

# Nature Watch

Diversity of Bats

*G Marimuthu*

**The author introduces us to the fascinating world of bats: their features, classification, habitats, food habits, and distribution.**

## Unique Characteristics of Bats

Bats are the only mammals that can fly. They are unique because of their capacity for flight and echolocation and their ability to hang upside down. Zoologists place the bats under the order known as Chiroptera. In Greek, the word *chiro* means hand, and *ptera* means wings. Their hands are modified to form a wing membrane which is a fold of skin stretched from the sides of the body to the elongated finger bones. The thumbs are free from the stretch of these wing membranes. The wings are divided into separate compartments by the elongated fingers. In this way, bats differ from the pterosaurs (the extinct flying reptile) whose wings were also folds of skin, but supported by a single elongated finger. The hind legs of bats also support the wing membranes. A few species of bats have a short or long tail which is either partly enclosed by the tail (interfemoral) membrane or extends between the two legs.

Bats are found in all parts of the world except the Arctic and Antarctic regions. The order Chiroptera comprising of nearly 850 species is the second largest in the world coming right after rodents (mice, squirrels, etc.). *Table 1* lists the 18 different families of bats, the number of species, their distribution and the type of food they prefer.

## Classification

Bats are arranged into two major categories or suborders: Megachiroptera and Microchiroptera. As the name implies, *megachiroptera* represents large bats, in which 150 species are in-



**G Marimuthu, affectionately called "Batman" has made pioneering studies on the behaviour and ecology of Indian bats. How bats catch frogs has been a major theme of his research.**

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**Table 1. Diversity of bats with their classification, distribution and diet.**

***	Suborder			Nb. of
**	Super family	Distribution	Diet	species
*	Family			
***	<b>Megachiroptera</b>			
*	Pteropodidae (Old world fruit bats, flying foxes)	Old World Tropics	fruits, nectar and flowers	150
***	<b>Microchiroptera</b>			
**	Emballonuroidea			
*	Rhinopomatidae (Mouse-tailed bats)	Africa, Asia and Borneo	insects	2
*	Craseonycteridae (Hog-nosed bats)	Thailand	insects	1
*	Emballonuridae (Sheath-tailed bats)	Tropics	insects	44
**	Rhinolophoidea			
*	Megadermatidae (False vampire bats)	Old World Tropics	animals from insects to vertebrates	5
*	Nycteridae (Slit-faced bats)	Africa to Java and Sumatra	from insects to vertebrates	13
*	Rhinolophidae	Old World	insects	69
*	Hipposideridae (Old world leaf-nosed bats)	Old World Tropics	insects	56

Echolocation of bats is a mode of detecting obstacles, by emitting high frequency ultrasounds and analysing the echoes that hit and come back from the obstacles.

cluded. They are characterized by large eyes and small and simple ears with no echolocation ability. *Microchiroptera* consists of about 700 species. They are smaller in size, have small eyes and the ability to echolocate. Their ears are larger in size with a variety of elaborate



***	Suborder			No. of
**	Super family	Distribution	Diet	species
*	Family			
**	Phyllostomoidea			
*	Noctilionidae (Bulldog bats)	New World Tropics	insects and fish	2
*	Mormoopidae (Mustached bats)	New World	insects	8
*	Mystacinidae (Short-tailed bats)	New Zealand	insects, fruit, nectar, carrion	1
*	Phyllostomidae (New world leaf- nosed bats)	New World Tropics	insects, fruit, pollen, verte- brate's blood	123
**	Vespertilionoidea			
*	Natalidae (Funnel-eared bats)	New World Tropics	insects	4
*	Furipteridae (Thumbless bats)	New World Tropics	insects	2
*	Thyropteridae (New world disk- winged bats)	New World Tropics	insects	2
*	Vespertilionidae (Plain-nosed bats)	Worldwide	insects, fish and other vertebrates	283
*	Myzopodidae (Old world disk- winged bats)	Madagascar	insects	1
*	Molossidae (Free-tailed bats)	Tropics	insects	82

flaps and folds surrounding the ear canal in addition to the pinna. One common structure seen here is the tragus. It is a spear shaped part projecting upwards from the base of the ear up till the middle portion of the ear canal. The brown long-eared bat of Europe has





**Figure 1(a) (top left)** A colony of the Indian flying fox *Pteropus giganteus* roosting during daytime hanging from a banyan tree. **Figure 1(b) (top right)** The ‘flying fox’, so called since the facial features appear like those of a fox.

