Small Mammal Mail

Newsletter celebrating the most useful yet most neglected Mammals

for CCINSA & RISCINSA -- Chiroptera, Rodentia, Insectivora, & Scandentia

Conservation and Information Networks of South Asia

Volume 4 Number 1 **ISSN 2230-7087** **February 2012**

Contents

Members

CCINSA Members since Jun 2011

Dr. Kalesh Sadasivan, PRO
Travancore Natural History Society,
Thiruvananthapuram, Kerala
kaleshs2002in@gmail.com

Mrs. Shagufta Nighat, Lecturer & PhD Scholar, PMAS Arid Agri. Univ. Rawalpindi, Pakistan
shaguftanighat@yahoo.com

Mr. Naeem Akhtar, Student
PMAS Arid Agri. Univ., Rawalpindi, Pakistan. smilenaeem@gmail.com

Ms. Rabia Zaman Bhatti, Student, PMAS Arid Agri. Univ., Rawalpindi, Pakistan. rabia.zaman.bhatti@gmail.com

Ms. Sara Zafar, Student
PMAS Arid Agri. Univ., Rawalpindi, Pakistan. manhaseher@gmail.com

Dr. Muhammad Sajid Nadeem, Asst. Prof., PMAS Arid Agri. Univ. Rawalpinidi, Pakistan
sajidaaur@gmail.com

Mr. Sreehari Raman, Research Associate, Kerala Agri. Univ., Thrissur, Kerala. sree.forestry@gmail.com,

Ms. Mega Ganeshan, Nano Promotional Officer, Practical Action, Colombo, Sri Lanka
wildmega@gmail.com

Mr. Pubudu Darshana Weerarathna, Project Manager, Ruk Rakaganno (The Tree Society of Sri Lanka), Colombo, Sri Lanka. wildpubudu@gmail.com

Mr. Murali Krishna, Research Scholar, NERIST, Nirjuli, Itanagar, Arunachal Pradesh. murali7murali@gmail.com

Dr. Ashish Diliprao Tiple, Head & Asst. Prof., Vidhyabharati College, Wardha, Maharashtra
ashishdtiple@gmail.com

Ms. Shriranjani Iyer, Student, Seeranaickenpalayam, Coimbatore, Tamil Nadu. shriranjani8@gmail.com

Mr. Rahul D. Prabhukhanolkar, Freelance Ecologist, Belgaum, Karnataka
pkrahul85@gmail.com

Ms. Sajida Noureen, Student, PMAS Arid Agri. Univ., Rawalpinid, Pakistan
wish_hope5@yahoo.com

Mr. Sushil Kumar Barolia, Research Scholar, M.L.S University, Udaipur, Rajasthan. harshitasushil@yahoo.com

Mr. Md. Nurul Islam, Student, Chittagong Vet. & Animal Sci. Univ., Chittagong, Bangladesh
nurul.dvm@gmail.com,

RISCINSA Members since Feb2011

Mr. K.L.N. Murthy, Prog. Officer, Centre for Environment Education, Ahmedabad, Gujarat
klnmurthy25@gmail.com,

Mrs. M.S. Vidia Panicker, Asso. Prof., Sree Narayana College, Thiruvananthapuram, Kerala
vidiasha@gmail.com

Ms. Saba Yasmin, Student, PMAS Arid Agri. Univ., Rawalpindi, Pakistan
znsaba.yasmin13@gmail.com

Dr. Muhammad Sajid Nadeem, Asst. Prof., PMAS Arid Agri. Univ., Rawalpinidi, Pakistan. sajidaaur@gmail.com

Mr. Sreehari Raman, Research Asso., Kerala Agri. Univ., Thrissur, Kerala
sree.forestry@gmail.com,

Ms. Mega Ganeshan, Nano Promotional Officer, Practical Action, Colombo, Sri Lanka. wildmega@gmail.com

