**Table 1.** Effect of alcoholic extract of *M. pruriens* on stress-induced (6 h, 37°C) and alloxan-induced (20 mg/100 g body wt.) lipid peroxidation ($n$ = 6)

| | Lipid peroxidation inducing agent | |
|---|---|---|
| Group | Stress | Alloxan |
| Normal | 433.73 ± 26.60 | 433.73 ± 26.60 |
| Only extract | 313.33 ± 20.14 | 313.33 ± 20.14 |
| Only inducer | 822.92 ± 12.67 | 779.78 ± 46.22 |
| Extract + inducer | 447.81 ± 33.81 | 346.51 ± 23.13 |

Extract was given orally at the dose of 60 mg/100 g body wt. to the animals for 30 days.

radicals are considered to be important for normal physiology when produced in excess, they cause cellular damage. The radicals initiate a chain reaction of lipid and protein peroxidation by attacking on the double bonds of these molecules. About 40 diseases are now being considered as free radical-mediated. Most of them are metabolic, nervous or other old age diseases. Radical-induced oxidation of peptides generates reactive carbonyl derivatives (RCD), which are involved in rheumatoid arthritis, Alzheimer's disease, smoking-related pathologies, muscle dystrophy, re-perfusion injuries, etc.[12]. In our previous communication, we have reported the dose- and time-dependent response of *M. pruriens* on lipid peroxidation[8]. Its clinical use for several free radical diseases, especially the age-related male infertility and Parkinson's disease is well documented[2]. Its protective response on these *in vivo* models suggests two possibilities. Either it is acting on the nervous system or else it is removing the free radicals generated due to catecholamine and iron interaction[13]. Stress is another factor which induces lipid peroxidation, both directly at the tissue level and also through the high release of catecholamines[13]. Stress causes 50% increase in protein oxidation as measured by its carbonyl content and about 40% decrease in the glutathione content of the fundic stomach, suggesting oxidative damage by stress. It also causes time-dependent increase in the superoxide dismutase activity in mitochondria and a decrease in the glutathione peroxidase activity[14]. Since this extract is inhibiting the lipid peroxidation induced by alloxan and also by $FeSO_4$, it could be concluded that its action is through the removal of free radicals. The mechanism could be through the removal of hydroxyl radicals, which are produced by the interaction of catecholamines with iron or by direct chelation of free iron. *In vitro* studies have already shown its role in the removal of $^{\bullet}OH$ radicals. Effects on alloxan-induced model could be due to its property of trapping the superoxides, because it is reported that alloxan initiates the process of lipid peroxidation through the production of superoxides.

1. Chopra, R. N., Nayar, S. L. and Chopra, I. C., *Indian Medicinal Plants*, CSIR, New Delhi, 1956.
2. Vaidya, R. A., Allorkar, S. D., Seth, A. R. and Panday, S. K., *Neurology*, 1978, **26**, 179–186.
3. Pant, M. C., Uddin, I., Bhardwaj, U. R. and Tewari, R. D., *Indian J. Med. Res.*, 1968, **56**, 1808.
4. Santra, D. K. and Majumdar, D. N., *Indian J. Pharmacol.*, 1953, **15**, 60.
5. Upadhyay, A. K., Ph D thesis submitted to Banaras Hindu University, Varanasi, 1998.
6. Tripathi, Y. B. and Upadhyay, A. K., *J. Ethnopharmacol.*, 2001 (in press).
7. Tero, *J. Free Radials Biol. Med.*, 1988, **4**, 155–161.
8. Tripathi, Y. B. and Upadhyay, A. K., *Phytother. Res.*, 2001, **15**, 1–5.
9. Ohkawa, M., Ohishi, N. and Yagi, K., *Anal. Biochem.*, 1979, **95**, 351–358.
10. Flohe, L. and Otting, F., *Methods Enzymol.*, 1984, **105**, 93–104.
11. Rowley, D. A. and Halliwell, B., *Clin. Sci.*, 1983, **64**, 649–653.
12. Parks, D. A. and Gragner, D. N., *Am. J. Physiol.*, 1983, **245**, 285.
13. Guliaeva, N. V., Luzina, N. L., Levshina, I. P. and Kryzhanovski, G. N., *Bull. Eksp. Biol. Med.*, 1988, **106**, 660–663.
14. Sutkovoi, D. A. and Barabari, V. A., *Ukr. Biokhim. Zh.*, 1985, **57**, 79–81.

