CAVE DWELLING BATS IN SRI LANKA

Rudolf Rübsamen[1] Michael Eckrich[2] and H. H. Costa[3]

1. *Zoological Department of the University of Leipzig, Talstrassen 33, D-04103 Leipzig, Germany*

2. *Zoological Department of the University of Munich, Luisenstrasse 14, D-80333 München, Germany*

Introduction

The first detailed description of the species of bats living in Sri Lanka and the distribution of these bats in the different climate zones was given by Phillips (1924). These data were later included in his "Manual of the Mammals of Ceylon" published in 1935. In the second revised edition of this manual published in 1980 some changes were made with regard to the nomenclature, but no further information about the present status of the bats in Sri Lanka was given.

The environment in Sri Lanka has changed dramatically within the course of the last 50 years. Since 1950 the human population has more than doubled and it is still increasing rapidly. Unlike in many other developing countries people are not concentrated in a small number of big cities but are living also in rural districts, in small villages and in medium sized towns of about 20,000 to 30,000 inhabitants (Federal Statistical Office, 1986). The economy of Sri Lanka is essentially based on agriculture, and areas coming under cultivation are increasing rapidly. This has caused serious inroads into the present pattern of forest vegetation. The problem has become so serious that the government of Sri Lanka is now taking steps to demarcate areas for conservation, especially in the regions coming under Mahaweli Project, the biggest land development project undertaken in Sri Lanka (Betz, 1982). Even with the present stringent restrictions imposed by the government, many habitats in the dry zone are still destroyed by chena cultivation and illegal cutting of trees for timber. This threat of continuous loss in wildlife habitats urgently necessitates a new census not only of the larger, more impressive mammals, but of all mammals of Sri Lanka.

No new data or information on the species of bats and their distribution in Sri Lanka has been recorded in the last 60 years. In 1981, we therefore started a new inventory of cave dwelling bats and their distribution as a preliminary for further studies mainly on the Sri Lankan rufous horseshoe bat (*Rhinolophus rouxi*). For this microchiropteran bat we investigated the foraging behaviour (Neuweiler et al., 1987), its food habits (Eckrich and Neuweiler, 1988), the length of the nocturnal activity periods (Yapa et al. 1990), the seasonality of reproduction the rate of birth and death of offspring in a maternity colony and the development of the echolocation system in early postnatal development (Rübsamen, 1987; Rübsamen and Schäfer 1990a, 1990b).

Materials and Methods

The data were based on observations carried out from July to October 1981 and were supplemented by data collected during field trips in March 1983, from September to November 1984, and during the same period in 1986, 1987 and 1989. In this study, caves, cave temples and abandoned mines were surveyed. Altogether 27 caves and cave-like places, which included all the big natural caves of the island were checked for the presence of bats. The species were identified with the aid of the checklists of Phillips (1980) and Eisenberg and McKay (1970). The names of most caves and of cave-temples were collected from the "Handbook for the Ceylon Traveller" (1974). The locations of abandoned plumbago mines were collected from the Geological Survey Department in Colombo, Sri Lanka. Additionally, current information about bat roosts were provided during our trip by locals. The different species of bats roosting in each cave were identified, and their respective numbers were counted independently by two observers.

Results

The cave dwelling Chiroptera of Sri Lanka comprise of six species belonging to four genera. These are: *Rousettus seminudus, Hipposideros speoris, Hipposideros lankadiva, Hipposideros bicolor, Rhinolophus rouxi* and *Miniopterus schreibersi*. Four further species, though not strictly cave living, were also found in caves. These were *Taphozous melanopogon, Pipistrellus ceylonicus, Megaderma lyra* and *Megaderma spasma*.