Mr. Pubudu Darshana Weerarathna, Project Manager, Ruk Rakaganno (The Tree Society of Sri Lanka), Colombo, Sri Lanka. wildpubudu@gmail.com

Ms. Shriranjani Iyer, Student, Seeranaickenpalayam, Coimbatore, Tamil Nadu. shriranjani8@gmail.com

Mr. Murali Krishna, Research Scholar, NERIST, Nirjuli, Itanagar, Arunachal Pradesh. murali7murali@gmail.com,

Dr. Ashish Diliprao Tiple, Head & Asst. Prof., Vidhyabharati College, Wardha, Maharashtra. ashishdtiple@gmail.com

Small Mammal Field Techniques Training, Thrissur, Kerala

B.A. Daniel[1] and P.O. Nameer[2]

Participants, organisers, coordinators and resource persons

ZOO/WILD and its networks CCINSA and RISCINSA organized five-days hands on training workshop hosted by Department of Wildlife, College of Forestry, Kerala Agricultural University. Thirty five bat and rodent researchers from India (Andhra Pradesh, Arunachal Pradesh, Assam, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Rajasthan, Sikkim, Tamil Nadu), Sri Lanka and Nepal attended this programme. Prof. Paul Racey, Visiting Professor, University of Exeter in Cornwall, Co chair, Bat Specialist Group of IUCN's SSC, Dr. Mike Jordan, Senior Conservation Advisor, National Zoological Gardens of South Africa, Regional Chair IUCN SSC Reintroduction Specialist Group were the lead trainers. Dr. Sanjay Molur, ZOO, Dr. P.O. Nameer and Dr. N. Singaravelan handled sessions. This training was sponsored by Chester Zoo, Knowsley Safari Park, Columbus Zoo and Conservation Breeding Specialist Group, USA.

During the inaugural, Dr. Nameer, College of Forestry, Kerala Agricultural University, host of the workshop, welcomed the gathering. He said 'this is an extremely important exercise, hands on training workshop in small mammals, that we will be having for the next five days. Small mammals are an important group of mammals because they constitute about 60-70% of mammalian diversity of the world. In spite of this, very little is known about them. ZOO is organizing training workshops on this since 2000 and organized training programmes in all south Asian countries and KAU is hosting for the second time. ZOO trained many researchers and they are generating small mammal information from all South Asian countries'.

Dr. Mohan Kumar, Dean, College of Forestry said 'I hope this training will produce a critical mass of a research workers and Scientist in the area of small mammal conservation to work in South Asia and they carry forward the research for this neglected group of organism".

Prof. Pushpa Latha, Registrar, KAU while inaugurating the workshop said that the importance of this training is very clear since every creature has a role in its ecosystem. Though small mammals constitute 60-70% of all mammals they are highly neglected. From the time memorial we are worshipping some rodents the vehicle of Lord *Ganesha* but still we have many myths related to bats and rodents. This workshop will help to save the beautiful creature of nature.

Sally Walker, Founder CCINSA / RISCINSA and ZOO during her talk shared the history of these workshop series. She said, this kind of workshop started with the IUCN Red List exercise in India. ZOO was interested in Conservation Assessment and Management Plan workshop which is a creation of Dr. Ulysses Seal who was the Chairman of IUCN SSC CBSG. In 1996 Government of India conducted Biodiversity Conservation Prioritization Project BCPP and as a part of it ZOO offered to help assess all the species of India. We divided species assessment in to seven workshops and one of the workshops was mammals. I learned that rodents and bats are the most speciose and actually there were very few experts we could call. Later after CAMP workshops ZOO started networks for lesser known groups and I started a network for bats and rodents. We combined bat and rodents since bats can be studied during night time and rodents during day. We had this workshop combining Chiroptera and different rodents.

[1]Scientist, ZOO, Coimbatore. badaniel@zooreach.org
[2]Asst. Prof. Kerala Agricultural University, Kerala. nameerpo@gmail.com

Dr. P.O. Nameer welcoming the gathering

Paul and Mike were our resource persons for all our workshops. I feel that animals should not be mistreated. Our trainers teach us to treat the animals well. She thanked KAU for hosting this training for the second time.

