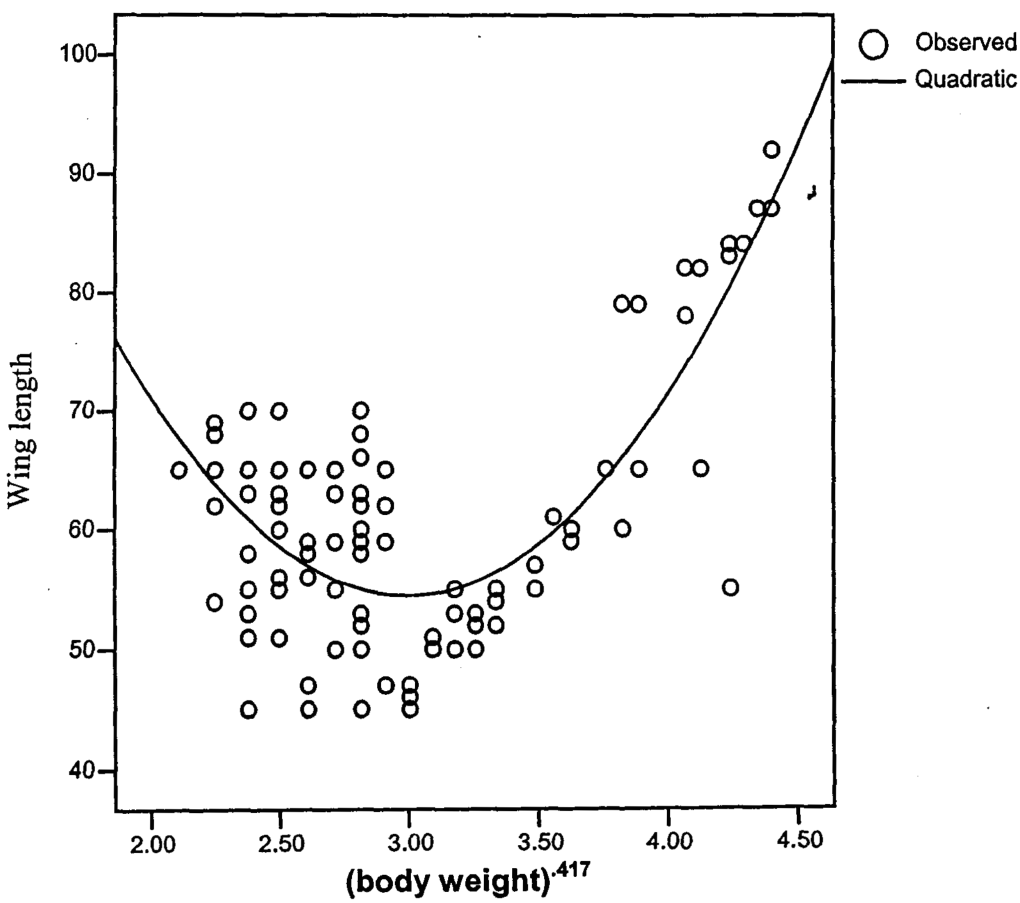

Figure 13: Ratio of wing length to body size

Table 6: Correlation analysis winglength to (body weight)$^{0.417}$

		WING	(body weight).417
WING	Pearson Correlation	1	.496(**)
	Sig. (2-tailed)	.	.000
	N	271	100
(body weight).417	Pearson Correlation	.496(**)	1
	Sig. (2-tailed)	.000	.
	N	100	100

The Karl Pearsons correlation coefficient between wing length and (body weight)$^{0.417}$ is 0.496. It is a positive value, which indicates that body weight almost increases with wing length.

WING SHAPE

(A) INDEX OF ROUNDNESS

The value of index of roundness for all species of *Sylviinae* moves within a range 0.45 to 0.80, which is shown in fig 14. But the migrant birds of this subfamily have a relatively smaller value for the index of roundness. It lies between 0.45 to 0.65. The presence of pointed wings for migrants clearly differentiates the species based on the flight potential.

Figure 14 describes the distribution of values for all the birds under the sub family.

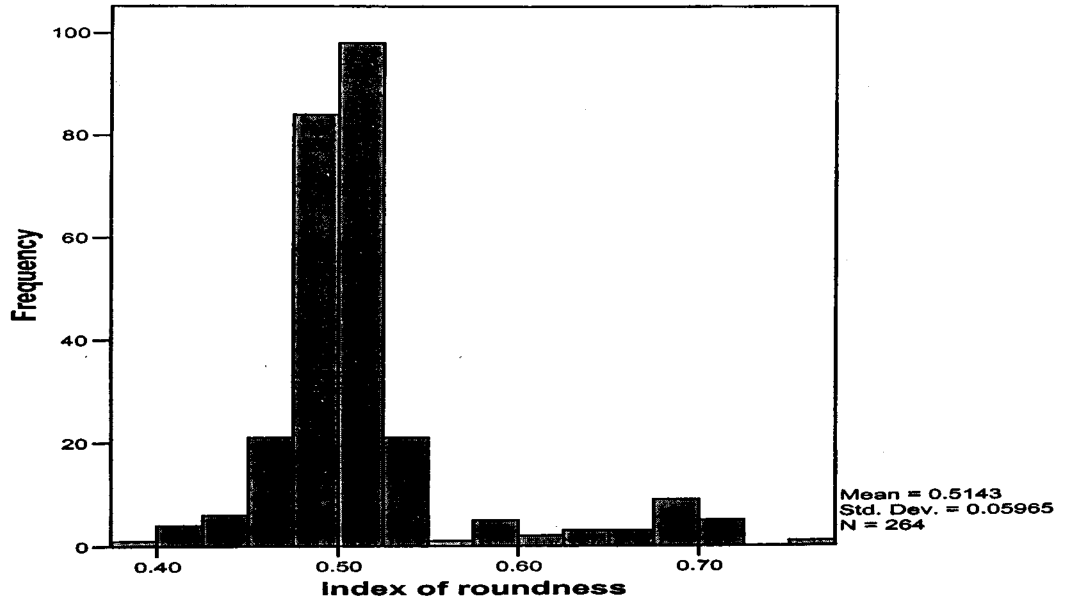

Figure 14: Distribution of index of roundness for all birds

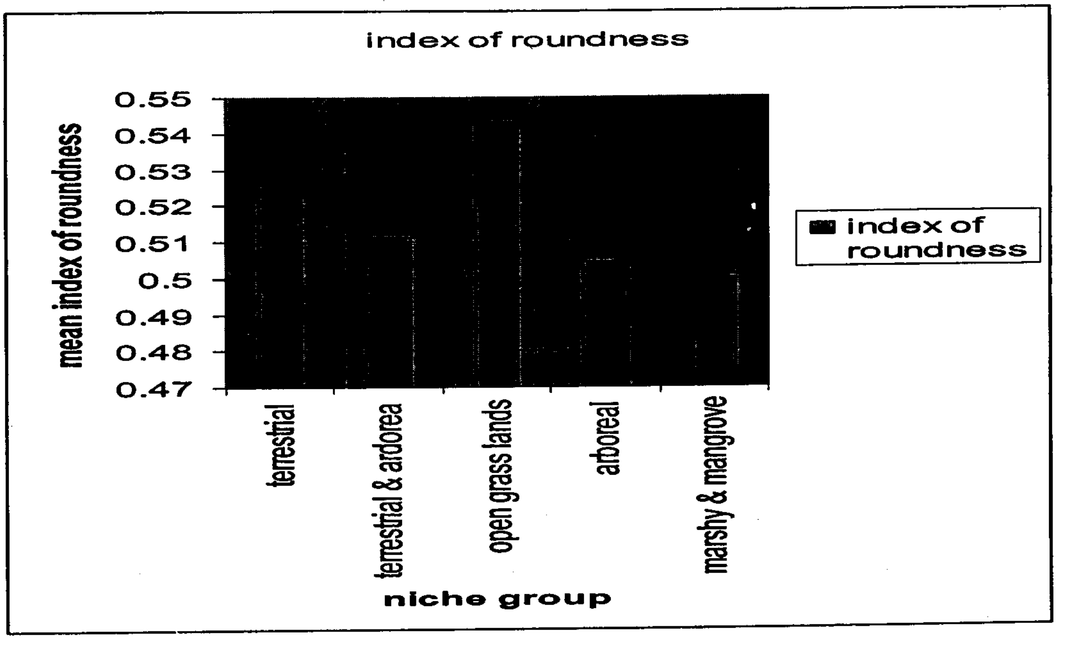

Figure 14 (a): Distribution of index of roundness for all niche groups

The general rule that species with pointed wings have their wing tip close to the leading edge of the wing is true for migrant species. Rounded and pointed wings are seen in birds of *Sylviinae.* The presence of rounded wings implies its behavior of short distance flying, whereas the pointed wings signify potential for long distant flight. It is to be noted that the subfamily of *Sylviinae* has two distinct groups like migratory and resident birds, that explains the presence of difference in wing shape. It can be demonstrated that a more pointed wing tip is achieved by appropriate increases and decreases in the length of primary feathers that compose the wing tip. Thus a longer and or more pointed wing seems to be necessary for coping with the demands of migrational flights.

(B) WING SPAN & ASPECT RATIO

The two variables are determinants to understand the capacity of flying. Different types of flight are associated with different shapes of the wing. All the species under study have relatively shorter wings, although some differences occur among the migratory species. In general the drag on the bird is very small because of the low relative air speed of the body. The geometric similarity requires that wing span should be proportional to (body size)$^{0.33}$. The fig. 15 shows the relation between wing span and body size for all the birds under study.

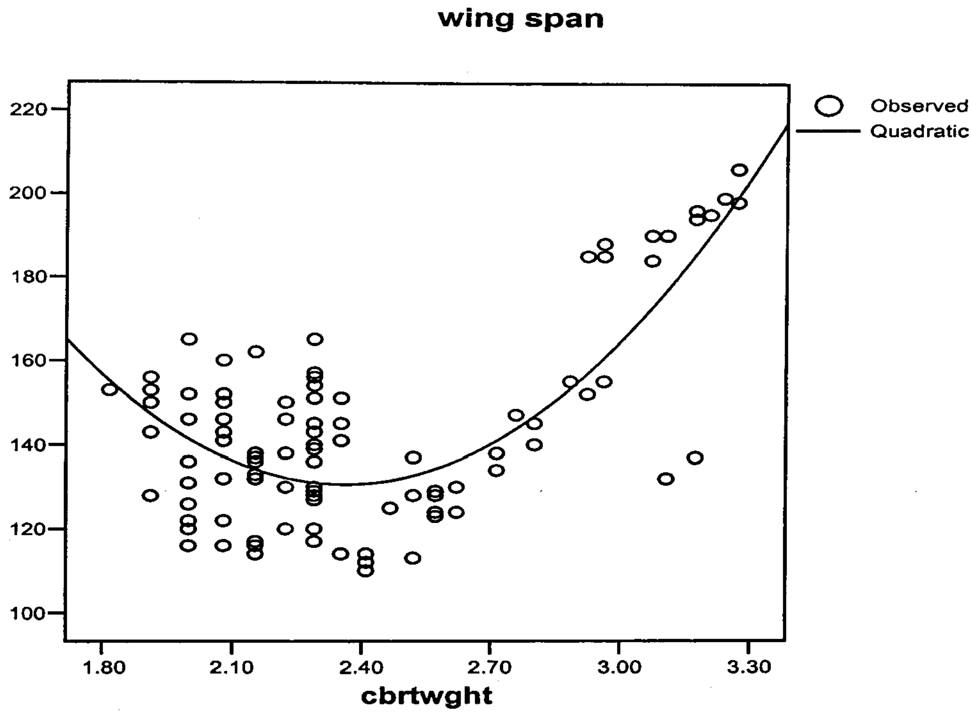

Figure 15: ratio of cube root weight to wing span

Table 7: Correlation analysis of wing span to (body weight)$^{1/3}$

		wing span	cbrtwght
wing span	Pearson Correlation	1	.526(**)
	Sig. (2-tailed)	.	.000
	N	271	100
Cbrtwght	Pearson Correlation	.526(**)	1
	Sig. (2-tailed)	.000	.
	N	100	100

The Karl Pearsons correlation coefficient between wing span and cube root of weight is 0.526. It is a positive correlation, that indicates that cube root of weight almost increases with wing span.

