

CHAPTER 5 – SUMMARY AND CONCLUSIONS



5. Summary and Conclusions

Amphibians are unique amongst vertebrate animals as they lead a bimodal life and are more sensitive to the changes in air, water and land. Community ecological studies of amphibians should ideally take into consideration the different life history stages of the species involved. However, as has been reported by Duellman and Trueb (1994), amphibians have adapted so much since their first emergence that not less than 29 different life history strategies can be seen in this class of vertebrates. Further, tropical amphibians tend to be most diverse in this regard.

Daniels (2005) has listed only eight of the universally known life history strategies for peninsular Indian amphibians. This is clearly an indication that the life histories of many species of Indian amphibians are as yet improperly known. As a result, community ecological studies that attempt to include the life history stages of the species involved could be too time consuming and complex that the generally accepted method of sampling only metamorphosed amphibians, especially the adults has been adopted during the present study.

The Western Ghats are amongst the 25 global biodiversity hotspots. They are best known for their amphibian diversity that surpasses all other biogeographical regions in India. Of the nearly 130 species of amphibians that are known from the Western Ghats, more than 70% are endemic. Interestingly, more species are being discovered and with each new discovery, the fact that the region has an enormous affinity with the early Gondwanaland's biodiversity is being reinforced.

The best example in this regard is the recent discovery of the burrowing frog from Kerala named *Nasikabatrachus sahyadrensis* (Biju and Bossuyt, 2003).

The state of Karnataka is geographically in a position that it shares the biodiversity of the central Western Ghats. And as it locally receives the highest rainfall in south India (example Agumbe) it has nurtured a very high diversity of amphibians. Around 75 species of amphibians are known from the State of which the majority is found only in the Western Ghats (Daniels, 2000). It is likely that another 10-20 species will be added to this list at the rate at which new discoveries are being made. What is of interest in the present context is that of the known species of amphibians in the State more than half have been observed during the study. That a fair representation of the amphibian fauna of the State has been achieved during the present study and that the total number of individuals sampled during the 3 years is in excess of 29,000, the results that have been obtained and discussed can be considered as conclusive. The main conclusions that have been drawn from the results of the investigation and presented in the thesis are summarized below.

5.1 Disturbance and Species Diversity

Study of amphibian fauna in the Western Ghats has largely focused on taxonomy. The first ever community ecological study that involved amphibians was that by Inger *et al* (1987) in the Ponmudi Hills of Kerala. Despite its merit, as the approach adopted by Robert Inger and his team treated amphibians along with reptiles as 'herpetofauna' a lot of unique patterns of diversity and habitat selection in amphibians got confounded in the analysis. Broad patterns of

distribution and the ecological factors that determined the geographical distribution of amphibians were first analyzed by Daniels (1992). In his analysis, Daniels highlighted two major findings: first, the length of the dry season has a greater influence on the local species diversity of amphibians in the Western Ghats and second, disturbance of habitat (wet evergreen forests) leads to a reduction in the species diversity of amphibians. He compared the pattern with that of birds in the Western Ghats and concluded that the two classes of vertebrates behave rather differently in response to habitat disturbance.

Fair amount of information exists today that suggest that disturbance of the wet evergreen forests favors the local increase in bird species diversity (Daniels *et al*, 1992; Daniels, 1997a). While the study of birds reported by Daniels was made in the Western Ghats of Karnataka, there has since been no study to assess the impact of habitat disturbance and loss on other classes of vertebrates. The present study is thus rather unique and a significant contribution to the general understanding of the subject.

Disturbance of habitat has apparently led to the reduction in the number of species of amphibians in the study area. It has also drastically reduced the abundance of species and hence the species diversity. Disturbance to habitats can be a various scales and different from what it is for the other classes of vertebrates, especially the highly mobile birds. In the Western Ghats, disturbance can start at very small scales in the form of removing leaf litter from the forest floor to manure the adjoining cultivation (Daniels, 1991a) to large-scale clearing of forests for the cultivation of tea (Daniels, 2003b). The range of disturbances

that natural habitats have experienced in the Western Ghats has only aggravated the rate at which amphibian species have disappeared locally. The results of the present study have reinforced the earlier observations.

5.2 Rarity of Species

Loss of habitat triggers a number of responses in amphibian communities locally. Apart from the local disappearance of species that are already rare (small populations) many otherwise abundant species tend to become rarer. In tropical communities, there are many rare species and this is particularly the reason for the many new discoveries. But, drastic changes in the numbers of the commoner forest species in the Western Ghats can only be attributed to the loss of habitat. Worldwide there has been a considerable concern on the declining amphibian populations (Blaustein and Wake, 1990; Lips *et al*, 2005a and 2005b). While the causes for the decline have been different across the globe (including diseases that are taking a toll on the amphibian populations), at least from what is known, habitat loss has been the primary factor that has rendered species of amphibians rare in the Western Ghats (Daniels, 2003b).

The lists of the rare species of amphibians in the Western Ghats include a number of endemic species of frogs and toads (that are also arboreal) and caecilians. However, as caecilians are highly cryptic animals, and the fact that the field methods (as that used in the present study) are not quite suited for sampling caecilians, it cannot be conclusively said that the apparent rarity in this group of amphibians is not an artifact of sampling. Amongst the anuran amphibians, some species are known to be rare by virtue of their life history

strategies and habitat choice. Amongst these, the tree toad *Pedostibes tuberculosus*, a species endemic to the Western Ghats, was for the first time reported from Karnataka during the study. This species was restricted to the undisturbed forests of the Kudremukh NP.

