CHAPTER 5

COMMUNITY STRUCTURE OF LIZARDS IN CERTAIN SELECTED HABITATS OF GUJARAT: A QUANTITATIVE ANALYSIS

"From tiny to gigantic, from drab to remarkably beautiful, from harmless to venomous, the lizards are spectacular products of natural selection."

Eric R. Pianka and Laurie J. Vitt (2003)

INTRODUCTION

Lizards have proven almost ideal organisms for ecological studies, largely because of their basic traits and remarkable diversity (Pianka and Vitt, 2003). Moreover, lizards do not fly away like the birds and are amenable to field manipulations thus, facilitating important ecological experiments. Further, being ectotherms and often abundant, lizards are relatively easy to locate, observe and capture, thus simplifying the ecological studies. Lizards are a conspicuous component of most natural communities, especially those in warmer parts of the world and hence, have always gained a wide interest from ecologists (Elton, 1946; Rand, 1964; Pianka, 1967; Sage, 1973; Maragou *et al.*, 1997; Smith and Engeman, 2003).

An ecological community consisting of all the organisms that live together at any given habitat can be visualized as a complex network of interacting species (Pianka, 1973). Several properties at the community level emerge from these interactions, which include trophic structure, energy flow, species diversity, relative abundance and community stability (Pianka, 1973). Historical factors such as degree of isolation (MacArthur *et al.,* 1966; MacArthur, 1972) and available biotic stocks (particularly the species pools of potential competitors and predators) have profoundly shaped lizard communities (Pianka, 1973). Climate too is a major determinant of lizard community and possibly influences the species density (Schall, 1977; Van Damme *et al.,* 1987). The effects of various other historical factors such as the Pleistocene glaciations on lizard communities, though very difficult to assess, could be considerable (Levins, 1968).

In practice, ecologists are usually unable to study entire communities, but instead interest is often focused on some convenient and tractable subset (usually taxonomic) of a particular community or series of communities. But an important point to keep in mind is that, unlike individual organisms, communities are not designed directly by natural selection (Losos, 1992; Cadle and Greene, 1993). Individuals exhibit differential reproductive success, but communities do not. One of the strongest tools available to community ecologists is the comparison of ecological systems which are historically independent but otherwise similar (Williams, 1964). Observations on pairs of such systems allow one to determine the degree of similarity in evolutionary outcome. Moreover, under certain circumstances such natural experiments may even allow some measure of control over such historical variables (Losos, 1994; 1996; Colli *et al.,* 1998). Lizard communities for instance, could be compartmentalized into guilds for convenience. Guild concept is applicable to a group of functionally similar species that exploit the environment (use specific niche axes) in similar ways (Pianka, 1966; 1969b; 1971a; 1972). The number of species coexisting within communities exhibits a separation in their guilds for example, diurnal terrestrial insectivorous lizards constitute a guild distinct from diurnal arboreal insectivorous lizards and both of these are different from guilds represented by nocturnal or fossorial or herbivorous lizards (Pianka and Vitt, 2003). However, the structure of lizard communities defined as simplest (and perhaps least interesting) would have assemblages with more accurate description (Pianka, 1973).

'Community Structure' is an important term used by community ecologists (Pianka and Vitt, 2003). If all species in a habitat used all resources randomly, then there would be no structure, which is not the case in any given natural condition. Lizard communities could be as simple as consisting of single species, for instance, North American populations of *Eumeces fasciatus,* or at the other extreme, could be the most complex of the communities like those of the Australian Sandbridge deserts, where as many as 40 different species occur in sympatry (Pianka, 1969b). Thus, examination of simple lizard communities often allows an investigator to determine underlying causes of structure with minimum number of extraneous variables, whereas examination of more complex system provides a means to assess the importance of often more obscure variables. Finding ways of simplifying communities for more thorough understanding remains a considerable challenge in the emerging field of community ecology. Therefore, defining and examining niche axes of component species (in this case lizards) is a good start because it allows to make direct comparison among species on various dimensions.

Animals partition environmental resources in three basic ways: temporally, spatially and trophically; i.e. species differ in times of activity; the places they exploit and/or the food they eat. Such differences in the activities, separate niches, reduce competition and hence, allow coexistence of a variety of species (Hutchinson, 1957). Among lizards these three fundamental niche dimensions are often fairly distinct and more or less independent of each other (Pianka, 1973). Thus, in this chapter results for two niche dimensions namely, spatial niche and trophic niche under two major sections 'patterns within communities' and 'comparisons between communities' are presented.

INTENSIVE STUDY AREAS

Four Intensive Study Areas (ISAs) varying in their physiography were selected for the study and these then were surveyed for a period of two years i.e. 2007-2008. The study sites included the areas of wilderness, rural as well as urban areas.

Intensive Study Area (ISA-1): Pavagadh Hill Forest

(GPS coordinates: 22° 26' N - 22° 30' N and 73° 29' E - 73° 33' E)

Pavagadh Hill Forest stands on the mount Pavagadh located on the southern fringe of district Panchmahal (Figure 2.3). The hill stands at a height of 864 m (one of the high hills of central Gujarat), is about 11 km in length from north to south and 6.4 km wide. The landuse pattern of the study area was analyzed through the satellite imagery obtained from IRS 1C, LISS III image (1:50000) (Figure 2.4). The forest was classified into three categories; dense forest (Figure 5.1a), moderate forest and degraded forest (Figure 5.1b). The foothills have many small villages and settlements and remaining area is under cultivation. This hill forest is fast degrading due to increasing pressure from anthropogenic activities *viz.* logging of forest for timber, collection of forest products, encroachment for agriculture and most importantly developmental activities in lieu of tremendous pilgrimage and tourism pressure. For details refer chapter 2.

Intensive Study Area (ISA-2): Sindhrot Village Scrubland/Vadodara Rural

(GPS coordinates: 22° 18' N - 22° 08' N and 73° 06' - 73° 21' E)

Sindhrot village scrubland is located to the West of Vadodara city at an approximate distance of 16 km near the village Sindhrot (Figure 2.5). This scrubland spreads over a vast area of around 7 sq km and is actually a part of ravines of two rivers namely river Mahi, a major river of central Gujarat and river Mini a small, but perennial river of central Gujarat. The landuse pattern of this study area was largely analyzed through the detailed ground truth. It was evident from the survey that the scrubland was having few small villages and scattered settlements. This was the rural habitat for the purpose of study. Figures 5.2a and 5.2b depict the ISA-2 during monsoon and summer respectively. For details refer chapter 2.

Intensive Study Area (ISA-3): Vadodara City/Vadodara Urban

(GPS coordinates: 22° 30' N and 73° 19' E)

Vadodara city having an area of 149 sq km is a part of Vadodara district covering a total area of 7,794 sq km (Figure 2.5). It is the 18th largest city of India with a population of 1.6 million (Census, 2005) and literacy rate of 78% (Census, 2005). Although major part of the city is an urban builtup area, interspersed between the concrete jungles are few remaining patches of wilderness that abode a characteristic biodiversity. These sites include some of the picturesque spots of ethnic beauty like the Laxmi Vilas Palace of Vadodara (Figure 5.3a) and the prime educational hub of Vadodara, campus of The Maharaja Sayajirao University of Baroda (Figure 5.3b). These mentioned sites and few others were selected as part of the urban habitat for the current study. For details refer chapter 2.

Intensive Study Area (ISA-4): A Scrubland near Naliya, Kutch

(GPS coordinates: 23° 17' N - 23° 21' N 68° 56' E - 68° 60' E)

This study area is covered under the arid zone (Biogeographic Zone No. 3) with its Kutch Province (No. 3A). Kutch has entirely different landscape from the rest of the state. The entire region is predominated by scrubland, interspersed with grassland in many areas and scattered saltflats and wetlands. Naliya is a small town located in Abdasa taluka in the westernmost part of the Kutch district. A small patch of scrubland near Naliya town was selected as an ISA for the current study. Figure 5.4a and 5.4b show the landscape of ISA-4 during monsoon and summer respectively. For details refer chapter 2.