**Figure 2 (bottom left)** A portion of a large colony of the fruit bat *Rousettus leschenaulti*, occupying an unused temple.

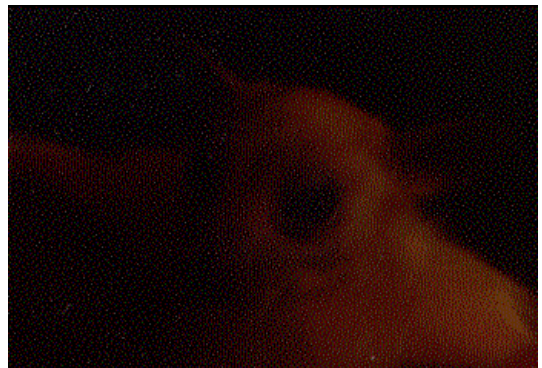
**Figure 3 (bottom right)** The short-nosed fruit bat *Cynopterus sphinx*.

large pinnae that are almost as long as its body. A few microchiropterans have a fleshy appendage surrounding the nostrils (Figures 4,5, and 11) known as ‘nose-leaf’. It aids in echolocation.

The size of the bats shows an amazing variety. The megachiropterans are commonly known as flying foxes. The Indian flying fox *Pteropus giganteus* is one of the largest bats in the world. It weighs about 1.5 kg. and has a wingspan of more than 1 metre. On the other hand the hog-nosed bat (microchiropteran) weighs only 2 g. and has a wingspan of about 13 cm. This is the smallest known mammal. It was discovered in 1973 in Thailand by a zoologist Kitti Thonglongyai and is hence named *Craseonycteris thonglongyai*.

### Habitats

Bats live in different types of habitats. The Indian flying fox *Pteropus giganteus* lives in colonies and hangs from the branches of trees such



as banyan, mango and tamarind. The majority of the microchiropterans live in dark caves and rocky crevices. Other places like temples, hollow trees, culverts, the underside of bridges and unused buildings are also occupied by bats. A few species modify large palm leaves by biting a series of holes across the centre of the leaf which makes the leaf hang like a tent. The bats hang from the apex underneath. The short-nosed fruit bat of India, *Cynopterus sphinx* modifies the twigs of the creeper plant *Vernonia*, shapes it into a dome-like tent and lives inside.

## Food

Regarding the type of food, the megachiropterans feed mainly on fruits like grapes, guavas, custard apples, bananas, papayas and chickoos. In addition they feed on leaves, petals and nectar. The microchiropterans generally feed on insects like moths, beetles, crickets and mosquitoes. In addition, a few species of bats feed on small animals like fish, frogs, mice and geckos. The vampire bats, which live only in Central and South America, feed upon the blood of large animals like horses, cows and pigs. Each night a vampire consumes 10-15 ml. of blood.

## Bats in India

In India, of the 12 species of fruit bats found, three are very common: the Indian flying fox *Pteropus giganteus*, the fulvous fruit bat *Rousettus leschenaulti* and the short-nosed fruit bat *Cynopterus sphinx*. About 100 species of microchiropteran bats live in different parts of India including the Eastern Ghats, Western Ghats, Himalayas and Andaman and Nicobar islands. A few species which live in South India are illustrated in the following section.