Paul Racey expressed his happiness to be here after eight years. The last workshop was very successful that generated interest from mammal researchers from all over India. He also said that IUCN has many commissions and SSC is one of the commissions. Bat Specialist group is one of the SG of SSC. Priority of BSG is action planning for conservation priority. Action plans have 20 major recommendations. The current priority of BSG is to revise the action plans. It will be a web based plan and will be updated systematically.

Mike Jordan said it is a pleasure to be back to Kerala. This training has created scientists producing information about small mammals in India and South Asia. There is so much to be achieved to save this group of species.

Sanjay thanked Kerala Agricultural University, staff and students for their assistance in organizing the training. He also thanked Knowsley Safari Park, Chester ZOO and Columbus zoo for their funding support and to CBSG as our mentor.

The programme started with self-introduction by all participants.

As an **introduction to small mammals**, Mike Jordan spoke about biodiversity of non-volant small mammals of the orders rodentia, insectivora and scandentia. He stressed upon the disparity and the neglect that is being received by the small mammals, though they account for about 55% of the mammals of the world. Paul Racey, as an introduction to volant small mammals gave a detailed introduction of bats with classification, general features, taxonomy, distribution ecology, feeding ecology etc. He added that first fossil bat was found 50MYa that belonged to Eocene period that had very long wings developed long ago. They already had echolocation. As on 2010 about 1124 bat species has been reported which accounts about 20% of mammals. There are still more to be described. Chiroptera is classified into Megachiroptera – 1 Family Pteropidae (old world fruit bats) and Microchiroptera – 17 families. Some recent editors do not use mega and micro instead they use Yinpterochiroptera and Yangochiroptera based on molecular genetics data.

Field techniques:
For non-volant different types of traps used for the study of rodents was explained. During the training live and single capture traps of varying dimensions were used. All aspects of Sherman trap was explained including cost and trap maintenance. Other traps generally used for rodent work such as Wire mesh traps, multi-capture traps such as

Dr. Paul Racey demonstrates sexing of bats

Dr. Mike Jordan explains handling of rodents

Trainers practicing setting-up mist net to catch bats

Dr. P.O. Nameer demonstrates dry skin preservation techniques on a rat

Uglan Traps were also discussed. With regard to volant mammals different types of nets to survey bats such as mist nets. Harp nets, canopy nets, flick nets and use of bat detectors were explained. Foraging strategy of bats was explained.

Demonstration on trap setting and mist nets:

Entire evenings of all workshop days were utilized to set up traps or mist nets. The Sherman traps set was monitored periodically and trapped rodents were used to learn handling, species identification, sexing, marking, weighing, age determination and breeding conditions of the species. After marking the species were released back in the same location caught. During trap setting, details about preparation of the baits for setting the traps was discussed. The participants were divided into groups and were taken to the nearby plantation areas for the demonstration of setting of traps. A total of about 40 traps were set at different plantation areas. Similarly mist net setup was demonstrated in orchards with in KAU campus and the participants in groups learned to set up mist nets during evenings. Identification of habitats and sampling methodologies were discussed during demo practice. Among non-volant mammals, *Rattus rattus, Mus booduga, Bandicoota bengalensis,* and among Volant mammals, *Cynopterus sphinx, Hipposideros ater*, *Hipposideros speoris, Rhinolophus rouxii* were caught.

As part of practice for identifying the species caught, dichotomous key and character matrix for identification of bats in the field was taught. During the course of bat examination, sexing, the breeding condition of the bats such as lactating females, pregnancy and age estimation.

Marking techniques:

During classroom and field sessions different methods of marking the bats such as temporary marking (marker pen, varnish), permanent marking (forearm bands/rings, necklace, tattooing, bleaching the fur) were explained and demonstrated. Study of the foraging behaviour of the bats, radio-tracking studies, use of bat detectors etc were explained by Paul. Mike explained methods of marking of

rodents such as microchipping, ear tagging and fur clipping.