The aspect ratio explains more about the functional dimensions of wing and wing span. Wings of most birds of *Sylviinae* have relatively high aspect ratio and low wing loading. Wing loading enables the bird to produce the required lift to fly. The resident birds of this family invariably hops on branches and often hovers in front of the branches, whereas the migrant birds are used to fly-catching, snatching and multiple hovering in search of food and these show the most power demanding food searching behavior. The Fig 16 gives interesting relation between aspect ratio and wing length of all birds of *Sylviinae* under study.

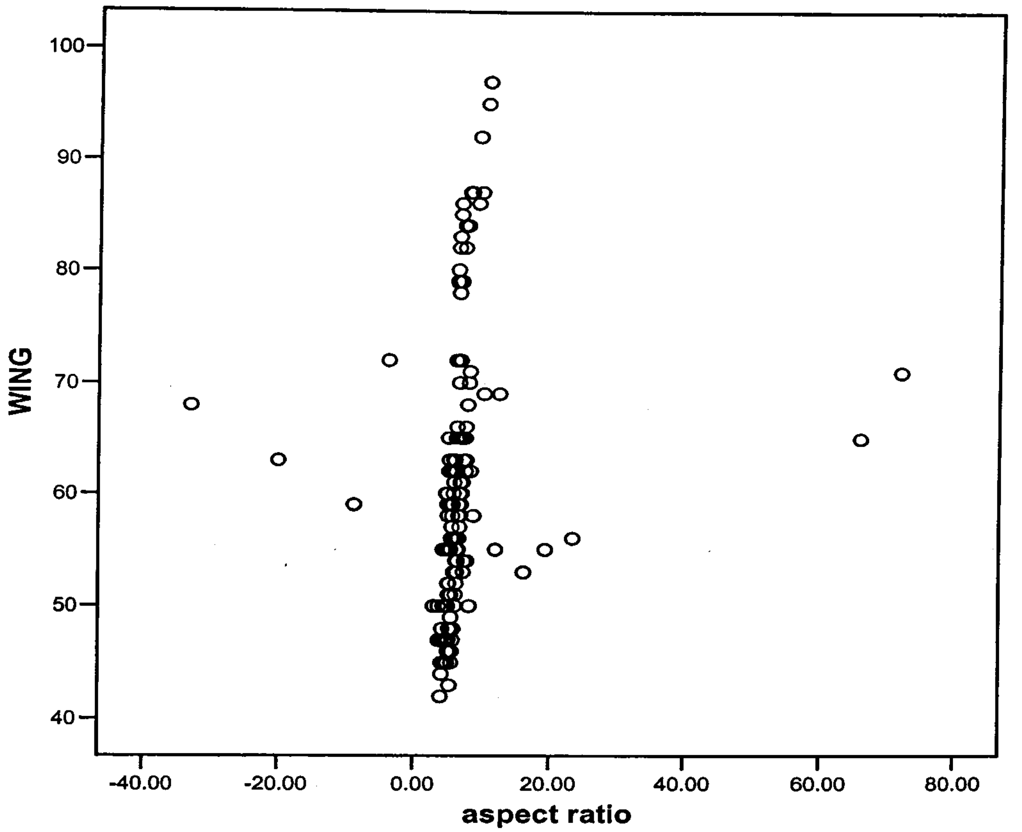

Figure 16: Relationship between Aspect ratio and wing length

Table 8: Correlation analysis of wing length to aspect ratio

		WING	Aspect ratio
WING	Pearson Correlation	1	.2
	Sig. (2-tailed)	.	.013
	N	271	268
aspect ratio	Pearson Correlation	.2	1
	Sig. (2-tailed)	.013	.
	N	268	268

The above table shows that the Karl Pearson's coefficient of correlation between wing length and aspect ratio is 0.2. It is a positive correlation that is, aspect ratio increases with wing length or long wing has high aspect ratio and short wings have low aspect ratio.

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Chapter IX

SUMMARY ON SYLVIINAE

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SUMMARY ON SYLVIINAE

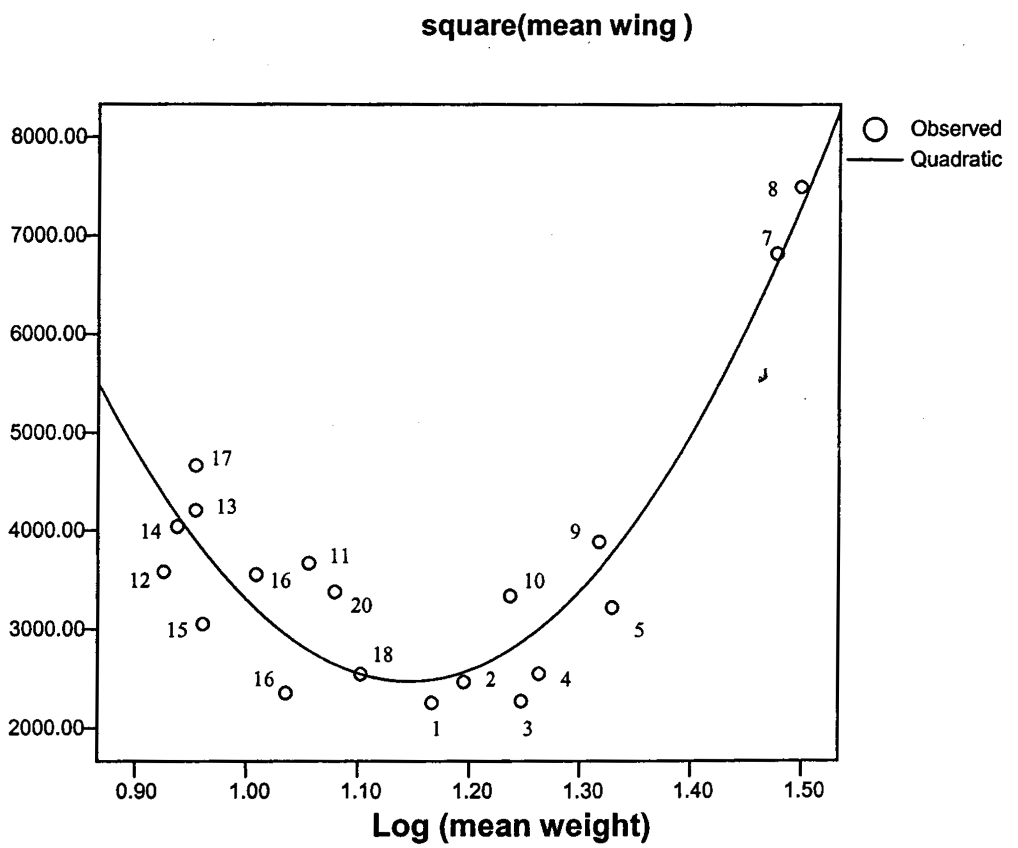
An analysis on the different variables of morphological adaptation

A case study on the subfamily *Sylviinae*

The discussion on the analysis of different variables that constitute the fabric of ecomorphological adaptations of birds of the subfamily *Sylviinae* also follows the same methodology employed earlier. The museum data are used to draw different possibilities of deductions in order to bring out reasonable explanations.

Index of roundness

As discussed earlier the concept of index of roundness is taken to be a key factor for the analysis. As a matter of generality, birds of this subfamily have a value between 0.4 and 0.75 with regard to index of roundness. It is to be noted that most of the migratory birds of this subfamily have smaller indices than resident ones. The migratory birds have the values between 0.4 and 0.55. It explains the migratory character of a few sylviids. The general rule that lower value of indices suggest the pointed wings, is seen true in the values of indices of the migratory species of *Sylviinae*. At the same time higher values of indices are found in the data of the resident birds. In fact the significant range of indices from 0.4 to 0.75 goes well with the already established findings on the shape of wings in the context of ecomorphological adaptation. The line of best fit explains the overall relationship of the square mean wing length to log weight in this subfamily. The following figure17 depicts the line of best fit.



Below line – wing length is less
Above line – wing length is more

Figure 17: Ratio of log weight to square of wing length

The figure shows a quadratic curve drawn with the values plotted against the log mean weight on the X-axis and square of mean wing on the Y-axis. The correlation is positive which explains functional correspondence between weight and wing length. Significantly the curve shows two types of association viz, when log weight increases upto 1.15 the square of mean wing decreases and after 1.5 it further increases. The difference has immediate relationship with the type of the bird like migratory and resident.

The quadratic curve and plotted values do not show significant variance. The following values speak of its analysis of variance.

	DF	sum of squares	mean square
Regression	12	31399845.1	1599922.5
Residuals	10	4965742.6	310358.9

The figure 18 describes the magnitude of deviation of each observation to the line of best fit, which is shown in mm. The figure shows very small deviation, which is indicative of the accuracy of the curve. The regression line signifies the prediction and it allows us to go for reasonable deduction.

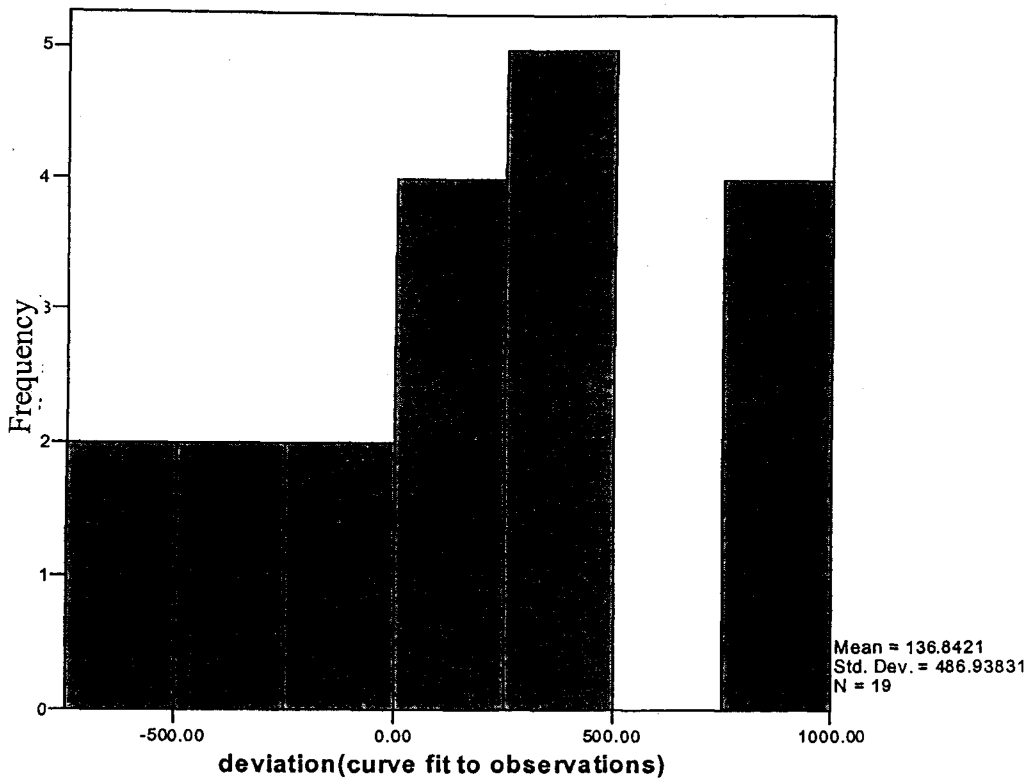


Figure 18: Magnitude of deviation

The graphical representations of mean weight of each niche group give more interesting details about morphological adaptation.