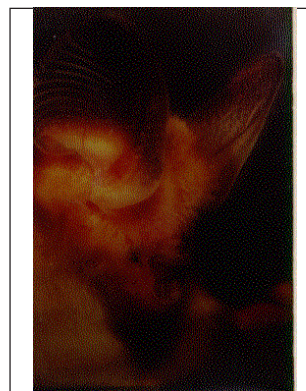
Ⓜ The Indian flying fox (*Pteropus giganteus*) as mentioned earlier lives in a colony consisting of hundreds of individuals (Figure 1a, b). They roost only in the branches of trees. Compared to other bats, *Pteropus* has fewer predators. Humans are potential predators and may hunt this species as a source of protein. However, we once observed a python capturing and feeding on this large-sized bat.

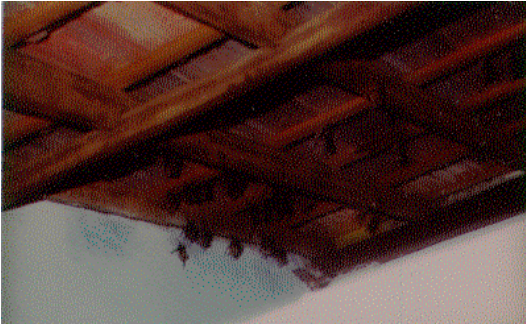


Figure 4 The leaf-nosed bat *Hipposideros speoris*.

In India, of the 12 species of fruit bats found, three are very common: the Indian flying fox *Pteropus giganteus*, the fulvous fruit bat *Rousettus leschenaulti* and the short-nosed fruit bat *Cynopterus sphinx*.

Figure 5 The leaf-nosed bat *H. fulvus*.





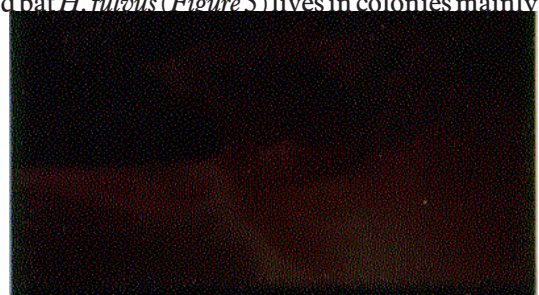
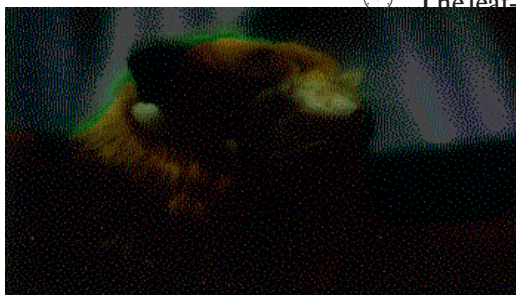
**Figure 6 (top left)** A portion of the colony of the leaf-nosed bat *H. ater*, occupying an unused building.



**Figure 7 (top right)** The sac-winged bat *Taphozous nudiventris kachhensis*.

**Figure 8 (bottom left)** An adult male tomb bat *T. melanopogon* has black fur, called a 'beard' at the ventral neck area.

**Figure 9 (bottom right)** The free-tailed bat *Tadarida aegyptiaca*.



⌚ The fulvous fruit bat (*Rousettus leschenaulti*) roosts in clusters in unused buildings and temples. It weighs about 110 g. *Figure 2* shows a section of a large colony of about 15,000 individuals occupying an unused temple.

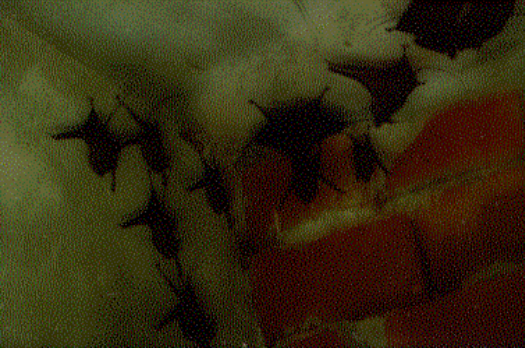
⌚ The short-nosed fruit bat *Cynopterus sphinx* (*Figure 3*) prefers foliage roosting. It roosts in trees under the dried leaves of Kitul palm, creeper plant *Vernonia*, etc. It weighs about 45-50 g. It lives in clusters of small colonies of about 10-30 individuals. The adult males are yellowish in colour.