Dry skin preservation of small mammals:
Maintaining voucher specimens are of great importance in taxonomy studies. Dry skin preservation help to retain the original colour and shape of the animal for a longer period and also the technique is very simple that require limited equipments like a pair of scissors and borax powder. P.O. Nameer demonstrated the dry skin preservation techniques of rodents (carding) for storage in the museum.

Animal handling:
Welfare of animals is a very important component in research who may do not care for welfare. The trainers explained about the welfare needs of the animal. Underlying principles in animal handling and restrain is that the same should be safe to the human as well as to the animal.

Pollination by rodents and bats:
Interaction between animals and plants are mutualistic. Among mammals fruit bats and some mammals are pollinators. Frugivorous and nectarivorous bats pollinate and disperse seeds of hundreds of species of plants. Dr. N. Singaravelan gave a talk on pollination ecology of bats giving examples and case studies reported from different parts of the world. He also gave a demonstration on pollination aspects.

Dr. Sanjay Molur, gave a presentation on methods on population estimation of small mammals based on his thesis work. He also explained about the small mammal networks Chiroptera Conservation and Information Network of South Asia (CCINSA) and Rodentia, Insectivora, Scandentia Conservation and Information Network of South Asia (RISCINSA).

At the end of the workshop the participants committed to contribute for the conservation of small mammals. At the end all participants received a certificate of participation.

A student of KAU learns handling bat

A session on rodent handling and sexing by Dr. Mike Jordan

The Nilgiri striped squirrel (*Funambulus sublineatus*), and the Dusky striped squirrel (*Funambulus obscurus*), two additions to the endemic mammal fauna of India and Sri Lanka

Rajith Dissanayake*

Some forty four mammal species are recognized as endemic to India (Alfred and Chakraborty 2002); that number is now extended by one. The Sri Lankan endemic mammal count goes up to seventeen (Dissanayake and Oshida 2012). Both additions are from the genus *Funambulus* (palm squirrels and allies) represented by highly voluble stripy squirrels that often frequent urban habitats.

Funambulus like so many diurnal squirrel groups could be regarded as honorary birds for the region (given they are small, sometimes noisy, associate with birds and as birds command several orders of magnitude more interest by nature watchers) though its taxonomy has lagged far behind any avian counterparts. The genus is largely restricted to the Indian subcontinent except for the northern palm squirrel, *F. pennantii*, that extends in range to Iran and has been introduced to Australia. To be fair, the two species from the title were categorically regarded as endemics for the relatively brief interlude of the First World War from 1914 until they were once more lumped together, in 1918.

The "Dusky striped" squirrel (*F. sublineatus*) prior to 1914 comprised the smallest species in the genus represented by a dark brown, almost blackish, relatively unknown and elusive squirrel, typically from montane, forest habitats in the wet-zone of Sri Lanka and the Western Ghats of India inclusive of the Nilgiri hills. Unlike other members of the genus their stripes are the least prominent, being only marginally paler than the overall, dorsal pelage and their ventral colouration is typically an olivaceous yellow. On the basis of work from the Bombay Natural History Society mammal survey, (Ryley 1914) the two squirrels were split into two species, *Funambulus trilineatus* in Sri Lanka and *F. sublineatus* in India. Shortly thereafter, *F. trilineatus* was renamed in honour of Kathleen Ryley as *F. kathleenœ* (Thomas and Wroughton, 1915) and thus it remained until in 1918 (Robinson and Kloss) when the two species were once more united, ranked as subspecies: the Sri Lankan form being re-designated *F. sublineatus obscurus* following a rather sketchy German species description (Pelzeln and Kohl 1886) that legally accorded priority to *obscurus* over the names discussed by Thomas and Wroughton in 1915.