MATERIAL AND METHODS

In the present study, various methods and techniques were employed for recording the reptilian diversity and sampling their population through time and space. Visual Encounter Survey (VES) was primarily used to prepare a checklist for all the intensive study areas (ISAs). Transects were used for a systematic sampling of the communities at various study sites. These surveys were done during times of maximum saurian activity. Visual encounter survey (VES), a standard technique proposed by Crump (1971) was largely used to record the diversity of lizards in the selected ISAs. Active combing operations were done in all the seasons and during both day as well as night to document both diurnal as well as nocturnal lizards. Moreover, the combing operations also helped analyze the micro-habitat requirements of different species. Hand-capturing method (Blomberg and Shine, 1996) was used for those species that could not be identified in the field. They were brought to the laboratory and carefully studied for their taxonomic characters. Identification of the species was done using standard monographs (Gunther, 1864; Boulenger, 1890; Smith, 1935; Daniel, 2002 and Das, 2008). Transect sampling such as line transects, belt transects and quadrat sampling (Southwood and Henderson, 2000) was used to sample the lizard communities in the selected ISAs. Suitable technique was selected and used based upon the topography and terrain of the site. Details of various sampling techniques are attended elsewhere (chapter 3). Statistical analysis of various properties of the community such as diversity, dominance, evenness, ecological distribution, niche breadth and niche overlap of lizard assemblages at all the study sites was worked out using the formulae from Krebs (1999). The results obtained were computed and analyzed using standard statistical softwares BD Pro Version 2.0 and EcoSim. Following were the indices evaluated for the current work:

1. Jackknife Index of species richness
2. Simpson's index of diversity
3. Shannon-Wiener Diversity Index
4. Margalef's Equation for Evenness
5. Berger-Parker Dominance Index
6. Levins's Measure of Niche Breadth
7. Levins's Measure of Standardized Niche Breadth
8. Horn's Index of Niche Overlap
9. Jaccard's Index of Similarity Coefficient
10. Coefficient of Community

RESULTS

The extensive field studies conducted for the period of two years in all the selected ISAs generated a quantum of data which was further analyzed for the various ecological parameters. Before proceeding with the ecological parameters it was essential to examine whether the sampling done for all the ISAs was sufficient enough to give desirable results. Therefore, a rarefaction analysis was performed to check the quantum of sampling and as depicted in figure 5.5 species accumulation curve have reached their asymptote for all the selected ISAs thereby indicating sufficient sampling. After ascertaining the sampling size through rarefaction analysis, further analysis of other ecological parameters was carried out.

As mentioned earlier the knowledge of taxonomic assemblages in the community is required to move ahead with the ecological studies. Thus, it was felt mandatory to have a comprehensive survey through all the selected ISAs for the presence of diverse taxonomic groups of lizard that they harbour. A total of 21 saurian species belonging to 8 families were recorded from all the four ISAs. Table 5.1 presents the percentage species richness as observed for all the ISAs. Considering such a rich diversity of lizards across the study sites, there was an urge to examine the diversity within the recorded 8 families and also to find whether all the families occurred at each study site. Figure 5.6 revealed the species richness within the families. It was found that two families of lizards namely Lacertidae and Uromastycidae were confined exclusive to ISA-4. It was also clearly evident that ISA-4 was the most diverse of all the communities (i.e. selected ISAs) with a maximum of 17 species occurring therein and therefore the species richness being highest for ISA-4 (Table 5.1, Figure 5.6).

Based upon the percentage species richness and the periodic sampling in all the study sites, percentage occurrence of each of the lizard species was worked out (Table 5.2). Using these values the frequency of occurrence of each lizard species in the selected ISAs was determined (Table 5.3). Majority of the species encountered were only in ISA-4 and were rare as against the common species that were either abundant or fairly common in all the ISAs. Species such as *Chamaeleo zeylanicus* though occurred in all the ISAs was still a rare species to find. Having known the frequency of occurrence for each of the study sites, the next stage was to elucidate the habitat preference of each of the individual species. To address this problem the habitat was broadly classified into five major heads and the lizards occurring therein were recorded. Table 5.4 shows the habitat utilization of different lizards in the selected ISAs. Every habitat provided a set of microhabitats and these were of prime importance to lesser faunal species as their basic needs were met within these microhabitats. For the ectothermal vertebrates i.e. amphibians and reptiles these microhabitats are not only their shelter but also provide them with an ideal microclimate. Thus, it was essential to highlight the possible microhabitats and the associated lizards within each microhabitat in all the ISAs. Table 5.5 depicts a comprehension of the lizard species recorded in all the ISAs and their exploration of the various microhabitats available in the given ISA. On completion of the qualitative analysis for each of the ISA further investigations with the quantification parameters were carried out.

Species Uniqueness

Analysis using Jackknife's index revealed highest uniqueness values for ISA-4 and lowest for ISA-3 (Table 5.6), indicating maximum unique species in ISA-4. Being an arid zone in the district of Kutch, it is but natural to have rich saurian diversity at ISA-4 like any other hot desert in the world. ISA-3 is an urban area under complete anthropogenic influence and therefore, no unique species occurred herein. As depicted in the figure 5.6, two lizard families namely Lacertidae and Uromastycidae are entirely exclusive to the Kutch region and the members of these families 3species of lacertids and one species of spiny-tailed lizard occurred only in this region. Though families Gekkonidae and Varanidae occurred throughout the state of Gujarat, certain species of these families namely *Cyrtopodion kachhensis* (Family – Gekkonidae) and *Varanus griseus* (Family – Varanidae) were found to be regional endemics (see chapter 4) and thus adding onto the list of unique species for the ISA-4. Values for uniqueness index for ISA-1 and ISA-2 were only marginally higher than ISA-3 suggesting the presence of only few unique species in these study sites (Table 5.6).

Species Diversity and Evenness

Simpson's as well as Shannon Wiener's diversity indices values were highest for ISA-4 and lowest for ISA-3 (Table 5.6; Figure 5.7) indicating that the scrubland of Kutch (ISA-4) was a rich habitat in terms of its saurian diversity whereas ISA-3 being an urban set up was poor in terms of its diversity. ISA-1 and ISA-2 were having fair enough diversity with no great difference (Table 5.6; Figure 5.7); of course ISA-1 being a reserve forest was more diverse as compared to ISA-2 which was only a non-protected scrubland with routine rural human activities. Having evaluated the diversity through Simpson's and Shannon Wiener's indices one also looked into the alpha diversity and the results showed that the diversity was much higher in case of ISA-4 (Table 5.6; Figure 5.8), indicating a pristine habitat and the diversity was lowest for the urban environment (ISA-3), while ISA-1 and ISA-2 were fairly comparable in their respective diversities (Table 5.6, Figure 5.8).

Evenness

Equitability 'J' is the measure for evenness of the habitats. The equitability values showed a complete evenness between ISA-2 (rural scrubland) and ISA-4 (scrubland in Kutch), while

ISA-1 had the highest index value and lowest value was for ISA-3 (Table 5.6). The possible explanation for this could be that both ISA-2 and ISA-4 were scrubland habitats; although these areas differed in their climatic condition and the floral diversity, more or less the physiography was similar, with few plant species being common and no big trees in the area, therefore the distribution of the species was horizontal. In contrast to this, ISA-1 was a forest area with a good density of large trees, thus providing a scope for both horizontal as well as vertical distribution of the species and hence had a higher index value.

Dominance

The dominance index values as depicted in Table 5.6, Figure 5.9 revealed that though ISA-3 was the least diverse of all the habitats, it showed higher dominance index. This could be explained in a way that since ISA-3 offered narrow range of microhabitats, the species that could maximally exploit these microhabitats occurred in large numbers. Moreover, ISA-3 being an urban environment under complete human influence harboured few human commensals which were well adapted to the urban habitat. Two human commensals namely *Hemidactylus flaviviridis* and *Calotes versicolor* were present in large numbers in ISA-3 and thus dominated the entire community.

Similarity and Coefficient of Community

The relative similarity between the communities (study sites) is measured through the Jaccard's similarity coefficient 'SC_j' and the Coefficient of community 'C'. Table 5.7 and 5.8 present the results of similarity coefficient and coefficient of community respectively. It is evident from the results that ISA-1 and ISA-4 were the least similar habitats (SC_j – 0.3333 and C – 33.20) with only 7 species common in them. The maximum similarity was observed between the other three sites i.e. between ISA-1 and ISA-2 SC_j– 0.909; between ISA-2 and ISA-3 SC_j– 0.9 and between ISA-1 and ISA-3 SC_j– 0.8181. It was observed that most number of species (10) was common to both ISA-1 and ISA-2 and similarly between ISA-2 and ISA-3 maximum number of species (9) was common. Taking a closer look at the results one can also say that ISA-2 and ISA-3 appeared to be the subsets of ISA-1. The coefficient of community was also observed to be minimum between ISA-1 and ISA-4 (33.20%) and maximum between ISA-2 and ISA-3 (76.86%).

Further, multivariate analysis done through the Principal Component Analysis (Figure 5.10) and the Bray-Curtis Cluster Analysis (Figure 5.11) revealed that ISA-1 and ISA-4 were entirely different in their physiography and climate, thus were separated widely. ISA-2 and ISA-3 had much similarity in their climate, though not in the physiography and moreover these areas (ISA-2 and ISA-3) also had a varying degree of anthropogenic pressure influencing the habitat, hence these are closely placed on the chart (Figure 5.10 and 5.11).