The following are the echolocating and insect-eating bats:

⌚ The leaf-nosed bat *Hipposideros speoris* (*Figure 4*) lives in colonies in caves, temples, unused buildings, etc. It weighs about 11 g. The fur of the adults is yellow. It breeds all through the year but more young are born during September-October. The individuals do not cluster together.

⌚ The leaf-nosed bat *H. fulvus* (*Figure 5*) lives in colonies mainly





in caves. It weighs about 9 g. The fur of the adults is white on the ventral and yellow on the dorsal sides. They breed from April to July.

🕒 The leaf-nosed bat *H. ater* prefers unused buildings (Figure 6) for roosting during day time. It weighs about 7g. It breeds from September to December. A unique feature of the hipposiderid bats is that they frequently move their head and ears while roosting.

🕒 The sac-winged bat *Taphozous nudiventris kachhensis* (Figure 7) lives in vertical rock crevices and weighs about 40 g. Upon close human approach the individuals crawl on all fours and move into deeper parts of the crevice. These bats breed during October-November.

🕒 The tomb bat *Taphozhous melanopogon* (Figure 8) lives in caves and temples and weighs about 25 g. The adult males have well developed black beards. They breed during April-May.

🕒 The free-tailed bat *Tadarida aegyptiaca* (Figure 9) also lives in narrow rock crevices. It has wrinkled lips especially on the upper jaw. It weighs about 20 g. It has a short tail extending from the interfemoral membrane. The individuals in a colony are noisy even during the day. These bats breed during September.

🕒 The mouse-tailed bat *Rhinopoma hardwickei* (Figure 10) lives in caves and wide rock-crevices. It weighs about 17 g. It has a long and slender tail. It breeds twice a year in April and November.

**Figure 10 (top left) A colony of mouse-tailed bats *Rhinopoma hardwickei*, occupying an unused tunnel in a building.**

**Figure 11 (top right) The Indian false vampire bat *Megaderma lyra*.**



⌚ The Indian pygmy bat *Pipistrellus mimus* is the smallest bat in India, weighing about 3 g. It lives in all sorts of places with narrow cracks and crevices. It slips into these spots on its back and the underparts of its body which come in contact with stones or wood. Twin babies is a characteristic of this bat. An individual female gives birth to twins three times a year thus producing six infants in a year. This is a fast rate of reproduction among bats.

⌚ The Indian false vampire bat *Megaderma lyra* (Figure 11) lives in caves and unused buildings. It weighs about 40 g. It is carnivorous — feeds upon frogs, mice, geckos, larger insects, etc. It has large and medially fused pinnae which receive the weak sound created by the movement of its prey on the ground. It breeds from March to June.

Some of the species of bats mentioned above live in different parts of the same caves or buildings.

### Suggested Reading

- A Brosset. Bats of Central and Western India. *J. Bombay Nat. His. Soc.* 59 1-57, 583-624, 707-746. 1962.  
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And, the latest from  
 the world of honey-  
 bees and their dance  
 language. ...

Breakdance ? That's  
 bad language !



MOHAN DEVADAS

# Molecule of the Month

A 'Hexacationic' Benzene Derivative!

*Uday Maitra*

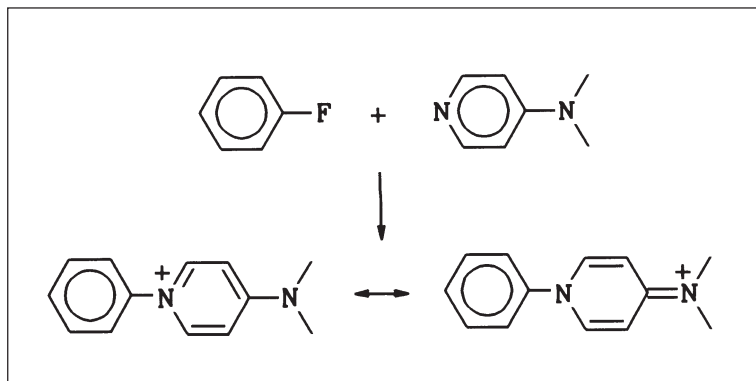
A stable hexacationic benzene derivative has been prepared by the displacement of all the fluorine atoms of hexafluorobenzene by six molecules of 4-dimethylaminopyridine.