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# Bats of the Indian subcontinent – An update

Uncertainty on the exact number of taxa of chiropterans occurring in the Indian subcontinent has been a matter of debate[1–4]. One of the 26 mammalian orders, Chiroptera includes about 925 to 950 species of bats the world over in two rather unequal sub-orders – the Megachiroptera and the Microchiroptera[5,6]. The former is represented by only one family (Pteropodidae) which is restricted to the Old World tropics of Africa and Asia, while the latter includes 17 families (Rhinopomatidae, Emballonuridae, Craseonycteridae, Nycteridae, Megadermatidae, Rhinolophidae, Hipposideridae, Noctilionidae, Mormoopidae, Phyllostomidae, Natalidae, Furipteridae, Thyropteridae, Myzopodidae, Vespertilionidae, Mystacinidae and Molossidae)[7].

About a quarter of known mammals in India are bats. A recent checklist of Indian mammals[8] lists 105 species of bats belonging to 35 genera and 7 families. Agrawal[9] puts on record a total of 110 species of bats belonging to 36 genera and 6 families based on an earlier publication[5]. The most comprehensive and up-to-date revision of the Chiroptera of

Indian subcontinent was published in 1997 (ref. 6). According to this publication there are 119 species of bats belonging to 37 genera and 8 families in the Indian subcontinent encompassing India, Pakistan, Nepal, Sri Lanka, Maldives, Afghanistan, Tibet and northern Myanmar (Table 1). The authors of this work relied mainly on the earlier work of Corbet and Hill[10] for assigning taxonomic status of many species.

In India, a total of 110 species of bats belonging to 33 genera and 8 families have been recorded[6]. Species not recorded within Indian limits are *Rousettus aegyptiacus* [Megachiroptera: Pteropodidae], *Rhinolophus blasii* [Microchiroptera: Rhinolophidae], *Triaenops persicus*, *Asellia tridens* [Microchiroptera: Hipposideridae], *Eptesicus bottae*, *Eptesicus gobienensis*, *Eptesicus nasutus*, *Vespertilio murinus*, and *Philetor brachypterus* [Microchiroptera: Vespertilionidae].

The senior author had an opportunity to interact with Paul J. J. Bates of Harrison Zoological Museum, London and Y. P. Sinha of Zoological Survey of India in Madurai last year while attending the practical workshop on field techniques, taxonomy and conservation of bats of India and south Asia. During discussions with them, it was felt that there exist some uncertainties regarding the taxonomic status of a few species of bats and an update is required. This note attempts to update the information on bats of the Indian subcontinent.

Following the trend of accepting the latest publication and improvising thereon, we accept the number of species listed by Bates and Harrison[6] as 119 for the Indian subcontinent, including 110 species recorded within Indian limits, excepting the case of *E. gobiensis* Bobrinskii, 1926.

After careful observation of existing information on bats, we find that the taxonomic status of two species add to the existing confusion of the numbers that were given earlier[2,8]. The first is the Bellary leaf-nosed bat *Hipposideros schistaceus* Andersen, 1918 [Microchiroptera: Hipposideridae]. Bates and Harrison[6] considered it synonymous with *Hipposideros lankadiva indus*, based on its affinities in forearm and skull morphometry. The first taxonomic reference of *Hipposideros lankadiva* was given by Kelaart[11], while Andersen[12] described *Hipposideros indus* (based on a specimen from Gersoppa), *H. i. mixtus* (Kolar), *H. i. unitus* (Mundra, Sangor) and *H. schistaceus* (Vijayanagar). Presently valid is the taxonomic status of *H. lankadiva*, including subspecies *H. l. lankadiva* (relatively larger with average forearm length of 90.3 mm and condylo-canine length of 30.8 mm) from Sri Lanka and *H. l. indus* (with average forearm length of 83.0 mm and condylo-canine length of 27.4 mm) from India. The second species is *Eptesicus nilssonii* (Keyserling and Blassius, 1839) that has been included among Indian mammals[13,14] as endemic to India, recorded only from Jammu and Kashmir. The current taxonomic status of this species is uncertain due to lack of museum specimens. Bates and Harrison[6] do not mention anything about this species, yet the synonymies provided under the entry of *E. gobiensis* Bobrinskii, 1926 include mention of three subspecies *Eptesicus nilssonii gobiensis*, *E. n. centralasiaticus* and *E. n. kashgaricus*. Probably, following Corbet and Hill[10], Bates and Harrison[6] included it as *E. gobiensis* Bobrinskii, 1926, and whatever little information is provided is based on Chakraborty[15] who mentions about two possible specimens collected from Gilgit (presently in Pakistan-occupied-Kashmir) way back in 1879. These changes bring down two species and one species, respectively, from the total number of Indian chiropterans provided by Walker[2] and Nameer[8].