Niche Breadth

Measuring the niche of a species in a particular habitat is an essential parameter to draw any inference towards the community structure. We considered the trophic niche of each of the lizard species in its respective habitat and further analyzed the niche breadth to understand the structure of the community. Table 5.9 shows the niche breadths of all the lizards species documented in all the ISAs. A significantly high niche breadth was observed in case of *Cyrtopodion kachhensis* (Table 5.9), indicating that the species exploited or rather utilized maximum possible resources (in this case prey species) that occurred in its habitat. Niche breadth was narrow for *Uromastyx hardwickii* and for both species of *Varanus* (*V. bengalensis* and *V. griseus*) (Table 5.9). For *Uromastyx hardwickii* minimum niche breadth was quite logical since it was the only herbivorous lizard recorded in the entire study. *U. hardwickii* feeds upon a variety of xerophytes occurring in its habitat (Dutta and Jhala, 2007), thus suggesting a predominantly vegetarian diet of the species but however it is not that *U. hardwickii* is entirely herbivorous in its diet. During the dry season when the availability of the food plants is scarce, *U. hardwickii* is known to shift over to insectivorous diet (Bhanotar *et al.,* 1978). The explanation for a minimum niche breadth in case of varanids (Table 5.9) is that, varanids are the giants of the lizard world and therefore their prey size is also relatively larger as compared to other small lizards. Varanids by and large have vertebrates on their menu that include amphibians, reptiles (chiefly small lizards and snakes), small birds and rodents. In addition to this varanids are even known to devour eggs of large reptiles and birds. This type of diet is no match for a small sized lizard that is chiefly insectivorous and thus varanids offer a bare minimum competition over the resources to their co-occurring species in the habitat. Rest of the lizard species that occurred in all the ISAs were primarily insectivorous and had a fairly comparable niche breadth (Table 5.9).

Niche Overlap

To ascertain the community structure in holistic way, analysis of niche overlap was necessary. Niche overlap was calculated for each study sites (ISAs) using standard index. Table 5.10 depicts the niche overlap at ISA-1, wherein a significant overlap was observed between *Calotes versicolor* and *Sitana ponticeriana* and between *Calotes versicolor* and two of the skinks namely *Mabuya carinata* and *Mabuya macularia*. It could be inferred that *C. versicolor* occurred as a sympatric species with *S. ponticeriana* and both species of skinks, thus resulting in a competition over the resources. However, any concrete conclusion can be drawn only after a thorough analysis of spatial and temporal niches. Least overlap was observed for *Chamaeleo zeylanicus* with majority of other lizards (Table 5.10). The possible reason could be that *C. zeylanicus* is chiefly an arboreal species having a narrow niche breadth (Table 5.9), and therefore the overlap found was minimum. *Varanus bengalensis* had a significantly low niche overlap and as explained earlier, *V. bengalensis* being a large lizard has an entirely different prey composition and thus hardly any competition over the resources was observed.

The niche overlap scenario is fairly comparable for study sites, especially ISA-2 (Table 5.11) and ISA-3 (Table 5.12) wherein a near identical picture could be seen. For ISA-2 and ISA-3 *Hemidactylus flaviviridis* occurred in sympatry with *Hemidactylus leschenaultia* while *Mabuya carinata* is found to be sympatric with *Mabuya macularia* in ISA-2. Taking into account the niche overlap results for ISA-4 (Table 5.13), it was evident that a significant overlap occurred among agamids, geckos, lacertids and the two species of varanids (Table 5.13). *C. zeylanicus* like in other ISAs, offered minimum overlap, also a least overlap was observed in case of geckos versus the other groups (Table 5.13). *U. hardwickii* and *Varanus sp.* also showed significantly low niche overlap.

DISCUSSION

The number of species coexisting within communities can differ in four distinct ways. They are: **a**. more diverse communities can contain a greater diverse variety of available resources, and /or **b.** their component species may, on the average, use a smaller range of these available resources (the former corresponds to roughly "more niches" or "more niche dimensions" and the latter to "smaller niches"). **c.** Two communities with identical range of resources and average utilization patterns per species can also differ in species density with changes in the average degree of overlap in the use of available resources; **d.** finally, some communities may not contain the full range of species they could conceivably support and species density might then vary with the extent to which available resources are actually exploited by as many different species as possible (Pianka, 1973). In the current study also we observed that of the four selected ISAs, ISA-4 was the most diverse community and offered a vast diversity of resources, followed by ISA-1. Both these areas (ISA-1 and ISA-4) were found to have a broad range of resources both in terms of space and food that a species could exploit and therefore partitioning of the resources was quite obvious. ISA-2 and ISA-3 were having a fairly identical range of resources and the utilization patterns of the species therein were also similar, thus indicating an average degree of overlap. ISA-3 being an urban environment offered limited scope of resource exploration to a given species and therefore, only adaptive species or the species that are established as human commensals thrived well in this habitat. As mentioned earlier that one discusses this chapter under two heads, namely the spatial niche and the trophic niche for better comprehension.

Spatial Niche

The use of space varies widely among lizard species. A few are entirely subterranean (fossorial), many others are completely terrestrial, while still others are almost exclusively arboreal (Pianka, 1973). Varying degrees of semi-fossorial and semi-arboreal activities are also known (Pianka, 1973). Microhabitat differences among species are often pronounced even within these groups. In the current study the habitats were classified into five broad categories (Table 5.4) and each of the categories possessed a set of microhabitats that were utilized by different lizard species (Table 5.5). Similar results indicating subtle differences in the use of shrub canopy occur among some of the arboreal lizards like *Anolis* (Rand, 1964; Rand and Humphrey, 1968; Schoener, 1968; Schoener and Gorman, 1968; Schoener, 1970). Some lizard species in the present study were strongly restricted to a rock-dwelling (*Cyrtopodion kachhensis*), bark-dwelling (*Hemidactylus leschenaultii*) or mid-shrub canopy (*Chamaeleo zeylanicus*) existence. In addition to such microhabitat specificity, various species have specialized in their habitat requirements. Pianka (1969a; 1972) has observed Australian desert lizards restricted to sandridge, sandplain, and shrubby habitats, thus he defines that the place niche is more inclusive than Rand's (1964) structural niche, as it includes both habitat and microhabitat preferences. Moreover, foraging space is also a part of the habitat and needs to be taken into consideration. For instance, some terrestrial lizards forage primarily in the open areas between plants, whereas others forage mainly under or within plants (Pianka, 1969a). Therefore, where exactly in the environmental mosaic does lizard forage, as well as its mode of foraging in the space, is perhaps an important ecological attribute (Pianka, 1973).

Lizards that exploit space in different way have evolved a variety of morphological adaptations for the use of space (Pianka, 1969a; Pianka and Parker, 1972; Sage, 1973); such morphological traits are often accurate indicators of their place niche (Pianka, 1973). Thus fossorial species typically have either reduced appendages (skinks, as in the present study) or none at all, while diurnal arboreal lizards (agamids and chamaeleons) usually possess long tails and slender bodies. Terrestrial species that forage in the open between shrubs and/or grass clumps generally have long hind legs relative to their size (lacertids, in the current study), while those that forage closer to cover or within dense clumps of grass usually have proportionately shorter hind legs e.g. *Uromastyx hardwickii*. Lamellar structure often reveals arboreal or terrestrial activity as well as texture of the substrate exploited (Collette, 1961), like geckos in the present study were found to use both terrestrial and arboreal habitats. Thus, it is logical that a lizard's body shape is so designed to suit its habitat and enable the species to explore the microhabitats therein. Competition for the space exists in nature however, the competition could be minimized through a change in the temporal activity.

Trophic Niche

Ecologists have built a strong case for the importance of food as the primary resource for many species (Hairston *et al.,* 1960; Lack, 1954), and one worker has even suggested that "niche" be operationally defined as "the nutritional role of the animal in its ecosystem that is, it's relations to all the foods available to it" (Weatherly, 1963). Substrate preferences (microhabitat segregation) are often important determinants of the foods eaten by a species (Pianka, 1966). Even differences in the foraging modes are also closely related with both the substrates and food exploited (MacArthur, 1958). Lizards exhibit plasticity in their foraging behaviour (Huey and Pianka, 1981) and are specialized in exploiting the food species as well as substrates in their respective habitats (Pianka, 1966).