The figures 19a, 19b, 19c and 19d are drawn with mean weight on X-axis and its frequency on Y-axis. The graph gives number of species included in each interval. It can be seen that the graph projects niche groups A2 and B2 with more weight than the other groups. They are *Cisticola junctidis salimalii, Prinia subflava franklini, Prinia sylvatica sylvatica, Prinia hodgsonii albogularis, Acrocephalus dumetorum, Acrocephalus agricola agricola, Phylloscopus affinis affinis, Phylloscopus trichiloides* *viridanus, Phylloscopus trichiloides niditus, Orthotomus sutorius guzuratus and Locustella certhiola.* It is to be noted that all these birds inhabit either terrestrial or terrestrial-arboreal habitats.

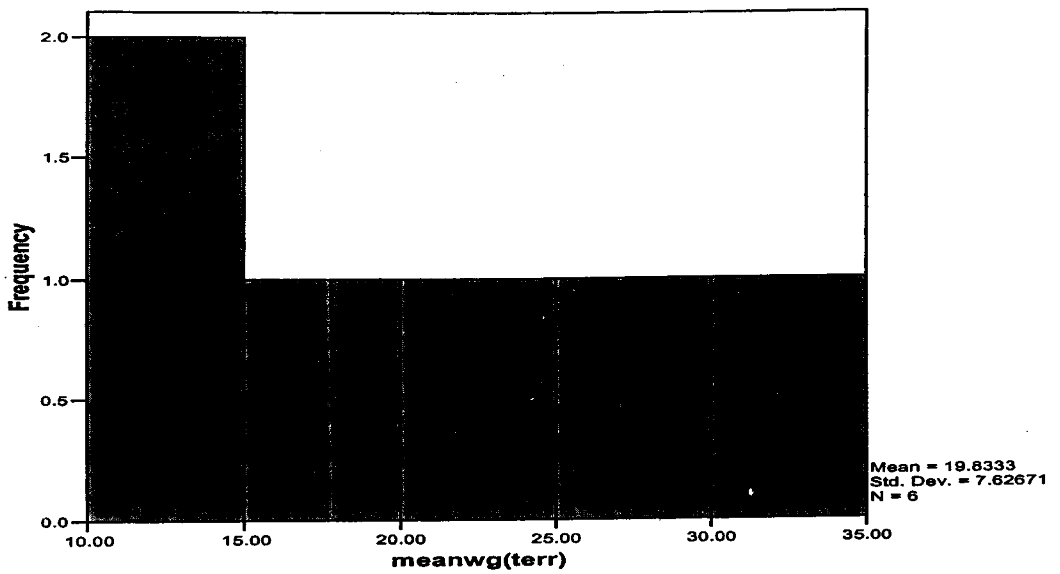


Figure 19a: Mean weight

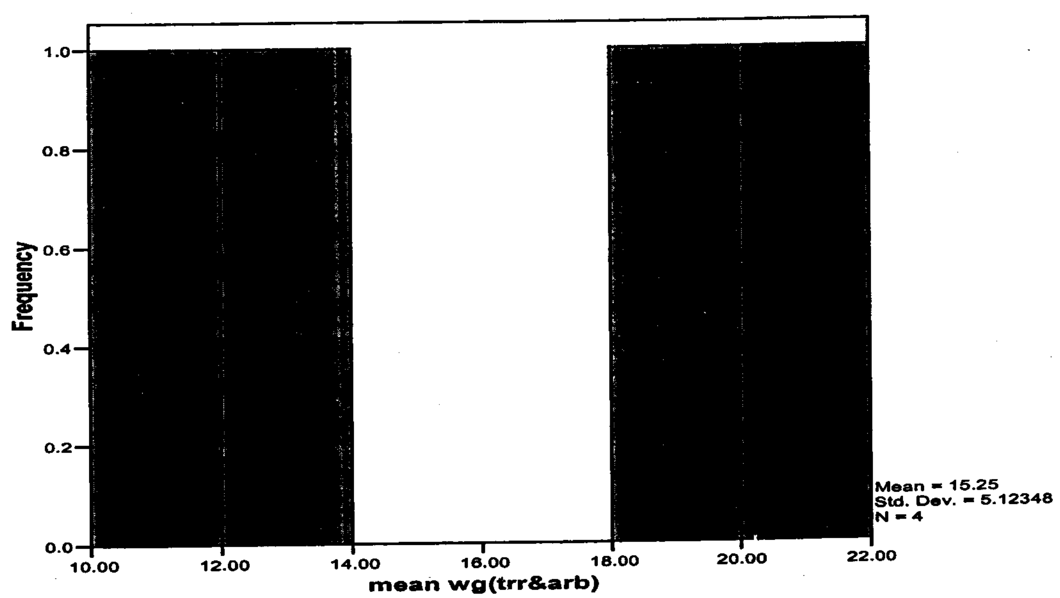


Figure 19b: Mean weight

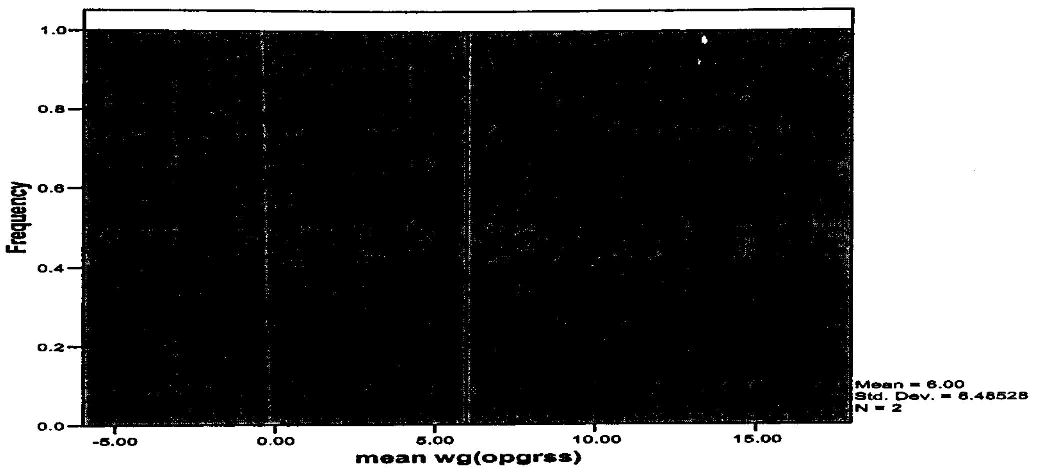


Figure 19c: Mean weight

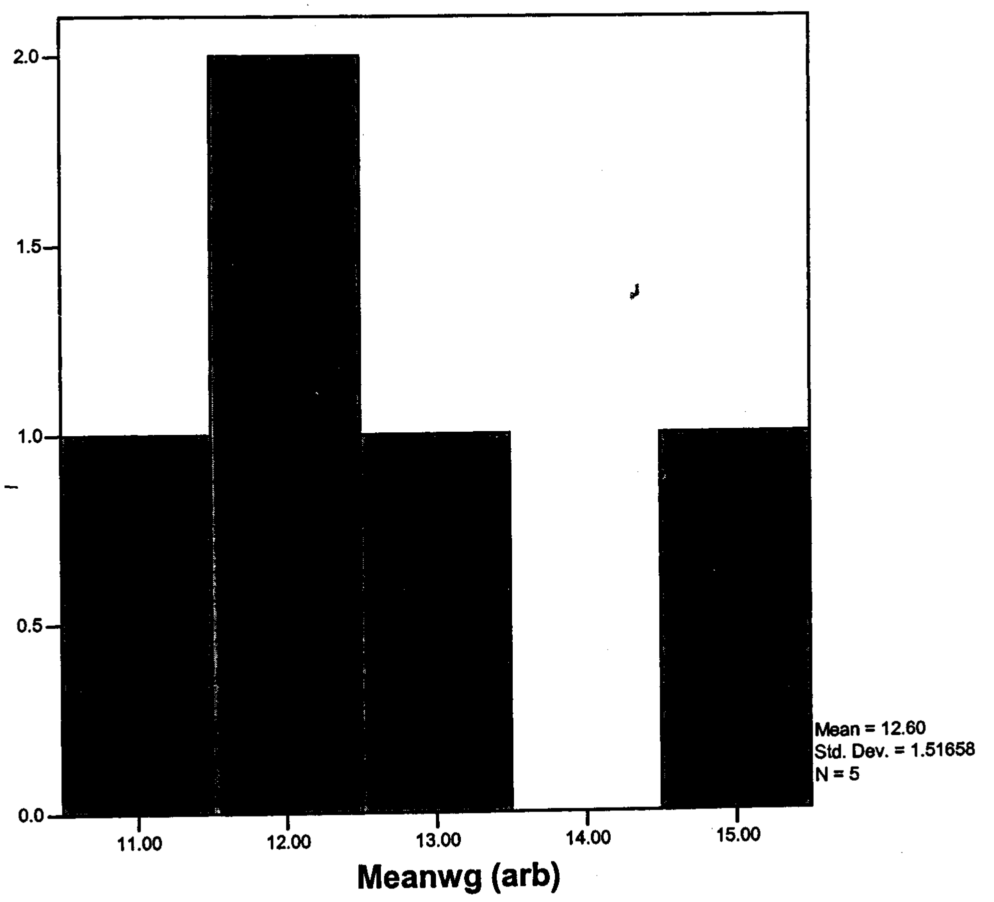


Figure 19d: Mean weight

The relation between index of roundness and T/W ratio has more to say about morphological adaptation. The figure 20 shows the plotted values for different niche groups. The figure is drawn with relative tail length on X-axis and index of roundness on Y-axis.