The subspecies together have received little attention in the scientific literature. Molecular work from my PhD research (Dissanayake 2008) was expected to indicate these two species as sister groups given obvious similarities. Surprisingly, *F. obscurus* (as *F. sublineatus obscurus*) was actually the molecular sister species of Layard's squirrel, *F. layardi*, also from Sri Lanka whereas *F. sublineatus* was associated with other Funambulines in India. As Dr. William Duckworth (Lao PDR) pointed out during the composing of the paper by myself and professor Oshida, the molecular similarity on the basis of mitochondrial DNA alone could indicate that introgression had taken place. In other words, the mitochondrial DNA of

Layards squirrel had replaced that originally in *F. layardi* had replaced that originally in *F. obscurus*, eliminating any apparent mitochondrial relationship to *F. sublineatus*; a phenomenon observed elsewhere. Morphologically, the two forms of "*F. sublineatus*" (*sensu lato*) are still statistically close though they are significantly different in body size and pelage, rather like similar species of warbler that were not easily told apart, but were subsequently separated using their songs or geography. In the Indian form, *F. sublineatus,* the stripes are clearer, shorter and closer together than in the Sri Lankan *F. obscurus*. *Funambulus sublineatus* is also a little smaller, though with a longer tail than its counterpart. We have no reliable mass comparison (let alone vocalisations) given there is only one recorded weight measure for the Indian species to go on (see below); on this basis, the Indian form is much smaller, around 40g as opposed to around 70g for *obscurus*. It seems highly likely (as Dr Duckworth would be prepared to bet) that the two species, so long regarded as similar are linked together through their nuclear DNA,

***c/o The Mammal Section, Natural History Museum, Cromwell Road, London, SW7 5BD; rajith@clara.co.uk**

though for reasons to be made clear, vindicating this will remain an uphill struggle.

The mitochondrial sister species of *F. obscurus*, Layard's squirrel (*F. layardi*) was and is still to some extent regarded as existing in India. Our paper supports alternative publications that suggest that this colourful animal is peculiar to Sri Lanka, akin to the equally colourful squirrels in the species now known as *Funambulus tristriatus*, the Western Ghats squirrel or the Jungle striped squirrel that is endemic to India.

It would indeed be a surprise if future nuclear DNA work indicates the former subspecies of *F. sublineatus* to be as separate as the mitochondrial DNA tree indicates them to be (if introgression had not happended, it seems likely it did). Recent work does however indicate that some animals such as frogs that were thought to be conspecific between India and Sri Lanka, were actually only superficially similar and not closely related, a relationship described as homoplasy. Overall, such observations highlight the Western Ghats and southern Sri Lanka as two close but distinct biodiversity hotspots.

The common name Dusky striped squirrel was coined by Sterndale in 1884 though it may be more appropriate to use two separate names for the two species, rather than simply Indian dusky striped squirrel and even worse (due to its length), the Sri Lanka dusky striped squirrel. I tentatively propose the re-use of Grigg's (1880) Nilgiri striped squirrel for India, given that *F. sublineatus* has long been associated with the Nilgiris and re-deploying Dusky striped squirrel to define *F. obscurus*. If using this name for both species (using only geography to separate them), the jury remains out as to their historically presumed alliance.

In Sri Lanka I have observed and filmed the dusky striped squirrel as one of the most active in the genus, that dashes about both on the ground and tree-tops, foraging under bark presumably for insects. Zoologists have monitored the animal has been monitored on the Island by zoologists since 1914 and scientists have access to its DNA from fresh material held at the Natural History Museum London. We still know very little about this squirrel. Its counterpart in India has fared far worse given there is no available fresh molecular material for DNA analysis (dry DNA material is both challenging and the results may be questioned) and this cannot be procured outside India legally.

The best scientific, life descriptions of *F. sublineatus* in English date to Ryley, 1913:

… weight of a male $1^1/_2$ ounces.
"Apparently local and by no means plentiful in Coorg. Mr. Cuthell informs me that these squirrels occur in pairs … in the thickest forest … Said to be extremely shy and difficult to discover … making off at the slightest sound." – G. C. S.