Most lizards are insectivorous and fairly opportunistic feeders, consuming without any obvious preference whatever arthropod they encounter with a broad range of types and sizes. Smaller species or individuals, however, do tend to eat smaller prey than larger species or individuals (Hotton, 1955; Schoener, 1967; Schoener and Gorman, 1968). Also differences in foraging techniques and place and time niches often result in exposure to a different spectrum of prey species. Ecological studies on lizards in other parts of the world reveal that few species have evolved severe dietary restrictions; these include the ant specialists *Phrynosoma* and *Moloch* (Pianka, 1966; Pianka and Pianka, 1970; Pianka and Parker, 1975), termite specialists such as *Rhynchoedura* and *Typhsosaurus* (Huey *et. al.,* 1974). On the other hand herbivorous lizards which include *Ctenosaurus, Diplososaurus, Sauromalus,* and *Uromastyx,* and secondary carnivores such as *Crotaphytus, Heloderma, Lialis,* and *Varanus* which prey primarily upon the eggs and young of vertebrates and the adults of smaller species (Pianka, 1966; 1968; 1969c; 1970) are much of generalist feeders, consuming a broad range of food types. In the current work none of the species was found to be a specialist feeder, however, because of their availability or abundance some of the prey species were preferred. For instance, *Sitana ponticeriana* showed a greater preference towards ants, as ants occurred in larger proportion in the diet of the species throughout the year (see chapter 6) and had a significant niche overlap with its conspecific *Calotes versicolor.* A significant niche overlap was observed amongst skinks (*Mabuya carinata* and *Mabuya macularia*), geckos (*Hemidactylus flaviviridis* and *Hemidactylus leschenaultii*), between the lacertids (*Ophisops jerdonii* and *Ophisops microlepis*) and also between the varanids (*Varanus bengalensis* and *Varanus griseus*), indicating these species to be sympatric and hence, resource partitioning between these species and the groups needed further evaluation. *Uromastyx hardwickii,* the only herbivorous lizard recorded in the study had a marginal niche overlap with other lizards occurring in the area that too mainly during the dry season when *U. hardwickii* shifted to insectivory from herbivory. Therefore, thorough studies on the niche dimensions of *U. hardwickii* are highly warranted.

Another aspect of lizard's food niche is concerned with the way in which they hunt their prey. This is more of a behavioural aspect, wherein two extreme types of foragers have been recognized amongst the lizards, a widely active forager and a passive or ambush predator using the sit-and-wait strategy (Pianka, 1966; Schoener, 1969; 1971). But the effectiveness of either of the strategy depends on essential criteria which also need an evaluation. Similarly the widely foraging tactic depends on the density and mobility of prey and the predator's energy needs (Schoener, 1969; 1971), in the same way success of the sit-and-wait method also requires a fairly high density, high prey mobility, and/or a low energy demand by the predator (Schoener, 1969; 1971). Studies on the foraging modes of lizards show that most teids and skinks and many varanids and lacertids are active foragers, typically on the move continually; in contrast, almost all iguanids, agamids, and geckos are relatively sedentary sit-and-wait foragers (Huey and Pianka, 1981). Almost similar observations were recorded in the current work wherein, skinks, varanids and lacertids were found to be active foragers. In addition to this *U. hardwickii* was also recorded as active forager, although the foraging occurred over short distances. Further, in case of other lizards occurring in the study sites, the true geckos (gekkonids) undoubtedly followed the sit-and-wait strategy but leopard geckos (eublepharids) exhibited a fair plasticity between these two modes. For agamids it could not be generalized whether they followed the passive predation method as stated by Huey and Pianka (1981), since agamids recorded in the present study exhibited much variation in their foraging strategies, it could be attributed to the varying prey density and the seasonal conditions. This dichotomy might appear artificial and these two tactics actually represented pure forms of a variety of possible foraging strategies. However, the dichotomy has substantial practical value because the actual foraging techniques used by lizards were often strongly polarized. These differences in the mode of foraging presumably were influenced by the types of prey encountered, thus affecting the composition of a lizard's diet.

Interaction between Spatial and Trophic Niches

Spatial niches and food niches of lizards change in time, both during the day and with the seasons (Pianka, 1973). Temperature also is a major determinant of lizard's place and food niches. Studies show that in the early morning, when ambient and substrate temperatures are low, lizards typically locate themselves in the warmer microhabitats of the environmental mosaic, later in the day as the temperatures rise, the same lizards usually spent most of their time in the cooler patches in the environmental mosaic (Heatwole, 1970; Schoener, 1970; Pianka, 1971a). Similar behavioural modulations in the time of activity of lizards were observed in the present study, however, a quantification of the time niche for each of the species or a group could not be achieved due to some constraints. Quantification of temporal niche is hence kept on the hold as a future scope of study. As the time of activity strongly affects a lizard's place niche, similarly the composition of the diet affects the food niche (Pianka, 1973). Fluctuations in the types of prey and their relative abundance with the seasons influence the diet composition of lizards. It was thus observed that the nocturnal lizards like geckos encountered a different spectrum of potential prey items than the diurnal agamids and those that forage over long distances like varanids usually encounter variety of prey species as compared to the short distance foragers like lacertids and skinks. The mode of foraging or the way in which a lizard uses space can influence both its place and food niches (Pianka, 1973). Thus widely foraging species typically have broader spatial niches than sit-and-wait species. However, the latter type of foragers often tends to have broader food niches than the former. This is quite understandable that the lizards with high overlap along one niche dimension, for instance microhabitat, may have low overlap along another niche dimension such as food eaten. This effectively reduces the interspecific competition between them.

Table 5.1 Percentage Species Richness of Lizards in different ISAs

Species	ISA-1	ISA-2	ISA-3	ISA-4
Brachysaura minor	-	-	-	+
Calotes versicolor	+	+	+	+
Sitana ponticeriana	+	+	+	+
Chamaeleo zeylanicus	+	+	+	+
Eublepharis fuscus	-	-	-	+
Cyrtopodion kachhensis	-	-	-	+
Hemidactylus brookii	+	+	+	+
Hemidactylus flaviviridis	+	+	+	+
Hemidactylus leschenaultii	+	+	+	-
Hemidactylus persicus	-	-	-	+
Hemidactylus triedrus	-	-	-	+
Acanthodactylus cantoris	-	-	-	+
Ophisops jerdoni	-	-	-	+
Ophisops microlepis	-	-	-	+
Lygosoma albopunctata	+	-	-	-
Lygosoma punctata	+	+	-	-
Mabuya carinata	+	+	+	+
Mabuya macularia	+	+	+	-
Uromastix hardwickii	-	-	-	+
Varanus bengalensis	+	+	+	+
Varanus griseus	-	-	-	+
Total number of Species	**11**	**10**	**9**	**17**
(%) Species Richness	**52.3**	**47.6**	**42.8**	**80.9**

Table 5.2 Percentage occurrence of Lizards during the study period

Species	ISA-1	ISA-2	ISA-3	ISA-4
Brachysaura minor	----	----	----	1.83
Calotes versicolor	13.40	19.60	20.53	7.33
Sitana ponticeriana	12.41	28.67	14.28	29.35
Chamaeleo zeylanicus	1.30	1.40	1.00	0.91
Eublepharis fuscus	----	----	----	1.37
Cyrtopodion kachhensis	----	----	----	4.12
Hemidactylus brookii	9.15	7.70	6.25	3.66
Hemidactylus flaviviridis	19.93	22.37	37.50	5.04
Hemidactylus leschenaultii	27.45	5.60	3.57	----
Hemidactylus persicus	----	----	----	6.42
Hemidactylus triedrus	----	----	----	1.83
Acanthodactylus cantoris	----	----	----	1.37
Ophisops jerdoni	----	----	----	13.38
Ophisops microlepis	----	----	----	4.12
Lygosoma albopunctata	1.00	----	----	----
Lygosoma punctata	2.28	3.50	----	----
Mabuya carinata	6.68	6.30	9.82	3.21
Mabuya macularia	4.24	2.80	5.35	----
Uromastix hardwickii	----	----	----	12.84
Varanus bengalensis	1.96	1.00	1.78	2.30
Varanus griseus	----	----	----	0.91

Table 5.3 Frequency of Occurrence of Lizards in different ISAs

Species	ISA-1	ISA-2	ISA-3	ISA-4
Brachysaura minor	NF	NF	NF	R
Calotes versicolor	A	A	A	A
Sitana ponticeriana	A	A	UC	A
Chamaeleo zeylanicus	R	R	R	R
Eublepharis fuscus	NF	NF	NF	R
Cyrtopodion kachhensis	NF	NF	NF	C
Hemidactylus brookii	C	C	UC	C
Hemidactylus flaviviridis	A	A	A	C
Hemidactylus leschenaultii	A	C	UC	NF
Hemidactylus persicus	NF	NF	NF	C
Hemidactylus triedrus	NF	NF	NF	UC
Acanthodactylus cantoris	NF	NF	NF	R
Ophisops jerdoni	NF	NF	NF	A
Ophisops microlepis	NF	NF	NF	A
Lygosoma albopunctata	UC	NF	NF	NF
Lygosoma punctata	C	C	NF	NF
Mabuya carinata	A	A	C	C
Mabuya macularia	C	A	C	NF
Uromastix hardwickii	NF	NF	NF	A
Varanus bengalensis	C	C	C	C
Varanus griseus	NF	NF	NF	R