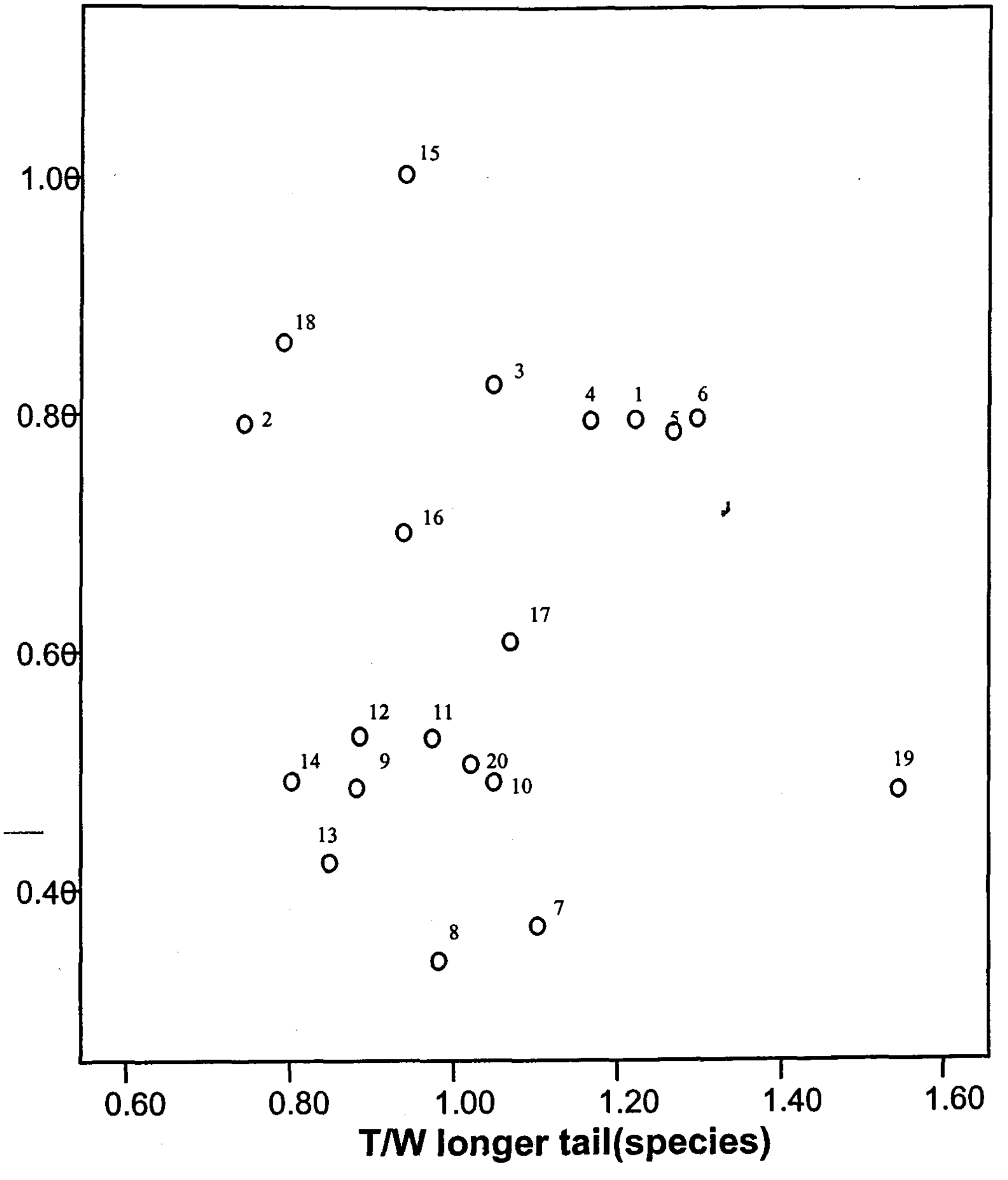


Figure 20: The relationship of index of roundness to T/W ratio

The figure 21 encircles the species based on the different niche groups. The distribution of the circles is to be seen in the wider context of behavioral pattern of these birds.

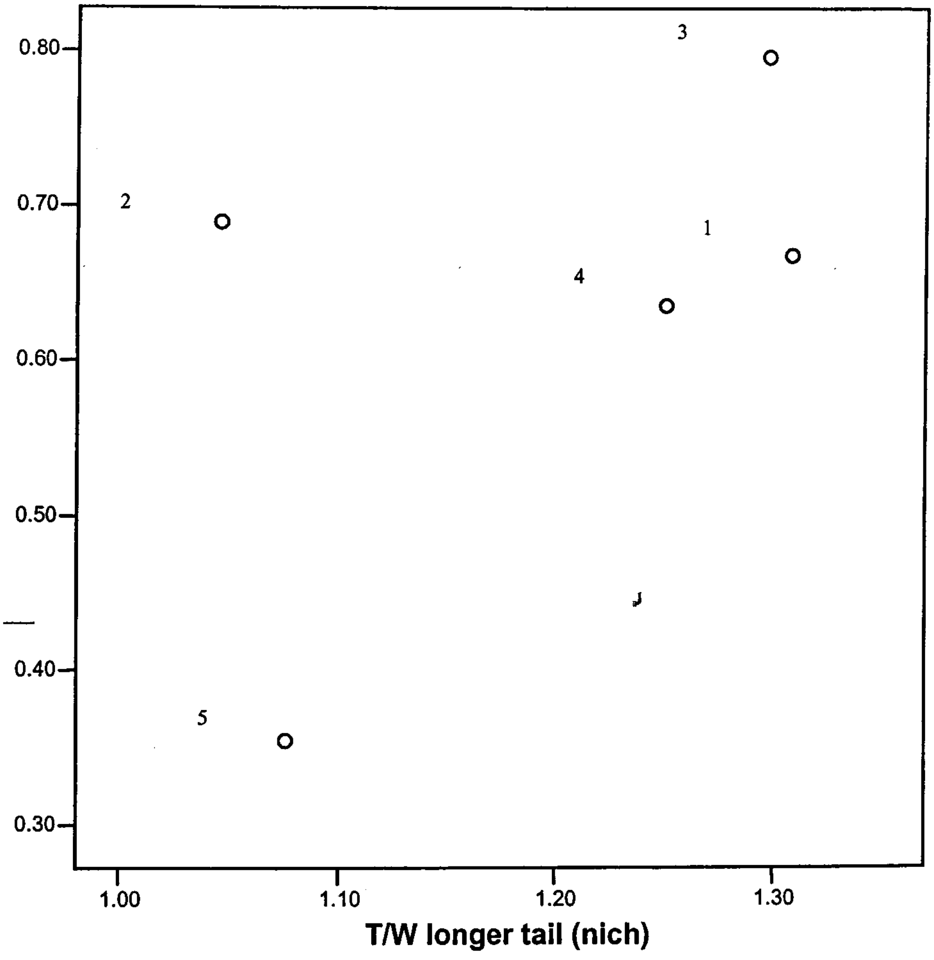


Figure 21: Mean index of niche

As it was in the case of *Timaliinae*, the concept of index of roundness can be linked to many other variables in order to draw up possible findings. The figures 22a, 22b, 22c, 22d and 22e explains the relationship between wing tips to index of roundness among species of different niche groups. X-axis shows index of roundness and Y-axis shows the frequency plotted against wing-tip. The figure 22a explains the relationship for niche group A2. A mean of 0.52 and std. deviation of 0.031 are seen in the graph. The figure 22b drawn for niche group B2 has a mean value of 0.51 and std. deviation of 0.033. The graph 22c shows the niche group C2 with a mean value of 0.27 and std. deviation of 0.381. The niche group D2 has a mean value of 0.5 and std deviation of 0.02. A mean value of 0.52 and std deviation of 0.028 are seen in niche group E2.