A recent publication by Sinha[16] refers to *Pipistrellus austenianus* Dobson, 1871 [Microchiroptera: Vespertilionidae] based on a specimen from Cherapunji, Meghalaya as a distinct species closely related

**Table 1.** Bats of Indian subcontinent*

| Sub-order | Family | No. of genus/genera | No. of species |
|---|---|---|---|
| Megachiroptera | Pteropodidae (Old World fruit bats) | 8 | 14 |
| Microchiroptera | Rhinopomataidae (mouse-tailed bats) | 1 | 3 |
| | Emballonuridae (sheath-tailed bats) | 1 | 6 |
| | Megadermatidae (false vampire bats) | 1 | 2 |
| | Rhinolophidae (horseshoe bats) | 1 | 16 |
| | Hipposideridae (leaf-nosed bats) | 4 | 15 |
| | Molossidae (free-tailed bats) | 2 | 4 |
| | Vespertilionidae (evening bats) | 19 | 59 |

*After Bates and Harrison[6].

**Table 2.** External, cranial and dental measurements (in mm) of *Pipisterellus abramus* and *Rhinolophus sinicus**

| | *Pipisterellus abramus* | | | *Rhinolophus sinicus* | | |
|---|---|---|---|---|---|---|
| | Mean | Range | *n* | Mean | Range | *n* |
| Head–body length | – | – | – | 49.4 | 43.0–52.5 | 16 |
| Tail length | – | – | – | 25.6 | 21.5–30.3 | 17 |
| Foot | 7.1 | 6.4–7.6 | 3 | 8.5 | 7.5–10.0 | 17 |
| Tibia | 11.9 | 10.8–13.0 | 3 | 19.5 | 18.5–21.6 | 18 |
| Forearm | 32.65 | 31.4–34.4 | 4 | 47.5 | 45.7–49.6 | 20 |
| Ear | – | – | – | 17.7 | 15.8–20.0 | 16 |
| Greatest length of skull | 12.4 | 12.1–13.2 | 3 | 20.8 | 20.2–21.5 | 15 |
| Condylo-basal length | 12.2 | 11.4–12.8 | 3 | – | – | – |
| Condylo-canine length | – | – | – | 17.8 | 17.4–18.4 | 16 |
| Zygomatic breadth | 8.2 | 8.2 | 1 | 10.5 | 10.1–11.0 | 20 |
| Breadth of braincase | 6.6 | 6.5–6.8 | 3 | 8.5 | 8.2–9.1 | 20 |
| Interorbital constriction | 3.95 | 3.8–4.1 | 2 | – | – | – |
| Postorbital constriction | – | – | – | 2.6 | 2.3–2.8 | 20 |
| Mandible length | 9.4 | 8.6–10.0 | 4 | 14.0 | 13.4–14.6 | 22 |
| Maxillary tooth row | 4.5 | 4.2–4.9 | 4 | 7.8 | 7.6–8.2 | 21 |
| Mandibular tooth row | 4.9 | 4.6–5.3 | 4 | 8.4 | 8.1–9.0 | 22 |
| Posterior palatal width | 5.5 | 5.0–6.0 | 4 | – | – | – |

*Recorded as *Rhinolophus rouxii sinicus* by Bates and Harrison[6].

to *P. savii* (Bonaparte, 1837) that was earlier synonymized to the latter species by Bates and Harrison[6].

The need to update the existing information on bats of the Indian subcontinent has been felt since the work of Bates and Harrison[6], as the authors inadvertently missed inclusion of Japanese pipistrelle *P. abramus* Temminck, 1840 [Microchiroptera: Vespertilionidae] in their work. Also important was to review the status of *Rhinolophus rouxii sinicus* [Microchiroptera: Rhinolophidae] in the light of the recent work carried out by Nikky Thomas of Harrison Zoological Museum (Bates, P. J. J., pers. commun.).