A – Abundant, C – Common, UC – Uncommon, R – Rare and NF – Not Found

Table 5.4 Habitat Utilization of different Lizard species in the selected ISAs

Sr. No.	Habitat	Species
1.	Arboreal	*Calotes versicolor, Chamaeleo zeylanicus, Hemidactylus leschenaultia,*
2.	Terrestrial	*Brachysaura minor, Sitana ponticeriana, Eublepharis fuscus, Hemidactylus triedrus, Acanthodactylus cantoris, Ophisops jerdoni, Ophisops microlepis, Varanus bengalensis, Varanus griseus*
3.	Terrestrial-burrowing	*Acanthodactylus cantoris, Ophisops jerdoni, Ophisops microlepis, Lygosoma albopunctata, Lygosoma punctata, Mabuya carinata, Mabuya macularia, Uromastix hardwickii*
4.	Rural	*Calotes versicolor, Sitana ponticeriana, Hemidactylus brookii, Hemidactylus flaviviridis, Lygosoma punctata, Mabuya carinata, Mabuya macularia, Varanus bengalensis*
5.	Urban	*Calotes versicolor, Sitana ponticeriana, Hemidactylus brookii, Hemidactylus flaviviridis, Mabuya carinata, Mabuya macularia, Varanus bengalensis*

Table 5.5 Microhabitat associations of Lizards in the selected ISAs

Sr. No.	Species	Microhabitat
ISA-1 Pavagadh Hill Forest		
1.	*Calotes versicolor*	Small to large trees and shrubs canopy; Boundary wall of loose rocks and boulders erected by the Forest Dept.; Old monumental remains; Ant hills and termite mounts
2.	*Sitana ponticeriana*	Small herbs and shrubs canopy; rocks and boulders; at times amidst the leaf litter; Ant hills and termite mounts
3.	*Chamaeleo zeylanicus*	Chiefly arboreal – trees and shrubs canopy
4.	*Hemidactylus brookii*	Rocks and boulders; Boundary wall of loose rocks and boulders erected by the Forest Dept.; Crevices of the old monuments; Hutments and temples
5.	*Hemidactylus flaviviridis*	Crevices of the old monuments; Hutments and temples; Lodges and guest houses
6.	*Hemidactylus leschenaultii*	Camouflaging on large tree trunks; Hidden in the gap between the dry bark and the trunk in fallen logs; Rocks and boulders; Crevices of the old monuments
7.	*Lygosoma albopunctata*	Leaf litter; Loose soil and burrows; under boulder and fallen logs
8.	*Lygosoma punctata*	Leaf litter; Loose soil and burrows; under boulder and fallen logs; termite mounts
9.	*Mabuya carinata*	Ground substratum below the herb canopy; Boundary wall of loose rocks and boulders erected by the Forest Dept.; Leaf litter; under boulder and fallen logs
10.	*Mabuya macularia*	Boundary wall of loose rocks and boulders erected by the Forest Dept.; Leaf litter; under boulder and fallen logs
11.	*Varanus bengalensis*	Ground substratum; at times on lower canopy of large trees; Old monumental remains
ISA-2 Sindhrot Village Scrubland / Vadodara Rural		
1.	*Calotes versicolor*	Small to large trees and shrubs canopy; Courtyards of houses made up of thorny vegetations; at time entering huts and houses; Plantations; Ant hills and termite mounts
2.	*Sitana ponticeriana*	Ground substratum; Small to medium shrub canopy; Plantations; Ant hills and termite mounts
3.	*Chamaeleo zeylanicus*	Medium to large size shrubs and trees canopy; Specific plantations that provided adequate camoufladge
4.	*Hemidactylus brookii*	Ground Substratum; Rocks and boulders; Hutments and houses
5.	*Hemidactylus flaviviridis*	Hutments and houses
6.	*Hemidactylus leschenaultii*	Trunks and barks of large canopy trees
7.	*Lygosoma punctata*	Ground substratum; Leaf litter; Plantations
8.	*Mabuya carinata*	Ground substratum; Leaf litter; Plantations; Boulders and bricks near hutments and houses; Stacked hay near houses; at times entering the houses
9.	*Mabuya macularia*	Ground substratum; Leaf litter; Plantations; Boulders and bricks near hutments and houses; Courtyards of houses made up of thorny vegetations; At times entering the houses
10	*Varanus bengalensis*	Ground substratum; on lower canopy of large trees; Boundary walls of huts and houses

Sr. No.	Species	Microhabitat
ISA-3 Vadodara City or Vadodara Urban		
1.	*Calotes versicolor*	Small to large trees and shrubs canopy; In gardens; Concrete compound walls of houses
2.	*Sitana ponticeriana*	Small to medium sized thorny shrubs canopy
3.	*Chamaeleo zeylanicus*	Medium to large size shrubs and trees canopy
4.	*Hemidactylus brookii*	Ground Substratum; Rocks, boulders and fallen logs; Houses
5.	*Hemidactylus flaviviridis*	Houses
6.	*Hemidactylus leschenaultii*	Trunks and barks of large canopy trees
7.	*Mabuya carinata*	Ground substratum; Leaf litter; Boulders and bricks; In the gardens; at times entering the houses
8.	*Mabuya macularia*	Ground substratum; Leaf litter; Boulders and bricks; Herbs and shrubs hedges in gardens; At times entering the houses
9.	*Varanus bengalensis*	Ground substratum; on lower canopy of large trees
ISA-4 Scrubland near Naliya, Kutch		
1.	*Brachysaura minor*	Ground substratum; Rocks and boulders; Thorny shrubs and bunch grasses
2.	*Calotes versicolor*	Medium sized shrubs canopy; Courtyards of huts and houses made up of thorny vegetations; at time entering huts and houses; Plantations; Ant hills and termite mounts
3.	*Sitana ponticeriana*	Ground substratum; Small to medium shrub canopy; Grasses; Ant hills and termite mounts
4.	*Chamaeleo zeylanicus*	Small to medium sized shrubs canopy
5.	*Eublepharis fuscus*	Ground substratum; Rocks and boulders; Thorny shrubs
6.	*Cyrtopodion kachhensis*	Rocky patches; Old monuments, deserted huts and houses
7.	*Hemidactylus brookii*	Ground substratum; Rocks and boulders; Small dense thorny shrubs
8.	*Hemidactylus flaviviridis*	Huts and houses
9.	*Hemidactylus persicus*	Old hut and houses; Deserted houses and monuments
10.	*Hemidactylus triedrus*	Ground substratum; Rocks and boulders; Ant hills and termite mounts
11.	*Acanthodactylus cantoris*	Ground substratum; Rocks and boulders; Sandy alluvial soil; Grassland interspersed with small thorny shrubs
12.	*Ophisops jerdoni*	Ground substratum; Rocks and boulders; Grass tussocks
13.	*Ophisops microlepis*	Ground substratum; Rocks and boulders; Grass tussocks
14.	*Mabuya carinata*	Ground substratum; Leaf litter; Rocks and boulders
15.	*Uromastix hardwickii*	Ground substratum; Burrows underground; Grasslands interspersed with small herbs and shrubs
16.	*Varanus bengalensis*	Ground substratum; Courtyards of huts and houses; Grasslands; *Euphorbia* and other thorny shrubs
17.	*Varanus griseus*	Ground substratum; Rocks and boulders; *Euphorbia* and other thorny shrubs

Table 5.6 Estimation of species uniqueness, diversity, evenness and dominance of lizard community at the selected ISAs

Parameters	ISA-1	ISA-2	ISA-3	ISA-4
Species Uniqueness				
Jackknife Index of Uniqueness	12.96	12.94	10.96	22.88
Species Diversity				
Simpson's Diversity (1 - D)	0.837	0.815	0.779	0.861
Shannon Wiener's Diversity (H')	0.872	0.827	0.765	1.017
Alpha Diversity	2.234	2.45	2.307	4.314
Measure of Evenness				
Equitability (J)	0.837	0.827	0.802	0.827
Measure of Dominance				
Berger-Parker Dominance (d)	0.275	0.287	0.375	0.294
Berger-Parker Dominance (1/d)	3.643	3.488	2.667	3.406
Berger-Parker Dominance (d%)	27.45	28.67	37.5	29.35