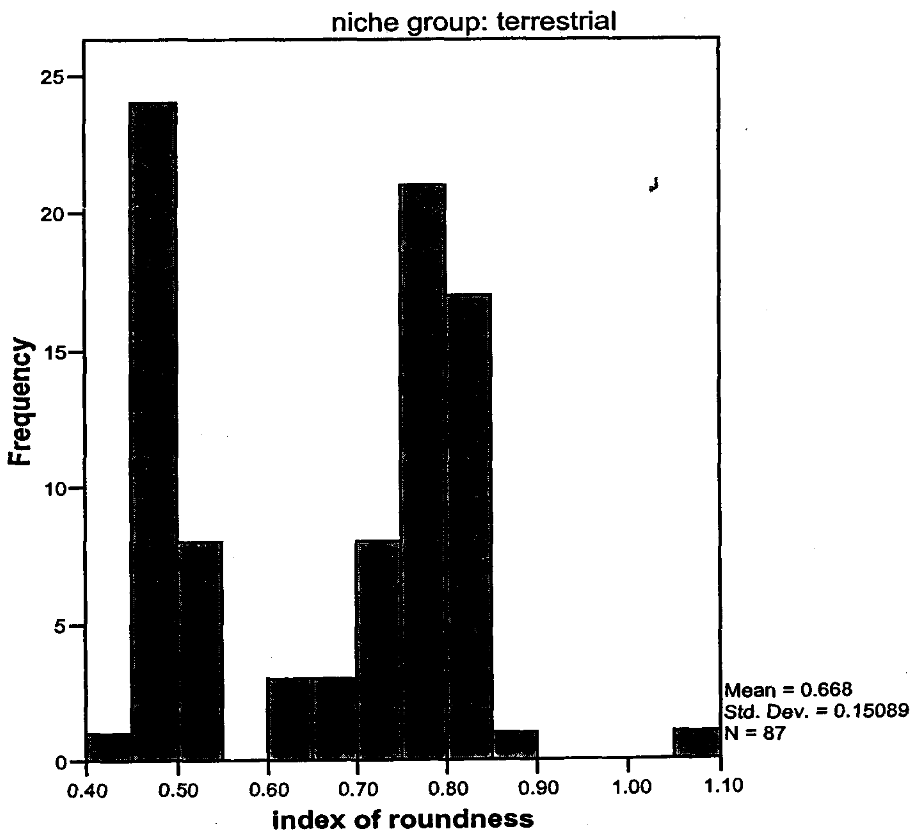


Figure 22a: Index of roundness

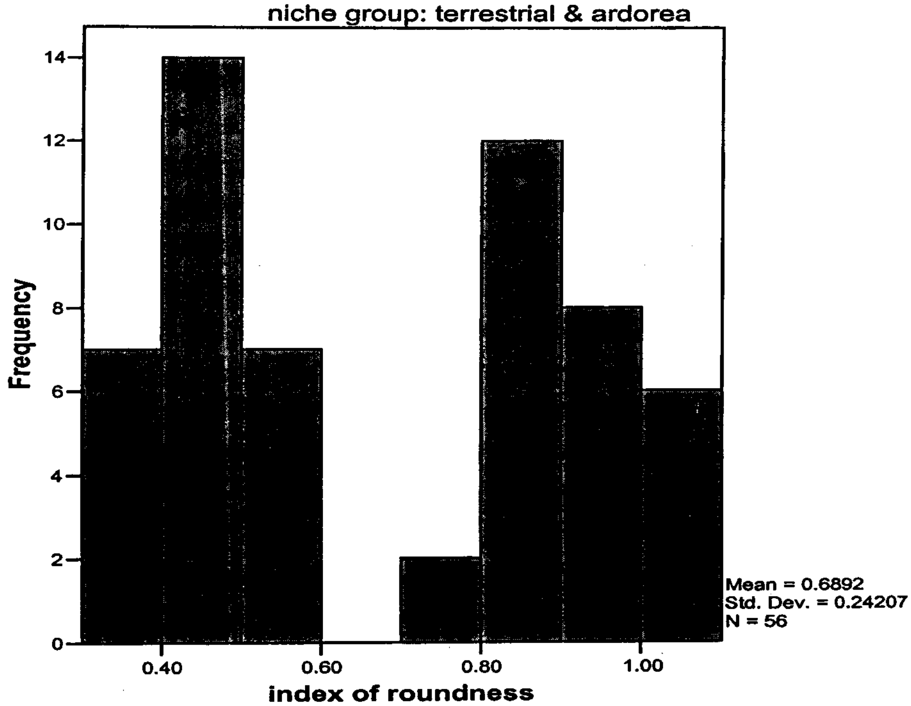


Figure 22b: Index of roundness

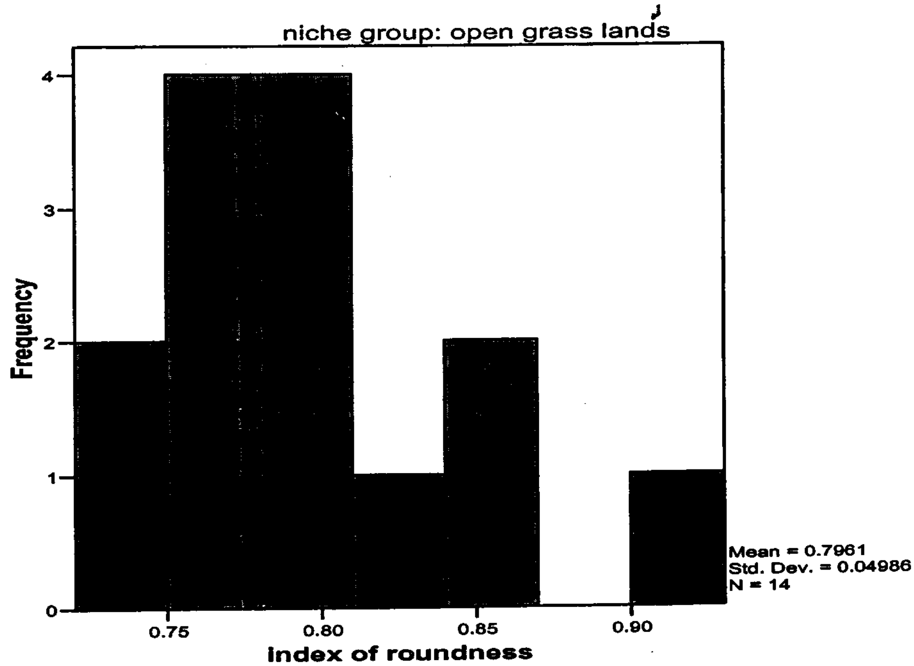


Figure 22c: Index of roundedness

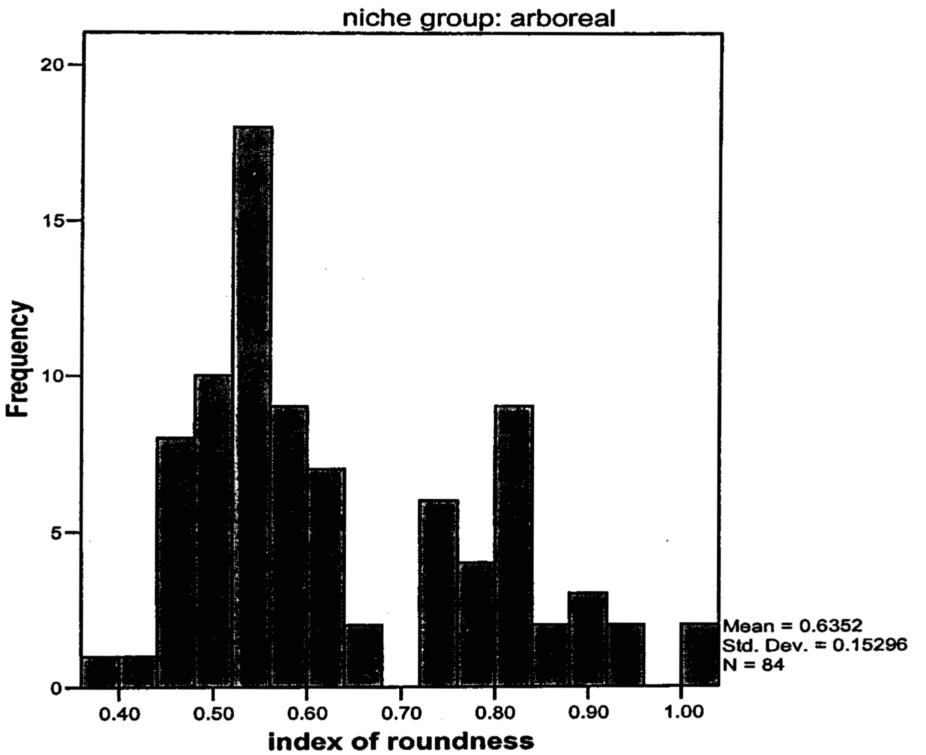


Figure 22d: Index of roundness

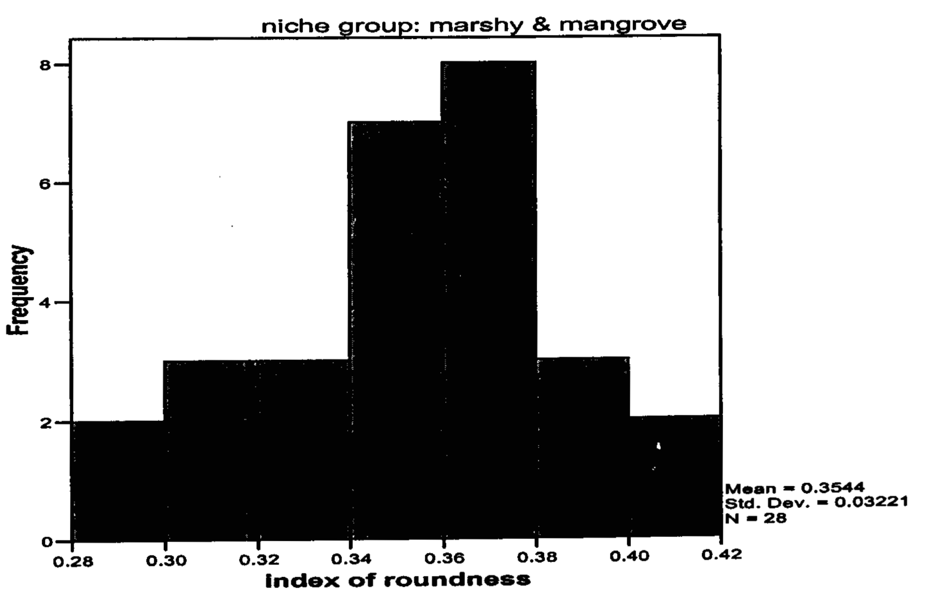


Figure 22e: Index of roundness

The distribution of tarsus to cube root of weight indices for the birds of combined niche groups is shown in figure 23. The graphs C2 and D2 have higher indices than the other groups, hence have relatively longer legs. They include *Cisticola exilis erythrocephala, Prinia socialis socialis, Hippolais caligata rama, Phylloscopus occipitalis occipitalis, Schoenicola platyura, Orthotomus sutorius guzuratus and Locustella naevia straminae.*

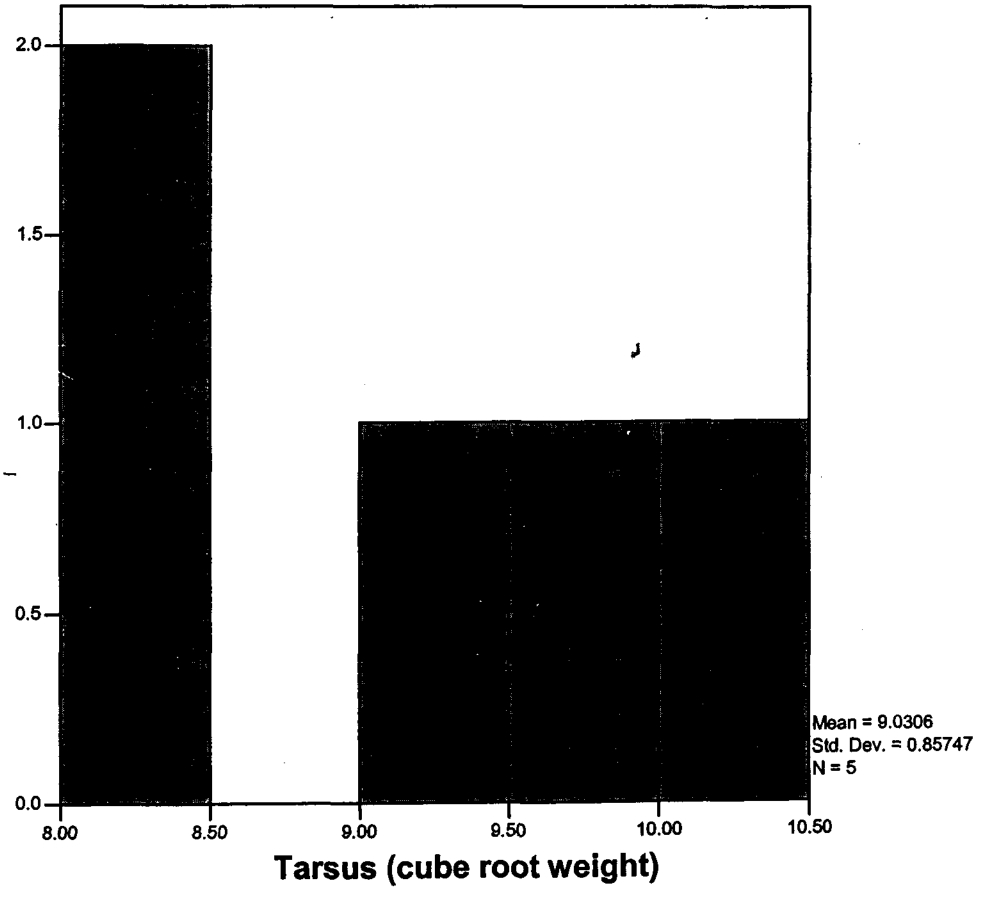


Figure 23: Distribution of cube weight of tarsus

The distribution of bill/cube root weight ratio's for the birds of combined niche groups is shown in figure 24. The niche groups C2 and B2, which overlap with each other shows high indices which indicates relatively longer bill length. The niche group D2 have higher index which lies between 7.5 and 8.5. It is indicative of relatively longer bill length.

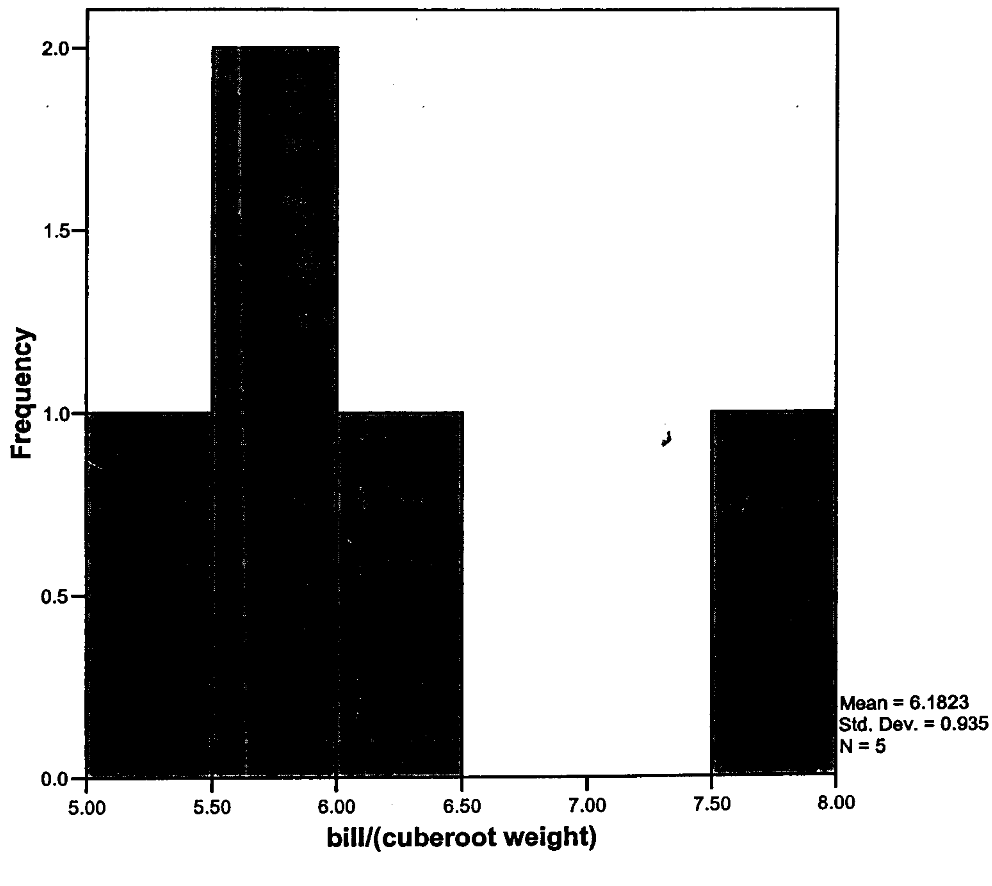


Figure 24: Distribution of cube weight of bill

The above discussion on the functional relationship among the different variables of morphological adaptations seen in subfamily *Sylviinae* underlines a set of vivid deductions. It has been discussed at the appropriate places in the preceding chapters. The statistical analysis goes well with theoretical postulates on ecomorphological adaptation. The given sample space is potent enough to generate as well as substantiate many of the well known correlations.