Temminck[17] based on a specimen from Nagasaki in Kyushu, Japan gave the first taxonomic reference of *P. abramus*. Although reported earlier to be present in India[18,19], the first authentic report of its occurrence is based on specimens from two localities in Arunachal Pradesh[20] that are present in the collection of Zoological Survey of India, Kolkata[21]. They were identified to be *P. abramus* by Hill and Harrison[22], though the earlier collector[20] identified it as a 'Common Indian Pipistrelle'. Further studies on specimens present in the National Zoological Collection of India (Zoological Survey of India, Kolkata) yielded two more records of this species from the Indian subcontinent – one from Uttar Pradesh [1 female, Allahabad, collected by J. Cockburn, 19 March 1977; misidentified as *Pipistrellus maurus* (= *savii*)], and another from northern Myanmar [1 female, Namkam, Northern Shan State, collected by R. B. S. Swell, 25 November 1926)[21]. External, cranial and dental measurements for this species on record are given in Table 2.

Nikky Thomas' work on the rhinolophids of Africa and Asia elevates the status of *R. r. sinicus* (subspecies) to *R. sinicus* (Bates, P. J. J., pers. commun.). Andersen[23] based on specimen from Chinteh in Anhui, China made the first taxonomic reference to *R. r. sinicus*. Within India, *R. sinicus* (formerly a subspecies) has been reported from the foothills of the Himalayas and north-east India, including Nagaland, Arunachal Pradesh and Meghalaya[6]. External, cranial and dental measurements for this species on record are given in Table 2.

Thus with the addition of these two species, namely *P. abramus* and *R. sinicus*, the chiropteran diversity in the Indian subcontinent is presently represented by 121 species belonging to 37 genera and 8 families, with 112 species belonging to 33 genera and eight families within Indian limits.


1. Varshney, R. K., *Curr. Sci.*, 1999, **77**, 734.
2. Walker, S., *Zoos'Print*, 1999, **1–14**, 1–6.
3. Krishnan, R., *Curr. Sci*., 2000, **78**, 10.
4. Varshney, R. K., *Curr. Sci.*, 2000, **78**, 11.
5. Koopman, K. F., in *Mammal Species of the World* (eds Wilson, D. E. and Reeder, D. M.), Smithsonian Institution Press, Washington, 1993, pp. 137–241.
6. Bates, P. J. J. and Harrison, D. L., *Bats of the Indian Subcontinent*. Harrison Zoological Museum Press, England, 1997.
7. Smith, J. D., in *Major Patterns of Vertebrate Evolution* (eds Hecht, M. K., Goody, P. C. and Hecht, B. M.), Plenum Press, New York, 1977, pp. 347–365.
8. Nameer, P. O., *Checklist of Indian Mammals*, Zoo Outreach Organization, Coimbatore,1998.
9. Agrawal, V. C., in *Faunal Diversity in India* (eds Alfred, J. R. B., Das, A. K. and Sanyal, A. K.), Envis Centre, Zoological Survey of India, Kolkata, 1998, pp. 460–469.
10. Corbet, G. B. and Hill, J. E., *Mammals of the Indo-Malayan Region*, Natural History Museum and Oxford University Press, London,1992.
11. Kelaart, E. F., *J. Ceylon Brch. R. Asiat. Soc.*, 1850, **2**, 216–217.
12. Andersen, K., *Ann. Mag. Nat. Hist.*, 1918, **2**, 374–384.
13. Molur, S., Nameer, P. O. and Walker, S. (eds) *Report on the Workshop on Conservation Assessment and Management Plan for Mammals of India*, Zoo Outreach Organization and Captive Breeding Specialist Group, Coimbatore, 1998.
14. Walker, S., *Zoos'Print*, 1999, **1–14**, 7–12.
15. Chakraborty, S., *Rec. Zool. Surv. India Misc. Publ. Occas. Pap. No. 38*, Zoological Survey of India, Calcutta, 1983.
16. Sinha, Y. P., *Rec. Zool. Surv. India Misc. Publ. Occas. Pap. No. 174*, Zoological Survey of India, Kolkata, 1999.
17. Temminck, C. J., *Monographies de Mammalogie tome 2*, Leiden, France, 1840.
18. Dobson, G. E., *Monograph of the Asiatic Chiroptera and Catalogue of the Species of Bats in the Collection of Indian Museum*, Taylor and Francis, London, 1876.
19. Thomas, O., *Proc. Zool. Soc. London*, 1886, **1886**, 54–79.
20. Robinson, H. C., *Rec. Indian Mus.*, 1913,**8**, 85–98.
21. Das, P. K. and Sinha, Y. P., *J. Bombay Nat. Hist. Soc.*, 1995, **92**, 252–254.
22. Hill, J. E. and Harrison, D. L., *Bull. Br. Mus. Nat. Hist. (Zool.)*, 1987, **52**, 225–305.
23. Andersen, K., *Proc. Zool. Soc. London*, 1905, **2**, 75–145.


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