Pedostibes tuberculosus is listed as an endangered species in the IUCN Red List of 1990 (Vial and Saylor, 1993) and as 'vulnerable' in the CAMP Summaries of India (Zoo Outreach Organization, 2000). This toad is one of the many species of amphibians of the Western Ghats that are rare and are facing serious threat of habitat loss and population decline. That habitat disturbance and loss have led to the local decline of the already rare and vulnerable species of amphibians has become evident in the present study as another species of amphibian viz., *Philautus glandulosus* listed as vulnerable in the CAMP Summaries (Zoo Outreach Organization, 2000) was observed only in the undisturbed forests of Kudremukh NP.

5.3 Recommendations for Future Research and Conservation of Amphibians in the Western Ghats

Research on amphibians in the Western Ghats has gained a momentum that is far greater now than it was anytime in history. However, the quest is for the discovery and description of new species. While it is good to learn more about the 'unknown' and understand the prehistory of the Western Ghats, overemphasis on field studies that only add to the existing taxonomic knowledge on amphibians could be detrimental to the fauna in the long run. The dangers of large-scale and indiscriminate collections for the sake of discovering new species and taxonomic revisions were pointed out earlier (Daniels, 1991a). Spurts of

specimen collection have destroyed populations of amphibians locally throughout the world. What we hence need is a comprehensive strategy that leads to the conservation of the rich and diverse fauna of amphibians in the Western Ghats. The following are some recommendations (based on the present study) that could help conserve the amphibian fauna of the Western Ghats in general and the state of Karnataka in particular.

- The Protected Area network of India, especially that in biodiversity hotspots as the Western Ghats, has not been established with organisms other than large mammals in view and as such any protection that is afforded to amphibians is incidental. As a result, loss of habitat, such as the drying of a small stream or removal of leaf litter from the forest floor, goes unnoticed. This lacuna has to be highlighted and rectified.
- A detailed inventory of the amphibian species of the Western Ghats should be created with photos and maps for each species along with their habitat requirements. The inventory should highlight those species that are known from the state of Karnataka identifying those that are endemic to the State. Facilities should be created for updating the inventory from time to time. Such an inventory will help in local conservation planning.
- While it is important to carry out surveys for the sake of taxonomic updating, focused research on breeding strategies and life histories of the various species has to be initiated. While such research will contribute to the conservation of amphibian species and communities in the Western Ghats, sound knowledge of breeding and life history strategies will eliminate the range of doubts that prevail over the specific identity of many species of amphibians.
- Since most species of amphibians are not protected by the Indian Wildlife (Protection) Act, 1972, field collections are not carefully monitored and regulated. Further, the general lack of authentic field guides has aggravated the need for collecting every example to verify its identity. If

rampant field collection of amphibians is to be regulated, there has to be a series of authentic and simple field guides published (both in English and regional languages). In addition to the illustrated guides, as anurans have specific calls like that of birds, these can be catalogued and made available as audio CDs. Such an initiative will not only enhance the interest of students on this class of vertebrates but also minimize the killing of amphibians for the sake of identification.

- Amphibians are the best indicators of ecological and environmental changes. An integrated approach to the field study of amphibians will add significantly to the long-term conservation of the rich biodiversity of the Western Ghats.

5.4 Epilogue

When more than one species of organisms coexist over a given space and time, they form a biological community. There are many species that become part of biological communities and there are a number of ways in which these species interact with each other and the local environment. Although by definition, biological communities are comprised of micro-organisms, plants and animals, conventionally, community ecologists have defined communities within specific physiognomic groups such as flowering plants or taxonomic groups as butterflies, amphibians, reptiles, birds, mammals, etc., wherein the focus is on the selected groups of organisms to the neglect of others. While such a narrow definition might render field research, especially in tropical ecosystems, more viable, the ecological processes that influence any particular community are not quite understood.

The most common outcome of such a narrow focus is that when there are apparent correlations between different taxonomic communities that inhabit a

particular habitat or landscape, it is hard to conclude whether the relationship is indeed a 'cause-effect' one or simply that both groups of organisms are responding to some ecological factor in a similar or different way. For instance, when there is a negative correlation between the diversity of woody plants and birds (as often seen in the Western Ghats; Daniels, *et al* 1992), it is hard to say whether the lower diversity of flowering plants has been responsible for the greater diversity of birds or plants and birds respond entirely differently (rather oppositely) to an ecological factor such as altitude, light or rainfall. Similarly, when amphibian communities respond to habitat loss in different ways, it cannot be said that a single factor was responsible for the change. Amphibian declines across the globe have been attributed to many different factors as discussed earlier. However what is of relevance here in the present study is the fact that loss of habitat and changes in the local amphibian community structure tend to be associated. Such a pattern in itself is adequate for monitoring the health of the environment in general and the rainforests in particular.

Rainforests are amongst the most vulnerable of natural ecosystems in the world today. Many attempts have been made to identify bio-indicators for monitoring the health of the tropical rainforests. Amphibians seem to be ideal tools that can be used in bio-monitoring programs. A quest for newer species is important. However, a better understanding of the life history stages and ecological requirements of the many species of amphibians that inhabit the tropical rainforests is an absolute must. In the words of Dr Stanley A Rand, a senior herpetologist of the Smithsonian Tropical Research Institution at Panama, '*there*

are many more aspects of natural history of amphibians to be discovered and some can be found using no more elaborate equipment than a light, two eyes and a large fund of patience. They can be recorded using no more than a pencil and a notebook” (Daniels, 2005).