The Anova results given below, Table 9 sum up the significance of the operation employed by the researcher in the present study. The three variables wing, bill and tarsus of all specimens under study have shown different levels of relation among the different species in the ecomorphological context. It also shows the level of adaptation that has taken place. It is to be noted that the functional premise generated by the above three variables have strong coefficient of correlation.

Table 9: The Anova results of wing, bill and tarsus length

ANOVA

WING

	Sum of squares	Df	Mean square	F	Sig
Between groups	21629.904	4	5407.476	78.176	.000
Within groups	18399.469	266	69.171		
Total	40029.373	270			

There is a significant difference in the case of wing length

ANOVA

BILL

	Sum of squares	Df	Mean square	F	Sig
Between groups	1179.229	4	294.807	5.830	.000
Within groups	13450.963	266	50.568		
Total	14630.192	270			

There is a significant difference in the case of bill length

ANOVA

TARSUS

	Sum of squares	Df	Mean square	F	Sig
Between groups	1668.146	4	417.037	12.183	.000
Within groups	9105.559	266	34.231		
Total	10773.705	270			

There is a significant difference in the case of tarsus

Table 1: The Anova results of wing, bill and tarsus length

The significant coefficient of variation in the wing length in this subfamily reinforces the postulate that the length of the wing is necessary and sufficient condition for evolving foraging strategies and migrational behavior of the birds. This suggests the evolution of different kinds of foraging strategies like fly-catching multiple hovering, snatching, flitting etc, in the different groups of birds.

The coefficient of variation for mean bill length among species of *Sylviinae* is more or less same as that of coefficient of variation for mean tarsus length. The evolution of different behavioral strategies for obtaining different types and sizes of prey items is to be understood against this feature. It also explains the degree of adaptability, leading to the selection of different morphological characters. Hence the variation in the bill size.

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Chapter X

DISCUSSION ON COMPARISON: TAMILIINAE AND SYLVIINAE

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DISCUSSION ON COMPARISON – TIMALIINAE AND SYLVIINAE

The present chapter is an attempt to compare some of the conspicuous characters of the birds in the context of morphological adaptation. It is done against the premise of behavioral pattern. Obviously it is an epilogue of the discussion carried out by the present researcher as detailed in the earlier chapters. It does not mean that it is an attempt to rewrite the observation made elsewhere in the thesis. Rather it is a summing up of the predominant traits of the analysis.

BODY LENGTH & WEIGHT

It is very clear that the size of the birds either in terms of length or weight is not significantly big enough to label as very small or very long. All birds of these two subfamilies, if we put together generates a range from 102mm to 258mm. Significantly the birds of *Timaliinae* have longer length than birds of *Sylviinae*. It is to be noted that 195mm is the upper limit of the size of the birds of *Sylviinae*, whereas majority of birds of *Timaliinae* has a value greater than 200mm. This feature goes well with their foraging strategies in their habitat. Comparatively smaller size of *Sylviinae* justifies their foraging strategy to exploit their habitat by hovering and flitting. Small size is an advantage for the birds to resort to these methods. It is very significant to observe that all the migrant birds of *Sylviinae* have a size which ranges between 140mm to 165mm.It is a higher range in the birds of *Sylviinae*, but it is smaller to *Timaliinae*. Comparatively heavier weight of these migrant birds is well explained by Bergmann's Rule. It scientifically establish the ecomorphological adaptation among the migratory birds of *Sylviinae*.

TARSUS LENGTH

The variations in the dimensions of tarsi among different species and genera of insectivores passerine birds in relation to ecology and behavior have been discussed by number of authors (Osterhaus 1962, Schoener 1965, Grant 1967 1971, Root 1967 and Fretwell 1969). The main function of the tarsus together with the other bone elements of hindlimbs is to support and transport the bird when it is not flying. Tarsus length of the bird has often been associated with foraging perch characteristics. Species foraging on stable perches in an upright posture tend to have longer tarsi relative to body weight, than those foraging on unstable perches. Relative tarsal length is considered adaptive, as it is suited to the locomotor needs of the species in the niche it occupies.

The lengths of different leg elements are related to the birds feeding behavior. A bird which often hangs under branches and/or climbs should have a short tarsus. This is to minimize the muscle force needed for flexion during hanging. Consequently, it has been well established that the birds with longer tarsi are seen mostly inhabiting the ground. The depth of the debris on the substrate upon which a bird forage also has a bearing on the leg length. It is worth noting that most of the species of *Timaliinae* have longer tarsi. The specie viz, *Turdoides* and *Garrulax* have relatively longer tarsi and they prefer to forage on the ground and low bushes. The birds of these species usually rummage among the fallen leaves, flick them aside or turn them over in search of insects. In general the species of *Timaliinae* are short distant flyers and their comparatively taller tarsi support them in defining this behavior. This observation theoretically and practically synchronizes with other features of this species. The species *Turdoides* and *Pellorneum* are noted distinctively for their strong and long tarsi.

The length of tarsi of *Sylviinae* invariably are shorter when compared to *Timaliinae*. It never crosses 30mm in length, whereas species of *Timaliinae* have length more than 30mm and goes upto 38mm. This variation is significant and calls for reasonable explanation. The birds of *Sylviinae* have longer tarsi enabling them to forage on tree/canopy. It is also true with species of *Timaliinae*, which has shorter tarsus. The general observation holds that the birds with shorter tarsus hunt among trees and foliage of small trees. They restlessly hunt insects among leaves and blossoms; often flies out from the extremity of a twig to take insects on the wing. It is true for all birds of the species of *Timaliinae.*

In short, discussion on the length of tarsi for both the subfamilies underlies a significant pattern which is indirectly linked with their foraging behavior. Needless to say tarsus length is one of the strongest indices of understanding the mechanism of adaptation. The tarsometatarsus is shorter in those species exploiting vertical surfaces (Spring 1965, Winkler and Bock 1976, Norberg 1979 James 1982 Lederer 1984). Perhaps, the distal reduction of legs optimizes efficiency of the musculature supporting the body weight. This reduction diminishes the distance between the centre of gravity of birds and vertical surface reducing the effort needed to hold the body close to the trunk. On the other hand, long tarsus is related to feeding among foliage both in trees and bushes and not with cursorial locomotion, which one would expect (Correlation between relative tarsometatarsus length, TL/FL and ground use; $r = -0.472$, $n = 1$, $p > 0.1$). A longer tarsometatarsus allows a longer radius of action for searching food among the foliage, rather than length of femur and/or tibiotarsus because step length is increased most, by increasing of tarsometatarsus instead of other legbones.

BILL LENGTH

Bill morphology is a much debated and discussed topic in the morphological adaptation. There is a well defined relationship between food type, habitat and bill morphology. Long flat bills are typical of birds which have to catch mobile prey, especially flying insects (Lederer 1975, 1980). Gleaning of more sedentary prey favours shorter, slightly curved bills. In the marsh habitats, emerging mobile prey is abundant in the higher flooded vegetation of the reed beds, whereas less mobile prey is more likely to be encountered in short vegetation and undergrowths (Leisler, Ley, and Hans Winkler 1989). Conversely a relatively shorter and wider bill would be of greater use in fly catching and for foraging in foliage (Dilger 1956).

The discussion on bill length of the two sub families brings out certain distinct features; Most of the birds of the subfamily *Timaliinae* have comparatively longer bill than *Sylviinae.* This would permit us to treat variable of bill length independent of types of prey, rather it connects this variable with the feeding strategies frequently employed in its ecological niche. In addition, the coefficient of variation for mean bill length among species of *Timaliinae* is significantly higher than the coefficient of variation for mean tarsus length, which suggests the evolution of different behavioral strategies for obtaining different types and sizes of prey items. Consequently this led to the selection of different morphological traits while the apparatus for foraging the prey remained substantially the same.

TAIL LENGTH

The tails of the birds have important aerodynamic functions; they produce lift , supplementing that created by the wings, influence flight manoeuvrability and agility, and are particularly useful at low flight speed. However the tail also affects aerodynamic costs by decreasing drag - the longer the tail the greater the drag. Natural selection for aerodynamically efficient flight, commensurate with the ecological requirements of the species, should therefore act on tail length and shape and may increase or decrease tail length.

The relative tail length of the birds of both the subfamilies show consistent pattern. The values of tail length of *Timaliinae* move towards 1/3rd of its body length, whereas this variable for *Sylviinae* centres around half of its body length.

LONG TOE

Toe is a supporting factor for the birds to climb up. In vertical climbing, the toes are held in a near vertical direction on the trunk and have to support the whole weight of the bird. In general, the long and slender legs and toes of *Acrocephalus* warblers are probably not capable of very strong grip, but they help in vertical climbing. The warblers inhabiting marshy areas can run or walk on ground. They possess a long middle toe which is adapted for running. The grasshopper warbler, *Locustella naevia* is best adapted for running. The inner toe additionally accounts for the adaptations for aquatic warblers for running. The birds of *Timaliinae* in general have short toes, which help them in *pedestrial* searching and flitting.

WING LENGTH

The form of

birds' wing is basically important to the successful exploitation of an ecological niche, that it inevitably yields many instructive examples of adaptive evolution. It also provides interesting examples of convergence to such important function as locomotion and obtaining food. Therefore a discussion on wing, its form and content is required to understand the features of morphological adaptation. As shown in the figure describing the relationship of log weight to square wing length, it is clear that C*isticola exilis erythrocephalus, Phylloscopus trichiloides nitidus, Acrocephalus agricola agricola, Arcocephalus dumetorum, Prinia hodgsonii albogularis, Prinia subflava franklini and Prinia sylvatica sylvatica* have positive correlation and *Prinia socialis socialis and Arcocephalus stentoreus brunnescens* have weak correlation.

As discussed earlier, the differences in the winglength and ratio W/L for all species under study, do not show significant variance. In comparison, the wing length of *Sylviinae* are shorter than that of *Timaliinae*. It probably helps to forage through thick dense vegetation. The shorter wings of the species living in dense vegetation have been remarked on by Hamilton (1961).

WING SHAPE

Wing shape has been scientifically related to the discussion on morphological adaptation. The index of roundness is one of the popular methods employed to analyse the wing factoring the process. The value of index of roundness determines the shape of the wing. The statistical analysis of data for the index of roundness of all species of *Timaliinae* gives a range from 0.8 to 0.9. Theoretically index of roundness can assume a value 0>=x<=1. Rounded wings are seen for higher values of index of roundness. The observations do support this character for *Timaliinae*. The similar analysis made for *Sylviinae* shows interesting observation. The migratory species have lower values while the resident ones have higher values. The birds with higher values for index of roundness have pointed wings. The general rule that species with pointed wings have their wing tips closer to the leading edge of the wing is true for migrant species. A similar situation was previously noted by Kipps, who compared more or less migratory species of number of passerine genera for this feature.

Like wing length, wing shape appears to be more closely related to distance of migration at the intraspecific level, than at interspecific level. The analysis on wing shape and the index of roundness suggest that the variation in index of roundness among species of *Sylviinae* can be accounted for largely by differences in their distance of migration. The rounded wings of Timaliinae and few Sylviinae seem to be a sign adaptation for its rapid foraging movements. The rounded wings of most small passerines is an adaptation for numerous rapid take offs and emargination of the leading primaries assists in this.

WING SPAN

Wing span is considered to be another variable to define the function of ecomorphological adaptation. A bird can vary its wing span by broadening its wing at shoulder, elbow and wrist. As the bird flexes, the wing span is reduced. This changes the wing area proportionally, with a resulting change in aspect ratio and wing loading.