Table 5.7 Comparison of the selected ISAs through similarity coefficients

Study Sites	ISA-1	ISA-2	ISA-3	ISA-4
ISA-1	11*	10**	9**	7**
ISA-2	0.909***	10*	9**	7**
ISA-3	0.8181***	0.9***	9*	7**
ISA-4	0.3333***	0.35***	0.3684***	17*

*, Actual number of species in each ISA, **, Number of shared species of lizards between two study sites, ***, Values for similarity coefficient

Table 5.8 Comparison of selected ISAs through coefficient of community

Study Sites	ISA-1	ISA-2	ISA-3	ISA-4
ISA-1	-	62.36*	53.58*	33.20*
ISA-2	-	-	76.86*	48.75*
ISA-3	-	-	-	36.36*
ISA-4	-	-	-	-

*values of coefficient of community

Table 5.9 Niche Breadth of different Lizard Species

Species	**Levin's Niche Breadth**	**Levin's Standardized Niche Breadth**
Brachysaura minor	4.2946	0.4118
Calotes versicolor	3.6045	0.3255
Sitana ponticeriana	2.9378	0.4844
Chamaeleo zeylanicus	2.7637	0.2939
Eublepharis fuscus	3.9818	0.3727
Cyrtopodion kachhensis	9.0025*	0.8891*
Hemidactylus brookii	5.2399	0.5299
Hemidactylus flaviviridis	5.0045	0.6674
Hemidactylus leschenaultii	5.5312	0.6473
Hemidactylus persicus	4.1411	0.3926
Hemidactylus triedrus	2.4971	0.3742
Acanthodactylus cantoris	4.2731	0.8182
Ophisops jerdoni	4.3514	0.6702
Ophisops microlepis	4.281	0.5468
Lygosoma punctata	6.8865	0.7358
Mabuya carinata	5.9171	0.6146
Mabuya macularia	4.0914	0.4416
Uromastix hardwickii	1.238**	0.0476**
Varanus bengalensis	1.5878**	0.1175**
Varanus griseus	1.3991**	0.0798**

* Maximum Niche Breadth, ** Minimum Niche Breadth

Table 5.10 Niche Overlap at ISA-1: Pavagadh Hill Forest

	Cv	*Sp*	*Cz*	*Hb*	*Hf*	*Hl*	*Lp*	*Mc*	*Mm*	*Vb****
Cv	-	0.8988*	0.2847	0.2144	0.1644	0.1754	0.7251	0.8153*	0.7781*	0.0401
Sp	-	-	0.0034**	0.2269	0.3098	0.282	0.6983	0.7139	0.6675	0.0019
Cz	-	-	-	0.198	0.3619	0.476	0.2479	0.371	0.4693	0.0765
Hb	-	-	-	-	0.3571	0.4801	0.6919	0.3087	0.3083	0.0769
Hf	-	-	-	-	-	0.903	0.309	0.3444	0.32	0.0049
Hl	-	-	-	-	-	-	0.3005	0.3435	0.3069	0.0335
Lp	-	-	-	-	-	-	-	0.8025*	0.6908	0.0641
Mc	-	-	-	-	-	-	-	-	0.7989*	0.0825
Mm	-	-	-	-	-	-	-	-	-	0.0684
Vb	-	-	-	-	-	-	-	-	-	-

* Significant Overlap, ** Least Overlap and *** Significantly least Overlap
Cv-Calotes versicolor, Sp-Sitana ponticeriana, Cz-Chamaeleo zeylanicus, Hb-Hemidactylus brookii, Hf-Hemidactylus flaviviridis, Hl-Hemidactylus leschenaultii, Lp-Lygosoma punctata, Mc-Mabuya carinata, Mm-Mabuya macularia, Vb-Varanus bengalensis

Table 5.11 Niche Overlap at ISA-2: Sindhrot village Scrubland/Vadodara Rural

	Cv	*Sp*	*Cz*	*Hb*	*Hf*	*Hl*	*Mc*	*Mm*	*Vb****
Cv	-	0.8958*	0.296	0.2433	0.1828**	0.2013	0.7147	0.7137	0.0508
Sp	-	-	0.0034**	0.2142	0.2905	0.2643	0.6059	0.5469	0.0001
Cz	-	-	-	0.1849**	0.3372	0.4582	0.3748	0.4765	0.1046
Hb	-	-	-	-	0.3571	0.4801	0.3922	0.3476	0.0623
Hf	-	-	-	-	-	0.903*	0.4222	0.3448	0.0021
Hl	-	-	-	-	-	-	0.4165	0.3337	0.0238
Mc	-	-	-	-	-	-	-	0.8138*	0.0794
Mm	-	-	-	-	-	-	-	-	0.0912
Vb	-	-	-	-	-	-	-	-	-

* Significant Overlap, ** Least Overlap and *** Significantly least Overlap
Cv-Calotes versicolor, Sp-Sitana ponticeriana, Cz-Chamaeleo zeylanicus, Hb-Hemidactylus brookii, Hf-Hemidactylus flaviviridis, Hl-Hemidactylus leschenaultii, Mc-Mabuya carinata, Mm-Mabuya macularia, Vb-Varanus bengalensis

Table 5.12 Niche Overlap at ISA-3: Vadodara City/Vadodara Urban

	Cv	*Sp*	*Hb*	*Hf*	*Hl*	*Mc*	*Mm*	*Vb****
Cv	-	0.927*	0.1701	0.1512**	0.1598**	0.5905	0.6306	0.0236
Sp	-	-	0.1479**	0.2779	0.2098	0.5337	0.5233	0.0001
Hb	-	-	-	0.3722	0.4594	0.494	0.3013	0.0614
Hf	-	-	-	-	0.9006*	0.4546	0.3225	0.0014
Hl	-	-	-	-	-	0.3643	0.2653	0.0224
Ml	-	-	-	-	-	-	0.7884	0.0597
Mm	-	-	-	-	-	-	-	0.0593
Vb	-	-	-	-	-	-	-	-

* Significant Overlap, ** Least Overlap and *** Significantly least Overlap
Cv-Calotes versicolor, Sp-Sitana ponticeriana, Cz-Chamaeleo zeylanicus, Hb-Hemidactylus brookii, Hf-Hemidactylus flaviviridis, Hl-Hemidactylus leschenaultii, Mc-Mabuya carinata,Mm-Mabuya macularia, Vb-Varanus bengalensis

Table 5.13 Niche Overlap at ISA-4: Scrubland at Naliya, Kutch

	Bm	*Cv*	*Sp*	*Cz*	*Ef*	*Ck*	*Hb*	*Hf*	*Hp*	*Ht*	*Ac*	*Oj*	*Om*	*Mc*	*Uh****	*Vb****	*Vg****
Bm		0.9875*	0.8697*	0.3377	0.4921	0.1676**	0.2504	0.2056	0.1943**	0.2921	0.7983	0.8448*	0.8893*	0.8365*	0.0333	0.049	0.0345
Cv			0.8988*	0.2847	0.4103	0.1156**	0.2144	0.1644**	0.1413**	0.2478	0.7456	0.7824	0.8348*	0.7781	0.0281	0.04	0.0273
Sp				0.0034**	0.2203	0.0605**	0.2269	0.3098	0.1337**	0.2302	0.6265	0.6288	0.6847	0.6675	0.0132	0.0019	0.025
Cz					0.5808	0.4799	0.198**	0.3619	0.4821	0.1292**	0.4605	0.5265	0.5091	0.4693	0.042	0.0765	0.0129
Ef						0.3756	0.2316	0.3361	0.5674	0.3037	0.8592*	0.6742	0.659	0.7437	0.0529	0.0931	0.0568
Ck							0.7282	0.5015	0.8954*	0.1749**	0.332	0.1054**	0.1119**	0.1996	0.0186	0.0476	0.03
Hb								0.3571	0.4217	0.2682	0.2988	0.2012	0.2216	0.3083	0.025	0.0769	0.0455
Hf									0.6796	0.1362**	0.3755	0.2425	0.2383	0.32	0.0144	0.0049	0.021
Hp										0.2574	0.5814	0.1754**	0.1711**	0.277	0.0179	0.0134	0.0184
Ht											0.2682	0.444	0.4145	0.2696	0.0134	0.0147	0.0097
Ac												0.8314*	0.8482*	0.9362*	0.0503	0.0596	0.0401
Oj													0.9953*	0.936*	0.0486	0.0663	0.04
Om														0.9474*	0.0479	0.0661	0.0401
Mc															0.0524	0.0684	0.0475
Uh																0.0066	0.0027
Vb																	0.9948*
Vg																	