Fig. 1a shows the distribution pattern of the species of cave living bats in the caves surveyed. Table 1 gives a census of the estimated number of individuals at each place. Fig. 1b shows the situation of the caves in relation to the climate and vegetation zones demarcated as: (A) subarid climate area (*Manilkara-Chloroxylon* series), (B) semiarid climate area (*Chloroxylon-Berrya-Vitex-Schleicheria* series), (C) semihumid climate area (*Filicium-Euphoria-Artocarpus-Myristica* series) and (D) euhumid-subhumid climate area (Doona-*Dipterocarpus-Mesua* series) (after Mueller-Dombois and Sirisena, 1967). The two coherent forest regions, i. e., the dry-mixed evergreen forest and the wet and mountain evergreen forest are also shown on this map. Comparing our counts with the data of Phillips (1924, 1935, 1980) several changes become obvious. The old cave-temples were restored, and bats were kept out of many places with the help of special lattice-windows. In many of these temples the smell of the bats was still remaining, but the bats

themselves had disappeared. A similar development took place in India. At Adjanta and Elora (East of Bombay), for example, Brosset (1962) counted many thousands of bats in a number of cave temples, whereas only very few bats were found at the same places in 1979 (Schuller and Rübsamen, unpublised observations). In Sri Lanka as well as in India, the bats in the cave-temples mainly belong to the species *Taphozous melanopogon*, which also roosts in rock crevices. These bats tolerate dim light at their roosting site. *Taphozous melanopogon* was found in every climatic zone of Sri Lanka. All in all we observed seven colonies of these bats in the very dry area around Anuradhapura and Mihintale (Isurumuniya and Mihintale Caves) as well as in the semihumid hill region at Ella (Ravana Cave, Fig. 1a). It was always difficult to estimate the number of individuals as these bats used to hide in narrow cracks. A similar distribution in different climate zones was found for *Hipposideros speoris*. We observed ten colonies in areas extending from the semiarid region in Habarana (Ritigala Cave) to the lower hill region around Laxapana Falls (Power Station Cave, Fig. 1a). These bats tend to form large colonies if the roosting places are adequate. In some colonies we counted between several hundred and a few thousand individuals (Table 1). In dry areas, this species was found alone in the caves or it roosted together with *Taphozous melanopogon*, while in the regions with more rain it occured together with all other cave dwelling bats except *Hipposideros bicolor*. *Hipposideros speoris* seems to be well adapted to the dry climate in the northern and eastern regions and often lives in caves where no water is to be found. *Hipposideros bicolor* was only found at one place near Welimada (Esterepure Cave) at an altitude of 4600 feet. The colony was formed by a few hundred individuals, roosting together with a colony of some hundred *Rhinolophus rouxi*.

Hipposideros lankadiva was observed at five places in the areas (C) and (D), forming colonies of up to some thousand individuals. They preferred caves providing water and were always found together with other bats. At Kolonne they roosted together with *Hipposideros speoris* and *Megaderma sp.* and at Wawulgalge near Koslanda with *Rousettus seminudus*, *Miniopterus schreibersi*, *Hipposideros speoris* and *Rhinolophus rouxi*. *Rhinolophus rouxi* seems to have a similar distribution as *Hipposideros lankadiva*. The rufous horseshoe bat only occurred in the rainy south-west, the semihumid zone and the subhumid hill zone. It only roosts in caves providing water. We found four colonies of rufous horseshoe bats. During September and October those at Kolonne and at Welimada only consisted of males and the remaining two were large maternity colonies formed by many thousands of females accompanied by only a few males. During our first visit to Wawulgalge near Koslanda in the second week of September 1981 nearly all females were pregnant, and at the time of our second visit in the middle of October they had given birth. The young were already large enough to be left at their hanging places during daytime while the mothers were flying around inside the cave. The young tended to crowd together in big clusters of thousands of individuals and continuously emitted isolation calls audible to the human ear. The cave was resounding with this noise, which was even louder than the shrieks of the thousands of fighting *Rousettus seminudus* annoying us during our first visit. Repeated careful observations of this colony from

1984 to 1989 confirmed the observation that the reproduction period in rufous horseshoe bats is precisely synchronized. The young were exclusively born within the first three weeks of October.

In this context two interesting points should be mentioned: According to Phillips (1935) and Brosset (1962) reproduction in *Rhinolophus rouxi* takes place in March and April. This is true for *Rhinolophus rouxi* in India. Whether these bats in Sri Lanka have reproductive cycles twice a year, or whether this is a population with a different reproduction rhythm, or even a different subspecies of rufous horseshoe bats, remains questionable.