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Chapter XI

SYLVIINAE – MORPHOLOGICAL DIFFERENTIATION

Chapter XI

SYLVIINAE –MORPHOLOGICAL DIFFERENTIATION

The subfamily *Sylviinae* has two distinct groups of birds, viz, migratory and resident. The sample space chosen by the researcher has 12 species of migratory birds out of 20. They are *Phragmaticola aedon aedon, Acrocephalus stentoreus, Acrocephalus dumetorum, Acrocephalus agricola, Hippolais caligata, Phylloscopus trichiloides viridanus, Phylloscopus trichiloides nitidus, Phylloscopus occipitalis, Phylloscopus affinis, Phylloscopus magnirostrus, Locustella certhiola rubescens and Locustella naevia straminae*. The sub space for sample has data on 159 numbers of birds. The resident constitutes 112 numbers of birds of 8 species. It is a well known fact that migration affects almost all aspects of the internal and external morphology of birds. Morphological differences between migrants and resident birds can be related to flight performance or to other ecological factors that act differently in these groups. Obviously the observations on the *Sylviinae* family bring out certain characteristics that keep these two groups distinct but not different. The discussions made on *Sylviinae* tried to focus on some of the basic variables like wing length, wing span, aspect ratio, tarsus length, tail length, bill length, long toe, index of roundness, total length and weight, and its proportionate contributions in evolving ecomorphological characters. The foregoing analysis is an attempt to project its statistical back up for the deductions already made.T-test has been employed for each variable. The following table gives details of the T- test.

Table 10: T-tests for different variables between migrant & resident

Group Statistics

VAR00002		N	Mean	Std. Deviation	Std. Error Mean
WING	Resident	112	52.46	7.550	.713
	migratory	159	63.74	12.662	1.004

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
WING	Equal variances assumed	6.430	.012	-8.434	269	.000	-11.287	1.338	-13.922	-8.652
	Equal variances not assumed			-9.163	262.548	.000	-11.287	1.232	-13.712	-8.861

There is a significant difference in wing length between migratory and resident birds.

Group Statistics

	VAR00002	N	Mean	Std. Deviation	Std. Error Mean
TAIL	Resident	112	49.73	13.602	1.285
	Migratory	159	56.07	15.050	1.194

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
TAIL	Equal variances assumed	.290	.591	-3.550	269	.000	-6.337	1.785	-9.852	-2.823
	Equal variances not assumed			-3.613	252.873	.000	-6.337	1.754	-9.791	-2.883

There is a significant difference in tail length between migratory and resident birds.

Group Statistics

VAR00002		N	Mean	Std. Deviation	Std. Error Mean
LONG TOE	Resident	112	17.54	3.693	.349
	Migratory	159	18.39	4.534	.360

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
LONG TOE	Equal variances assumed	.699	.404	-1.629	269	.105	-.845	.519	-1.867	.177
	Equal variances not assumed			-1.687	263.307	.093	-.845	.501	-1.832	.141

There is a significant difference in length of long toe between migratory and resident birds.

Group Statistics

	VAR00002	N	Mean	Std. Deviation	Std. Error Mean
WING SPAN	resident	112	128.41	14.989	1.416
	migratory	159	149.25	28.525	2.262

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
WING SPAN	Equal variances assumed	9.567	.002	-7.070	269	.000	-20.835	2.947	-26.636	-15.033
	Equal variances not assumed			-7.806	251.201	.000	-20.835	2.669	-26.091	-15.578

There is a significant difference in wing span between migratory and resident birds.

Group Statistics

	VAR00002	N	Mean	Std. Deviation	Std. Error Mean
WEIGHT	resident	37	15.1081	5.67540	.93303
	migratory	63	14.9365	8.66932	1.09223

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
WEIGHT	Equal variances assumed	11.378	.001	.108	98	.915	17160	1.59607	-2.9957:	3.33895
	Equal variances not assumed			.119	96.762	.905	17160	1.43649	-2.6795:	3.02273

There is a significant difference in the weight between migratory and resident birds.

Group Statistics

	VAR00002	N	Mean	Std. Deviation	Std. Error Mean
INDEX OF ROUNDNESS	Resident	112	.7821	.08459	.00799
	Migratory	157	.5321	.18135	.01447

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
INDEX OF ROUNDNESS	Equal variances assumed	22.248	.000	13.570	267	.000	25002	.01842	.21374	.28629
	Equal variances not assumed			15.122	234.949	.000	25002	.01653	.21745	.28259

There is a significant difference in index of roundness between migratory and resident birds.

The wing length, wing span, tail length, long toe, index of roundness and weight of the bird have significant variation between the migrants and resident birds.

The migratory birds of *Sylviinae* have comparatively greater wing length and wing span; and low index of roundness. Its morphological manifestations are reflected in longer and pointed wings with larger wing area. The data on the wing length for migratory birds clearly show higher values as distinct from the resident birds of *Sylviinae*. It is in confirmative with the rule that wing length tends to become greater at higher altitudes. It also underlines the theory in ecomorphology that the adaptation in flight in thin air of higher altitudes requires relatively larger wing length.

Table 11: Correlation analysis between Winglength & Aspect ratio.

		WING	aspect ratio
WING	Pearson Correlation	1	.2
	Sig. (2-tailed)	.	.013
	N	271	268
aspect ratio	Pearson Correlation	.2	1
	Sig. (2-tailed)	.013	.
	N	268	268

Correlation is significant at the 0.05 level (2-tailed).

The above table shows that the Karl Pearson's coefficient of correlation between wing length and aspect ratio is 0.2. It is a positive correlation that is, aspect ratio increases with wing length or long wing has high aspect ratio and short wings have low aspect ratio.

The statistics on the sample space for migratory birds of *Sylviinae* show the presence of pointed wings for these birds. It is to be noted that it strongly supports the theory that the migratory species possess pointed wings. An increase of wing span would increase wing area and thus the profile power (friction of air), unless the wings are made narrower to maintain the same wing area. The above theoretical postulate synchronizes with the data and finding of the sample space. The T-test for the index of roundness, wing length and wing span of the migratory birds supports this ecomorphological adaptation. The same variables can also be related to their foraging behavior.

Tail length has significant difference in resident and migratory birds. It is interesting to note that the migratory birds of this subfamily have comparatively longer tail. In the migratory birds rounded tails are seen. But the shape of the tail among the species of *Phylloscopus* is generally square ended or with the central tail feather slightly shortened. The migratory birds invariably forage on the vertical trunks of trees and under side of the branches. It is worth noting that *Phylloscopus affinis affinis* forages particularly among boulders on its breeding grounds. The long tails of these group can be related to this foraging behavior. In general migrant species of

Sylviinae have longer tails as opposed to the other shorter tails found in non-migratory birds.

The coefficient of significance for long toe does not show much difference. But in the case of weight, the significance is clear. Comparatively higher weight and larger size for the migratory birds of *Sylviinae*, can be explained with the theories relating to ecomorphology. It is generally assumed that increased wing length at higher elevations is an indication of increased body size. The Bergmann's Rule supports this deductions and the statistics of this sample space confirms at least in this context.

ADAPTATIONS OF BIRDS IN THE SUB FAMILIES OF *TIMALIINAE* AND *SYLVIINAE*

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2007

Chapter XII

CONCLUSION

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The discussions made in the earlier chapters are self-explanatory. The deduced observations, findings and inferences have been already given in the required points. The statistical analysis has been used throughout the discussion, wherever necessary to bring out collaborative arguments for the already existing postulates and inferences. It also justifies that the variations in morphological traits shows their adaptiveness. To sum up, the enquiry made by the researcher can broadly bring out the following points.

1. The analysis of different variables like bill, tarsus, wing, long toe, tail, total length and weight on its morphological adaptation indicates that its features, similarities as well as differences are capable of generating scientific observations. And it is quite applicable for both the subfamilies under study. The analysis supports the already existing inferences/concepts in the science of eco-morphology.

2. The sub families of Timaliinae and Sylviinae do exhibit the specific signs of adaptation which is well explained in terms of its morphological traits.

3. The morphological differentiation is clear in the sub family of Sylviinae as it has both migratory and resident birds. The differences

in the values of the variables are suggestive of the morphological differentiation, for which they are adapted.

4. The derived concepts like index of roundness, aspect ratio, and the line of best fit go well with the inferences already made on the adaptation of these two sub-families.

All the above broad deductions have been discussed at length in the earlier chapters of the present work. The thesis that ecomorphological characters go in tune with the adaptation process has been well established.

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BIBLIOGRAPHY

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Alatalo R V., 1982a. Evidence for interspecific competition among europeon titsparus spp. – *Annual Zoological Fennici* 19: 309-317

Alley, T R., 1982. Competition theory, evolution and the concept of an ecological niche – *Acta Biotheoretica* 31:165-179

Amadon D. 1943. Bird weights as an aid in taxonomy. *Wilson Bulletin* 55: 164-177

Arnold, 1983. Morphology, performance and fitness. *American Naturalist* 23: 347-361

Arnold and Bennettel, 1988. *The theory of linear models and multivariate analysis*. Prince Town, New York

Baldwin, 1931. Measurements of birds. *Celeveland. Museum. Natural History* 2 : 1-165

Baldwin, 1953. Annual cycles, environment and evolution in Hawaiian Honey creepers. *University of Californis Publication, Zoology* 52: 285-398

Barret-Hamilton & Mac Hinton, 1914. *A History of British Mammals*, Oxford Unity Publications London Vol 2 PP 748

Bent A C., 1949. Life Histories of North American Thrushes, Kinglets and their allies, *US Natural Museum Bulletin* 196: 1-454

Bock W J, Wahlert G Von, 1965. Adaptation and form-function complex. *Journal of Evolution Biolgoy*: 269-299

Bock W J., 1975. Concepts of methods of ecomorphology, *Journal of Bioscience.* Vol 19, No. 4 403 – 413

Bowman, R I., 1961. Morphological differentiation and adaptation in the Galapagoes finches, *University of California. Publication Zoology* 58: 1-302.

Brown W L and Wilson E O., 1956. Character displacement. *Systematic Zoology* 5: 49-64

Chapman F M., 1949. The post glacial history of zonotrichia capensis. *American Museum Natural History Bulletin* 77: 381-438

Cook L M., 1961. The edge effect in population genetics. *American Naturalist* 95:295-307

Darlington, *Zoogeography - The Zoological distribution of animals* 249 & 258, Cambridge University Press, London

Davis J., 1957. Comparative foraging behavior of spotted and brown towhee. *Auk* 74:129-166

Dilger W C., 1956. Adaptive modifications and ecological isolating mechanisms in the Thrush genera Catharus and Hylocichla. *Wilson Bulletin* 68: 171 – 199

Donald S Farner & James R King. Avian Biology, Oxford University Press, London

Emerson and Arnold, 1989. Intra and inter specific relationships between morphology, performance and fitness. In: Wake, DB, Roth, G (eds), *Complex Organismal Function, Integration and Evolution of Vertebrates, New York.*, PP 295 – 314.

Falconer D S., 1953. Selection for large and small size in mice. *Journal of Genetics* 51 : 470 – 501.

Fitzpatrick, 1980. Foraging behaviour of neotropical tyrant flycatchers. *The Condor* 82: 43-57.

Fitzpatrick S., 1999. The tail length in birds in relation to tail shape, general flight ecology and sexual selection. *Journal of Evolution Biology* 12: 49-60.

Francis C James, 1982. The ecological morphology of birds : A review. Annual Zoological Fennici 19 : 265-273

Francis C James. Environmental component of morphological differentiation in birds. *Science* Vol 221: 184-186.

Fritz Hertel & Liza T Balance. Wing eco morphology of sea birds from Johnston Atoll. *The Condor* 101 : 549-556.

Fretwell, 1969. Ecotypic variation in the non breeding season in migratory populations, a study of tarsal length in some Fringillilidae. *Evolution* 23: 406-420.