*, Significant Overlap, **, Least Overlap and ***, Significantly least Overlap

Bm-Brachysaura minor, Cv-Calotes versicolor, Sp-Sitana ponticeriana, Cz-Chamaeleon zeylanicus, Ef-Eublepharis fuscus, Hb-Hemidactylus brookii, Hf-Hemidactylus flaviviridis, Hp-Hemidactylus persicus, Ht-Hemidactylus triedrus, Ac-Acanthodactylus cantoris, Oj-Ophisops jerdoni, Om-Ophisops microlepis, Mc-Mabuya carinata, Uh-Uromastyx hardwickii, Vb-Varanus bengalensis, Vg-Varanus griseus

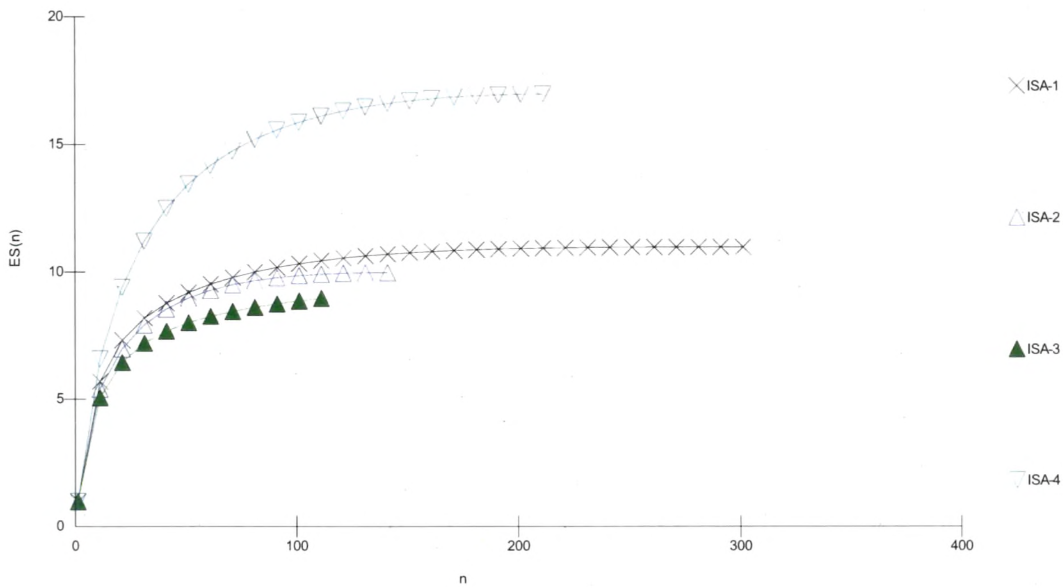

Figure 5.5 Rarefaction Analysis

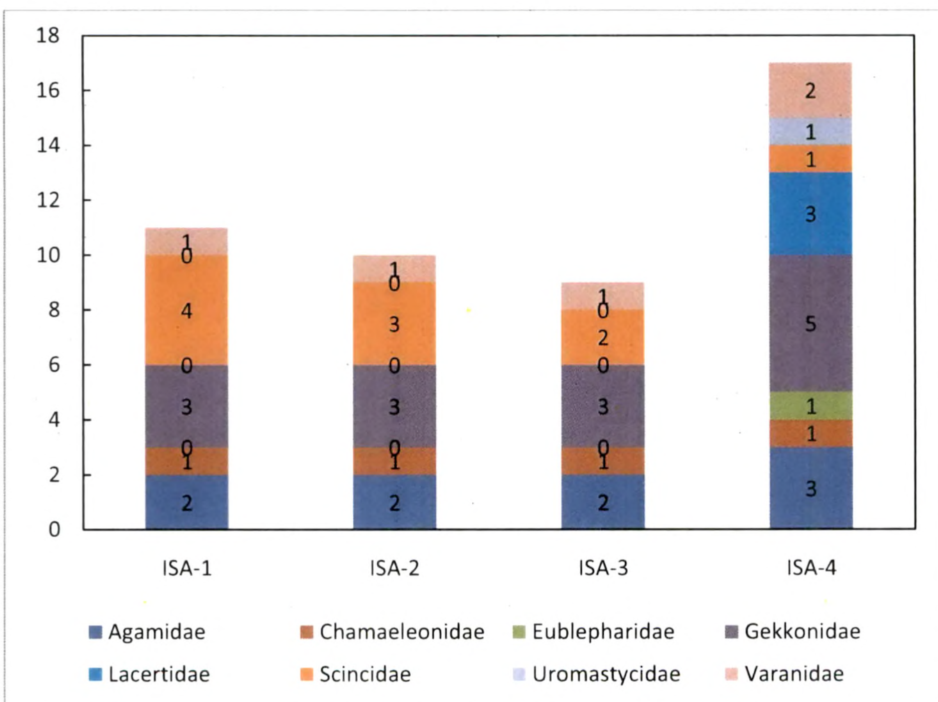

Figure 5.6 Family and species composition of lizard communities at the selected ISAs