Phillips (1980) reported that in *Rhinolophus rouxi*, the two sexes live together throughout the year. We found a strict separation of males and females during the reproduction period in September and October. This observation was further supported by checks of several small caves in the vicinity of this maternity colony near Koslanda and in places where we caught only male rufous horseshoe bats. Brosset (1962) reported congruent observations for the rufous horseshoe bat in India. However, separation of the two sexes in rhinolophids did not mean separation from other species of bats. At Wawulgalge near Koslanda a very large colony of pregnant females was roosting together with at least four other species of bats: *Rousettus seminudus*, *Hipposideros lankadiva*, *Hipposideros speoris* and *Miniopterus schreibersi*. Each of these species also formed medium-sized to large colonies hanging in different regions of the cave. In caves where we found large numbers of male rufous horseshoe bats they always crowded together with other species: with *Hipposideros bicolor* near Welimada and with *Hipposideros lankadiva* and *Hipposideros speoris* in two plumbago mines at Kolonne.

During our repeated observations at Koslanda from 1981 to 1987 we found that the size of the colony of *Rhinolophus rouxi* was continuously decreasing while in the same cave the number of *Rousettus seminudus* was increasing.

Megaderma lyra was found in a small cave near Embilipitiya. A second colony of Megadermatidae was found in the Istripura Cave near Pannala. It was a group of about 50 -100 bats, but it was not possible to catch even one of them. Although we were unable to identify the species, they most probably were *Megaderma lyra*. Phillips (1980) reported that *Megaderma lyra* was common in the wet zone especially in the western province. *Megaderma spasma* on the other hand was found in the dry areas of the eastern province. The results indicate that the number of these bats was diminishing.

Miniopterus schreibersi was found in Wawulgalge near Koslanda and in Wawulpane near Embilipitiya. The latter cave is an enormous limestone cavern underground with a waterfall and a pond inside, where these bats formed a colony roosting together with other species of bats. Of all bat species known so far, this species has the widest distribution

covering an area from France over North Africa, South-East Asia, northern parts of Australia up to Japan. Its unique characteristic is the formation of only few but very large colonies separated from each other by great distances. Brosset (1962) named these colonies "mother houses" and indicated that in India only two such colonies are known, the one in Mahabaleshwa near Bombay consisting of more than 100,000 individuals (Schuller and Rubsamen, unpublished observations 1979). At Wawulpane it was impossible to estimate the actual size of the colony, as the cave was too wide and as different species were roosting together. It would be interesting to find out whether this colony forms such a "mother house" for Sri Lanka, as the conditions in this cave are similar to those at Rancongne in France and at Mahabaleshwa in India (Brosset, 1962; own unpublished observation in 1979 [India] and 1980 [France]).

Pipistrellus ceylonicus is not a typical cave dwelling bat. But, in a small cave near Laxapana Falls, too lighted for cave bats, we found a small colony and caught one female with two young in the beginning of October 1981.

Rousettus seminudus was found in the south-west of Sri Lanka in many small caves and cave-like places. Furthermore, we observed four large colonies, three in natural caves (Wawulpane near Embilipitiya, Wawulgalge near Koslanda and Unawatuna Cave near Galle) and one in an abandoned house (Hikkaduwa). The latter colony (consisting of 300 - 500 bats) was observed in the middle of July 1981 roosting in an undisturbed building. There, a considerable number of the animals were relatively big-sized young bats being carried during flight by their mothers, although the young ones were able to fly by themselves for short distances. In the middle of September 1981, in the Unawatuna Cave near Galle young *Rousettus seminudus* were observed performing intensive flight exercises inside the roost. This cave was inhabited only by *Rousettus seminudus* (2000 - 3000 bats), and it was very impressing to watch them flying out at night. The cave was located in a rock near the seaside, and its only entrance was facing the water. When the sea was rough this entrance was rhythmically closed and opened by the breaking waves. The bats had to estimate this rhythm and they were rushing out of the cave in groups, following the retreating waves. Several thousand *Rousettus seminudus* were estimated roosting in Wawulpane (Embilipitiya). In this cave, which was shared with four other species, they were hanging in dim light at the highest point of the ceiling near the entrance.