Gaston A J., 1974. Adaptations in the genus phylloscopus *Ibis* 116: 432-450

Gatz A J., 1979. Ecological morphology of fresh water stream fishes, *Tulane studies in Zoology and Botany* 21: 91-124.

Gause G F.,1934. *The struggle for existence.* Baltimore

GIBB J., 1954. Feeding ecology of tits with notes on tree creepers and gold crest. Ibis 96: 513-543

Grant P R., 1964. A review of the avifauna of the Tres Marias Islands, Nayarit Mexico, *The Condor* 66: 221-228

Grant P R., 1965. The adaptive significance of some size trends in island birds. *Evolution* 19: 355-367.

Grant P R., 1966a. Ecological compatibility of birds species on island. *American Naturalist.* 100 : 451-462

Grant P R., 1966b. Further information on the relative length of the tarsus in land birds. *Postilla* 98: 1-13.

Grant P R., 1967. Bill length variability in the birds of the Tres Marias Islands, Mexico. *Canadian Journal of Zoology* 45: 805-815

Grant P R., 1971. Variation in tarsus length of birds in island and mainland regions. *Evolution* 25: 599-614

Grant P R., 1997. Ecomorphological analysis with weaverbirds and kingfishers. *Zoological Museum Berlin Annual Ornithology* 21: 17-43

Hamilton., 1958. Adaptive variation genus vireo. *Wilson Bulletin* 70: 307-349

Hans Winkler & Bernd Leisler, 1974. To be a migrant : Ecological burdens and chances.

Hespenheide, H A., 1973. Ecological influences from morphological data. *Annual review of ecology & systematics* 4: 213-229

Hinde R A., 1959. Behavior and speciation in birds and lower vertegrates. *Biology Reviews* 34: 85-120.

Hutchinson., 1959. A theoretical ecological model of size distributions among species of animals. *American Naturalist* 93: 117-126.

Huxley J S., 1942. *Evolution: the modern synthesis.* George Allen and Unwin Ltd London

Karr J R and F C James., 1975. Ecomorphological configuration and convergent evolution of species and communities. In: Cody ML & J M Diamond, *Ecology & evolution of communities*: 258-291

Kear J., 1962. Food selection in finches with special reference to inter specific differences *Proceedings of the Zoological Society of London* 138: 163-204

Lack D., 1947. *Darwin's finches.* University Press, Cambridge.

Lack D., 1949. Birds on Tenerife. *Ibis* 91: 138-144.

Lack D., 1949. *The significance of ecological isolation.* Prineeton University Press

Lederer, 1984. A view of avian eco morphological hypothesis. *Oekologie Vogel* 6: 119-126

Lederer R., 1975. Bill size, food size and jaw forces of insectivorous birds. *Auk* 92: 385-387

Lederer R., 1980. Prey capture by flycatchers and the importance of morphology to behavior, *Sociobiology* 5: 43-46.

Leis M Carrascal, Eulalia Moreno, Jose L Telleria, 1990. Eco morphological relationships in a group of insectivores birds of temperate forests in winter. *Holartic Ecology* 13: 105-111

Leister B., 1980. Morphological aspects of ecological specialization in bird genera. *Oekologe Vogel* 2: 199-220

Leisler and Winkler, 1985. Morphological aspects of habitat selection in birds. PP 415-433 in *Habitat selection in birds* (Cody, M.L.ed) Academic Press, Orlando

Leisler B and Winkler H., 2003. Morphological consequences of migration in Passerines. *Avian Migration* PP 175-186.

Leisler B Bans Law H.W and Hans Winkler, 1989. Habitat behavior and morphology of acrocephalus warblers – An integrated analysis. *Ornis scandinavica* 20, PP 181-186

Leisler B., 1990. Selection and use of habitat of wintering migrants, *Bird migration*. PP 156-174.

Lockwood R J, Swaddle & J M V Rayner, 1998. Avian wing tip shape reconsidered. Wing tip shape indices and morphological adaptations to migration. *Journal of Avian Biology* 29: 273-292.

Losos J B., 1990. Eco morphology, performance capability and scaling in West Indian Anolis, an evolutionary analysis. *Ecology Monograph* 60: 369-388.

Maybury W J and RAyner J MV., 2001. The avian tail reduces body parasite drag by controlling flow separation and vortex shedding. *Proceedings of the Royal Society London Series* B 268: 1405-1410

Mayr E., 1942. *Systematics and origin of species.* Columbia University Press, New York, P 344

Mayr, E., 1948. Evolution in the family dicruridae (birds) *Evolution.*

Mayr E., 1956. Geographical character gradients and climatic adaptations. PP 105-108.

Mayr E., 1963. *Animal species and Evolution.* Cambridge, Mass : Harvard University Press

Mayr E., 1982. *The growth of biological through,* Diversity, Evolution and inheritance, Cambridge, Harvard University Press.

Miles D B and Ricklefs R E and Travis J., 1987. Concordance of eco morphological relationships in three assemblages of passerine birds. *American Naturalist* 129: 347-364.

Miles D B and Ricklefs R E., 1984. The correlation between ecology and morphology in deciduous passerine birds. *Ecology* 65: 1629-1640

Miles D B and Ricklefs R E and Travis J., 1986. Concordance of eco morphological relationships in three assemblages of passerine birds. *American Naturalist* 129: 347-364.

Moreau, 1960. Climatic correlations of size in zosterops. *Ibis* 102: 137-138

Murphy R C and Chapin J., 1929. A collection of birds from Azores. *American Naturalist.* 384: 1-24.

Neimi G J., 1985. Patterns of morphological evolution in bird genera of new world and old world peatlands – *Ecology* 66: 1215-1228

Newton I., 1967. The adaptive radiation and feeding ecology of some British finches. *Ibis* 109: 33-98

Norberg U M., 1994. Wing design, flight performances and habitat use in bats. PP 205-230. In Ecological Morphology. *The University of Chicago Press, New York*

Norberg U M., 1979. Morphology of Wings, Legs and Tail of three coniferous forests tits, the golderest and the tree creeper in relation to locomotor pattern and feeding station selection. PP 85-10. In *Ecological Morphology* : The University of Chicago Press, New York

Osterhaus, 1962. Adaptive modifications in the leg structure of some North American Warblers. *American Naturalist.* 47: 474-486

Park T., 1948. Experimental studies on interspecies competition. Competition between flour beetles, Tribolium confusum and Tribolium castaneum. *Ecology Monograph.* 18: 265-308.

Pennycuick C J., 1975. Mechanics in flight In *Avian Biolgoy* (Farner & King) London Academy Press Vol 5: 1-75

Pennycuick C J., 1989. Bird flight performance; a practical calculation manual. Oxford University Press, London

Rand A L., 1936. Altitudina variation in New Guinea birds. *American Naturalist* 890: 1-14

Rensch, 1960. *Evolution above species level,* New York Columbia University Press, New York

Ricklefs Re and Cox GW., 1977. Morphological similarity and ecological overlapping among passerine birds on St. Kits, British West Indies – Oikos 29: 60-66

Ricklefs R E and Travis J., 1980. A morphological approach to the study of avian community organization. *Auk* 97: 321-338

Root R B., 1967. The niche exploitation pattern of the blue grey gnatcatchers *Ecology Monograph* 37: 377-390

Rothstein S L., 1973. The niche variation model – is it valid? *American Naturalist* 107:598-620

Rough garden J Norberg U M., 1979. Morphology of wings, legs and tail of three coniferous forests tis, the gold crest and tree-creeper in relation to locomotor pattern and feeding station selection. Published 1972 Evolution of niche width. *American Naturalist* 106: 683-718

Salim Ali and Ripley, 1989. *Handbook of birds of India and Pakistan* Vol 6 & Vol 7

Savile D B O., 1957. Adaptive evolution in the avian wing. *The Journal of Evolution Biology* 11: 212-224.

Schoener T W., 1965. The evolution of bill size differences among sympatric cogeneric species of birds. *The Journal of Evolution Biology* 19: 189-213

Schulenberg T S., 1983. Foraging behavior, ecomorphology and systematics of some antishrikes (Formicarridae: Thamnomanes). *Wilson Bulletin* 95: 505-521

Snow D W., 1954. The habitats of Eurasian tits. *Ibis* 96: 565-585

Spring L V., 1965. Climbing and pecking adaptation in some North American Wood Peckers. *The Condor* 67: 457-488

Steven, 1953. Recent evolution in the genus Clethrionomys. *Symposium on Experimental Biology* 7: 310-319

Thomas A LR., 1993a. On the aerodynamics of birds tails. Phils *Trans Roy Society London* B 340: 361-380

Thomas A L R., 1996. The flight of birds that have wings and a tail variable; Geometry expands the envelope of flight performance. *Journal of Theoretical Biology* 183: 237-245

Thomas A L R., 1996. Why do birds have tails? The tail as a drag reducing flap and trim control. *Journal of theoretical biology* 183: 247-253

Traylor M A., 1950. Altitudinal variation in Bolivian birds. *The Condor* 52: 123-126.

Van Vallen L., 1965. Morphological variation and the width of ecological niche. *American Naturalist* 100: 377-389

Van Vallen L., 1973. Are categories in different phyla comparable? *Taxon* 22 : 333-373

Vaurie, 1951. Adaptive differences between two sympatric species of ruhatches. *Proceedings of 10th International Ornithology Congress* 163-166

Voelker G., 2001. Morphological correlates of migratory distance and flight display in the avian genus Anthus. *Biological Journal of the Linnean Society* 73: 425-435

Wain Wright P C., 1988. Morphology and ecology fixed basis of feeding constraints in Carribean Labrid fishes. *Ecology* 64: 635-645.

Wain Wright P C., 1991. Eco morphology : Experimental functional anatomy for ecological problems. *American Zoology* 31: 680-693

Wain Wright P C., 1994. *Ecological morphology*, University of Chicago Press, New York

Wain Wright P C., 1995. Predicting pattern of prey use from morphology of fishes, *Environmental biology of fishes* 44: 97-113

Wallace A R., 1981. *Island life*. Macmillan, London

Warham J., 1996. *The petrels, their ecology and breeding systems*. Academic Press, London

Watson G E., 1962. Three siblings species of Alectoris patridge. *Ibis* 104: 353-367

Weins J A., 1983. *Avian Community Ecology: An iconoclastic view. In Brush, AH and clark GA Perspectives in Ornithology.*, Cambridge University Press, Cambridge PP 355-403

Williamson K., 1962. Identification for ringers; the genus phylloscopus. *British Trust for Ornithology* 105: 321-27

Williamson K., 1964. Identification for ringers, the genus Sylvia. British Trust fro Ornithology 210: 131-136

Willson MF, Karr J R, Roland R Roth 1975. Ecological aspects of avian bill size variation, *Wilson bulletin* Vol 7, No. 1 march 1975 PP 32-41

Wilson M F., 1969. Avian niche size and morphological variation. *American Naturalist* 103: 531-542

Winkler and Bock 1976. Eco morphology of birds.. *Proceedings of IXI International Ornithological Congress.* PP 2246-2295

Winkler H and Lesiler B. 1985. Morphological aspects of habitat selection in birds PP 415-433 in *Habitat selection in birds* (Cody, M.L.ed) Academic Press, Orlando

Winkler H. 1988. An examination of concepts and methods in ecomorphology, *Acta XIX Congress International Ornithology* Ottawa 2246-2253

Winkler, 1989. An examination of concepts and methods in ecomorphology, in *Acta XIX Congress International Ornithology*

Winkler H & B Leisler, 1992. On the ecomorphology of migrants. Ibis 134: 21-28

Winkler H and Leister B, 2003. Morphological consequences of migration in passerines in *Avian Migration* Springer – Verlag, Berlin