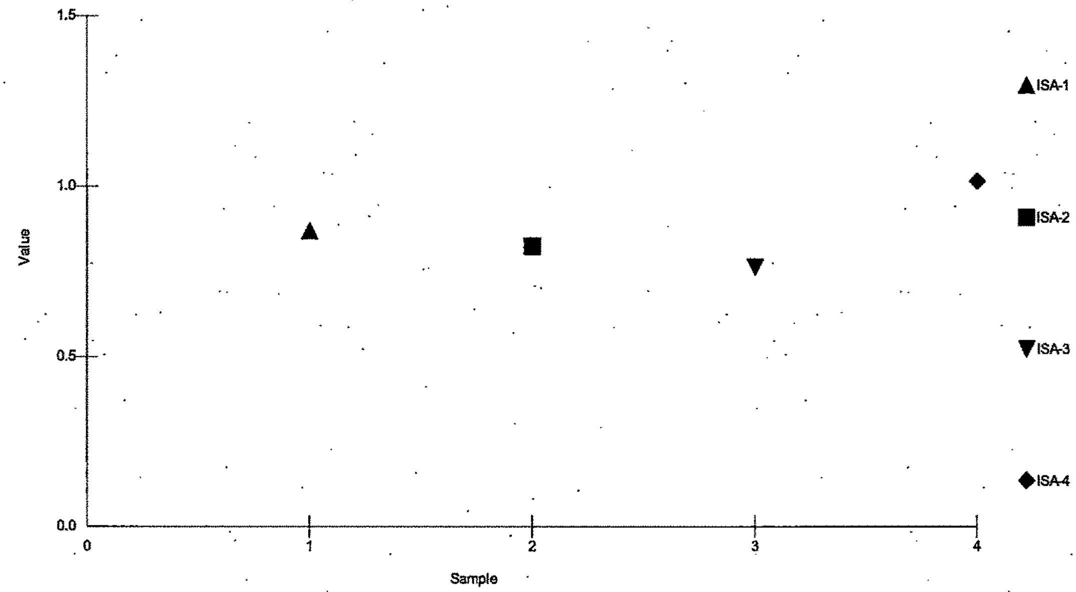

Figure 5.7 Species diversity at the selected ISAs through Shannon Wiener's Index

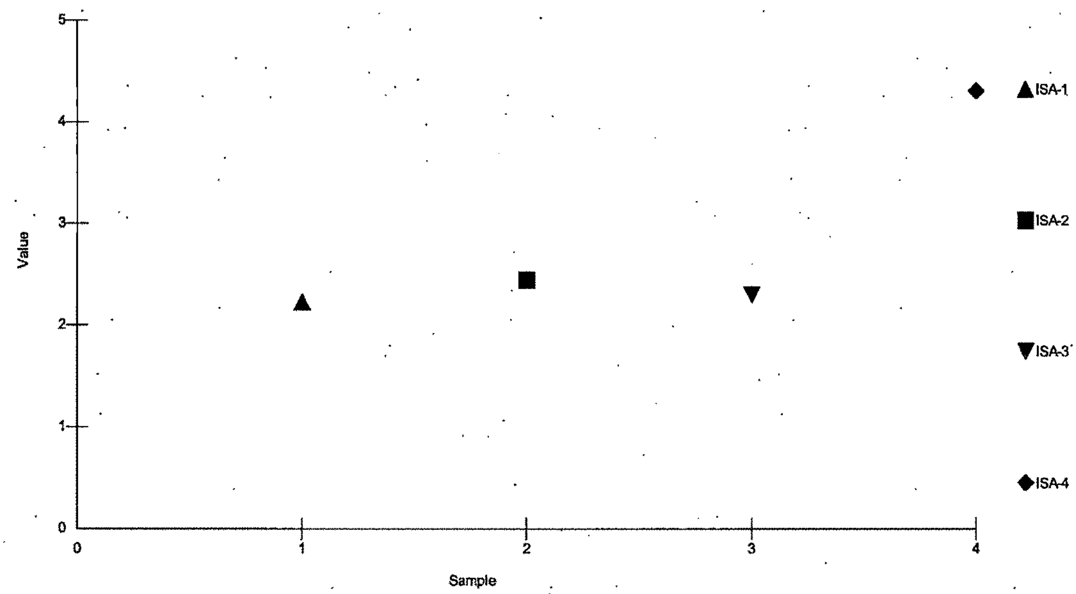

Figure 5.8 Species diversity at the selected ISAs through Alpha Diversity Index

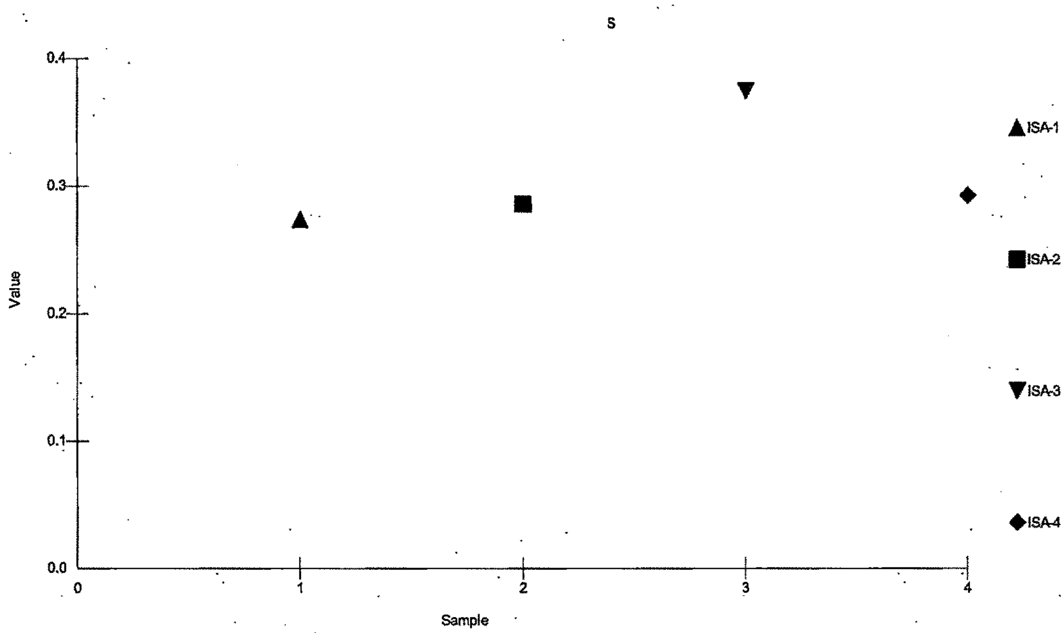

Figure 5.9 Species dominance at the selected ISAs through Berger-Parker Index

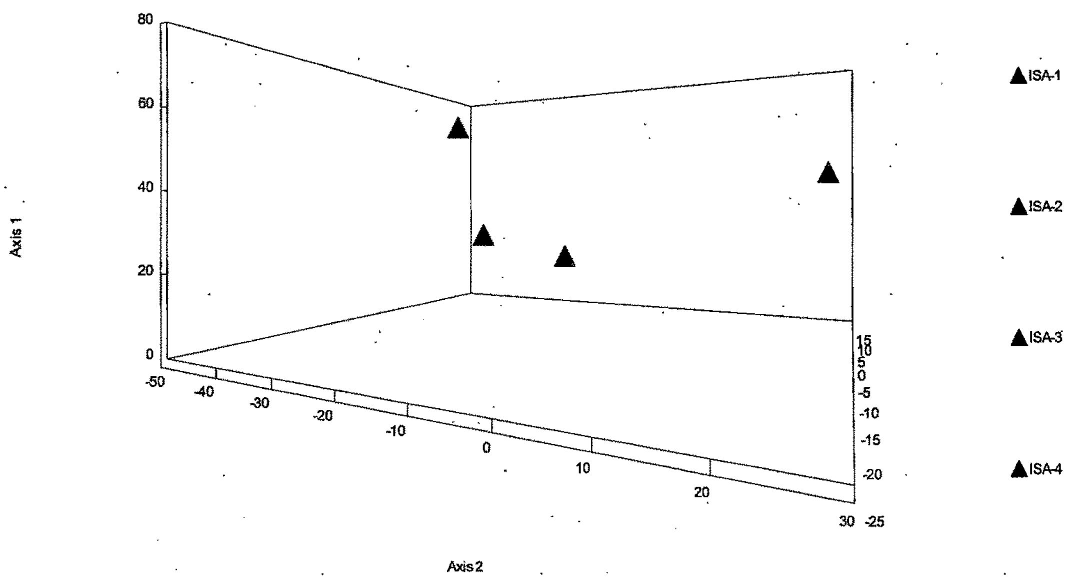

Figure 5.10 Relatedness of the selected ISAs through Principal Component Analysis

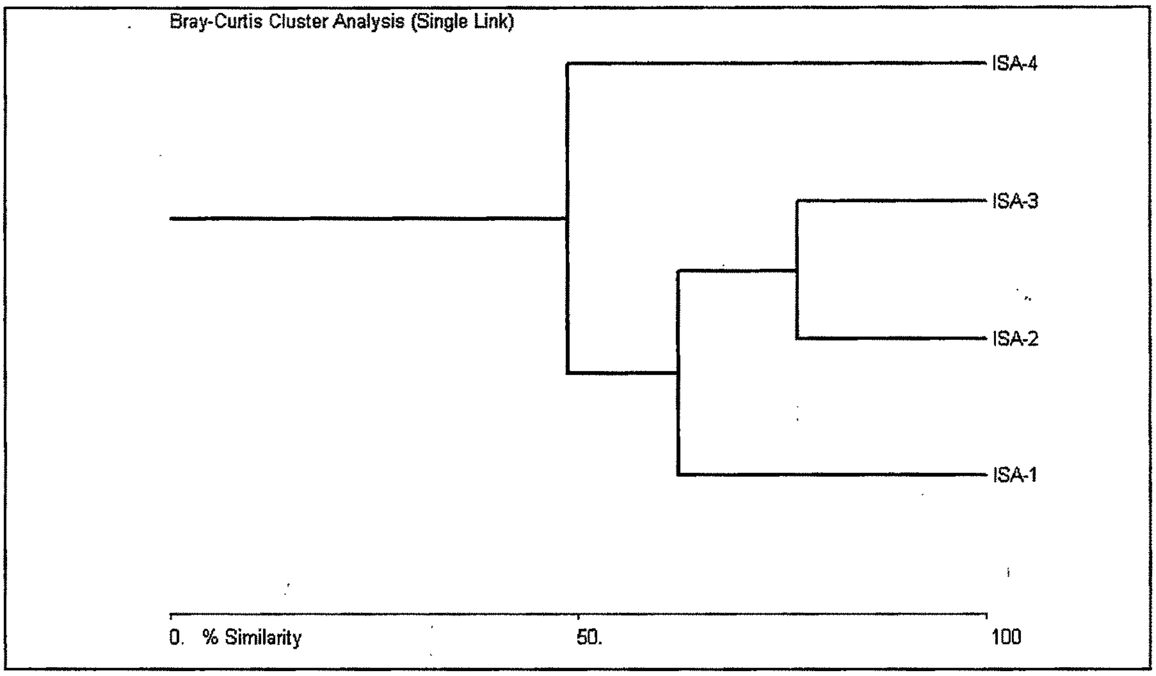

Figure 5.11 Similarity of the selected ISAs through
Bray-Curtis Cluster Analysis

Figure 5.1a - Intensive Study Area (ISA) - 1: Pavagadh Hill Forest
(Dense Forest in Monsoon)

Figure 5.1b - Intensive Study Area (ISA) - 1: Pavagadh Hill Forest
(Degraded Forest in Monsoon)

Figure 5.2a - Intensive Study Area (ISA) - 2: Sindhrot Village Scrubland/Vadodara Rural in monsoon

Figure 5.2b - Intensive Study Area (ISA) - 2: Sindhrot Village Scrubland/Vadodara Rural in summer

Figure 5.3a - Intensive Study Area (ISA) - 3: Vadodara city/Vadodara urban (Campus of Laxmi Vilas Palace)

Figure 5.3b - Intensive Study Area (ISA) - 3: Vadodara city/Vadodara urban (Campus of The M. S. University of Baroda)

Figure 5.4a - Intensive Study Area (ISA) - 4: A scrubland near Naliya - Kutch (Monsoon)

Figure 5.4b - Intensive Study Area (ISA) - 4: A scrubland near Naliya - Kutch (Summer)