The fact that we found young *Rousettus seminudus* in different caves from July up to October, indicates that in these bats the reproduction period is not precisely synchronized. Repeated observations of the colony near Koslanda from 1981 to 1987 indicated that the size of the colony of these frugivorous bats was continuously increasing. This might be due to an increase of food resources for megachiropteran bats in this area caused by rapid increase of land coming under chena cultivation.

Discussion

Our observations on the distribution of the different species of cave dwelling bats indicate that in Sri Lanka the greatest diversity of bat species occurs in the south-western region and in the central hill region. These are the regions where the big monocultural estates (tea, rubber and sugar cane) are situated (Betz, 1982). However, these are also the regions where destruction by cultivation has remained relatively small. Due to optimal climate conditions prevailing in these regions there is a rich and quickly growing vegetation. However, considering the proliferation of the number of small villages in the rural areas and the increasing population, this may not hold true in the future (Fedral Statistical Office, 1986).

Considering especially the two species *Rhinolophus rouxi* and *Hipposideros speoris*, obivious changes have occurred in the past 60 years: Phillips (1935) had reported that *Rhinolophus rouxi* was the most common microchiropteran bat in Sri Lanka, but looking at the overall distribution and our counts, now *Hipposideros speoris* is the most common species. *Rhinolophus rouxi* is a typical forest bat and it is restricted to areas with high precipitation. In India, this species is common in the Western Ghats in Kanara and in the Kokan (Brosset, 1982; Schuller and Rubsamen, unpublished observations, 1979). In Sri Lanka *Rhinolophus rouxi* is now found to be restricted to the semihumid and subhumid-euhumid zones and it no more occurs in the north and east of Kandy as described by Phillips (1935). In the course of our observations we found this species in the south-western areas of Sri Lanka, the region with the heaviest rainfall and large forests. This restriction of the distribution and decrease of colony size appear to be correlated with the continuous reduction of forest areas in Sri Lanka. *Hipposideros speoris*, now the most common cave dwelling bat, is a species of which Phillips (1935) says that it adapts itself to varied biotopes. We can confirm this, as we found *Hipposideros speoris* in the dry north at Ritigala and also roosting together with *Rhinolophus rouxi* in forest regions at Koslanda (Wawulgalge) and Kolonne (Plumbago Mine). Although *Hipposideros speoris* adapts itself to different biotopes, it seems to prefer the lowlands. We found it up to an altitude of 750 m and this observation coincides with the data of Phillips (1935).

In the east and south-east of Kandy, some caves were found to be inhabited only by a relatively small number of bats. Considering the size and the seclusion of these caves, no apparent reason for this paucity of bats could be found. Perhaps it would have caused by dramatic changes in the environment which had taken place in the surrounding countryside, where immense areas of forest had been burned down, causing the destruction of the natural vegetation.

As caves, especially natural caves, are very stable roosting places and bats concentrate there in during the daytime in very large numbers, it is possible to estimate exactly the size of bat populations in different biotopes. If identification of insectivorous and frugivorous species and counts of specimens are repeated in adequate time periods, information could be collected which could serve as indicators for the changes the

biotopes are undergoing. This especially might hold true for Sri Lanka, as the exchange of the bat fauna between this island and India, which might compensate local environmental influences, most probably is minimal.

Summary

The distribution of cave dwelling bats in Sri Lanka was surveyed in field trips in 1981, 1983, 1984, 1986 and 1987. Twenty seven places were repeatedly checked for the presence of bats, for cases of different species dwelling together in one cave and for the size of colonies. The results are compared with data from Phillips (1935). Our observations indicate that the number of bats restricted to forest areas *i.e.,Rhinolophus rouxi* l *and Hipposideros lankadiva,* formerly the most abundant species all over the island, had declined and was replaced by species which are more adapted to dry regions or which are less specialized in their foraging behaviour such as *Hipposideros speoris.*

Unlike previous reports we also found that in *Rhinolophus rouxi* reproduction takes place in the begining of October and that the birth of the offsprings is highly synchronized.

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