Uday Maitra is a member of the Organic Chemistry Faculty at Indian Institute of Science.

The nucleophilic displacement of a halogen atom attached to an aromatic ring is not a very favourable process.<sup>1</sup> Polyfluorinated aromatics are interesting in this regard, since the fluorine atom can act as a leaving group, as well as an activating group. Hexafluorobenzene, therefore, has been a popular molecule to examine the displacement of all the fluorine atoms by nucleophiles.

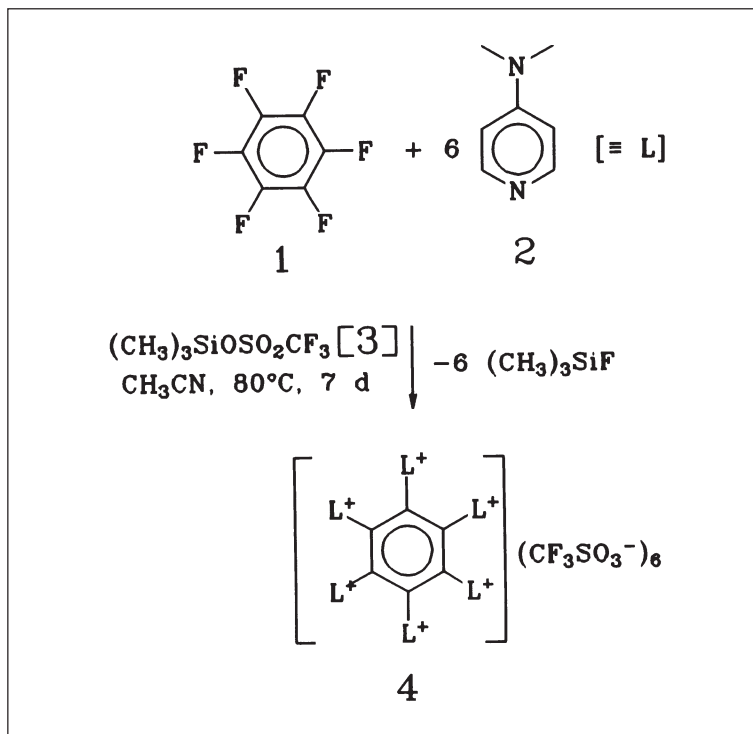
Imagine the (hypothetical) displacement of the fluorine atom of fluorobenzene by 4-dimethylaminopyridine (DMAP). The product of this reaction is a cation (an *onium salt*), which of course is resonance stabilized as shown in *Figure 1*. If we try to extend this idea with hexafluorobenzene, we would expect a hexa(onio)substituted benzene! At first sight this would appear to be impossible because of the accumulation of like charges. However, German chemists Robert Weiss and coworkers have

<sup>1</sup>Usually, aromatic compounds undergo *electrophilic* substitution reactions. Nucleophilic substitution on an aromatic ring requires electron withdrawing groups on the ring (or, special reaction conditions, as in a benzyne mechanism). Such 'activated' aromatic halides undergo nucleophilic substitution by an addition-elimination sequence. The negatively charged addition product is called a *Meisenheimer complex*.



**Figure 1** Resonance stabilization in N-phenyl-4-dimethylaminopyridinium salt.

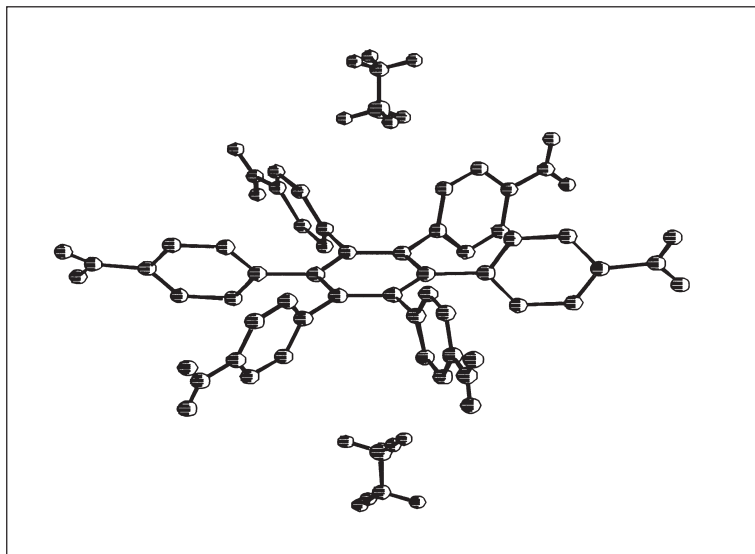
**Figure 2** Synthetic route to hexacationic benzene derivative **4**.



<sup>2</sup> Per(onio) refers to the complete substitution of all displacable groups ( $\text{F}^\square$ ) by the cationic group. For example, perfluoroalkyl group refers to a  $\text{C}_n\text{F}_{2n+1}$  unit.

recently shown that it is indeed possible (R. Weiss *et al.*, *Angew. Chem. Int. Ed. Engl.*, **1995**, *34*, 1319). They simply reacted hexafluorobenzene (**1**) and DMAP (**2**) with trimethylsilyl trifluoromethanesulfonate (TMS-triflate, **3**) in refluxing acetonitrile for seven days. What was formed in almost quantitative yield is the per(onio)<sup>2</sup> product **4**, with six triflate counter ions (*Figure 2*). Clearly, the formation of this product is aided by the formation of strong Si-F bonds in the other product of the reaction.

Salt **4** was crystallized from hot water, and the crystals so obtained were investigated by X-ray structure analysis. The pyridine rings were found to be almost orthogonal with respect to the benzene ring (with a torsion angle of  $80^\circ$ ; note that the analogous angle in hexaphenylbenzene is  $65^\circ$ ). Of the six triflate counter ions, two were found to be closely associated with the benzene ring (with one sitting above, and one below the benzene

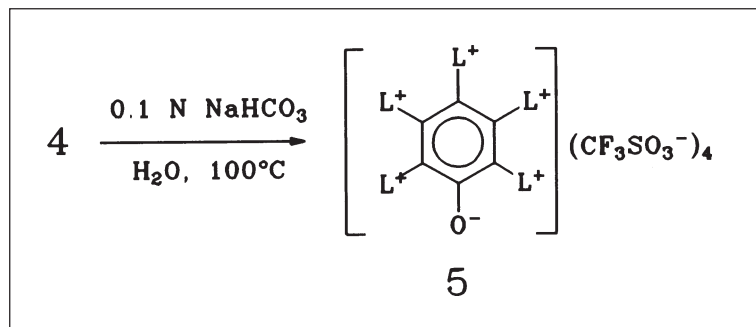


**Figure 3** Approximate ball and stick model of the molecular structure of **4** in the solid state. Only the two closely associated triflate anions are shown. The hydrogen atoms are omitted for clarity.

ring as shown in *Figure 3*).

How would you expect the reactivity of **4** to be? Since it is substituted by six cationic units, one would certainly expect greatly facilitated nucleophilic substitutions. In fact, if **4** is simply boiled with dilute  $\text{NaHCO}_3$  solution for 30 minutes, compound **5**, resulting from the displacement of one of the DMAP units, is formed (*Figure 4*). It is interesting to know that hexacyanobenzene also undergoes an analogous reaction under comparable conditions. The difference between **4** and hexacyanobenzene is that in **4** the activation is exclusively via electrostatic effects, whereas in hexacyanobenzene  $-M$  effect<sup>3</sup> plays an important role.

<sup>3</sup> The  $-M$  effect refers to electron withdrawing ability through resonance (mesomeric effect). Electron donation through resonance is represented by  $+M$ .



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**Figure 4** Facile nucleophilic displacement of one ligand from **4**.