And a pithy paragraph from Hutton in 1949 of four sentences terminating in … "In the forests at the south of the Varushnaad, however, it is quite common up to 5,000 ft." The best work so far perhaps is by Delessert (1843), in French with a splendid colour lithograph (pictured here). The details on it, such as the configuration of the footpads would not easily be available now, even from India due to restrictions on research.

Considering the lack of work, not just on the species, but the genus overall since the 1960s, the group holds several taxonomic puzzles that will probably resolve themselves over time. There is now the opportunity for more interest in the underrated Nilgiri striped squirrel, India's new endemic and its Sri Lankan twin. Both are confined to shrinking rainforest habitats and being visibly appealing (along with various endemic birds), potentially to be regarded as the subcontinent's smallest flagship mammalian representatives.

References

Alfred, J.R.B. & S. Chakraborty (2002). *Endemic mammals of India - occasional paper No. 201*. *Zoological Survey of India*, Kolkata.
Delessert, A. (1843). Souvenirs d'un voyage dans l'Inde exécuté de 1834 à 1839 Paris: Fortin, Masson et cie.
Dissanayake, R. (2008). A taxonomic revision of *Funambulus* (Mammalia, Sciuridae) [Unpublished PhD]. School of Health and Life Sciences, Kings College, University of London, UK.
Dissanayake, R & T. Oshida (2012). The systematics of the dusky striped squirrel, *Funambulus sublineatus* (Waterhouse, 1838) (Rodentia: Sciuridae) and its relationships to Layard's squirrel, *Funambulus layardi* (Blyth, 1849). *Journal of Natural History* 46(1-4): 91–116.
Grigg, H.B. (1880). *A Manual of the Nilagiri District in the Madras Presidency*. Government Press, Madras
Pelzeln, A.V & F.F. Kohl (1886). Ueber eine Sendung von Saugethieren und Vogeln aus Ceylon. *Verhandelungen zool - bot Ges Wien* 35: 525–528.
Robinson, H.C & C.B. Kloss (1918). A nominal list of the Sciuridae of the oriental region with a list of specimens in the collection of the Zoological Survey of India. *Records of the Indian Museum* 15(4):171–254.
Ryley, K.V. (1914). Scientific results from the Mammal Survey VI - (D.) *Funambulus trilineatus*, Kel., The Newera Eliya ground Squirrel. *Journal of the Bombay Natural History Society* 23: 662.
Sterndale, R.A. (1884). *Sterndale's Mammalia of India.* (Ed. by Frank Finn, issued 1929 and 2002). Cosmo Publications (2002), New Delhi.
Thomas, O & R.C. Wroughton (1915). Results from Mammal Survey C. - The Singhalese species of *Funambulus*. *Journal of the Bombay Natural History Society* 24(1): 29–66.

New site records of the Indian Giant Squirrel *Ratufa indica* and the Madras Tree Shrew *Anathana ellioti* (Mammalia, Rodentia and Scandentia) from the Nagarjunasagar-Srisailam Tiger Reserve, Andhra Pradesh

Aditya Srinivasulu[1] and C. Srinivasulu[2*]

The Nagarjunasagar Srisailam Tiger Reserve (15°53' N – 16°43'N and 78°30'E – 79°28'E) is located on the biodiversity rich Nallamala Hills (Srinivasulu and Srinivasulu, 2008). The vegetation of the Reserve is primarily of Southern tropical dry deciduous forest type (Champion and Seth, 1968; Srinivasulu, 2001) and consists of tree elements belonging to the genera T*erminalia, Acacia, Strychnos, Anogeissus, Adina, Hardwickia, Aegle, Dalbergia, Madhuca*, etc.. Open forests and grasslands comprise about 50% of the core area of the reserve. In the buffer area, nearly 30% of land cover is under agricultural cultivation.

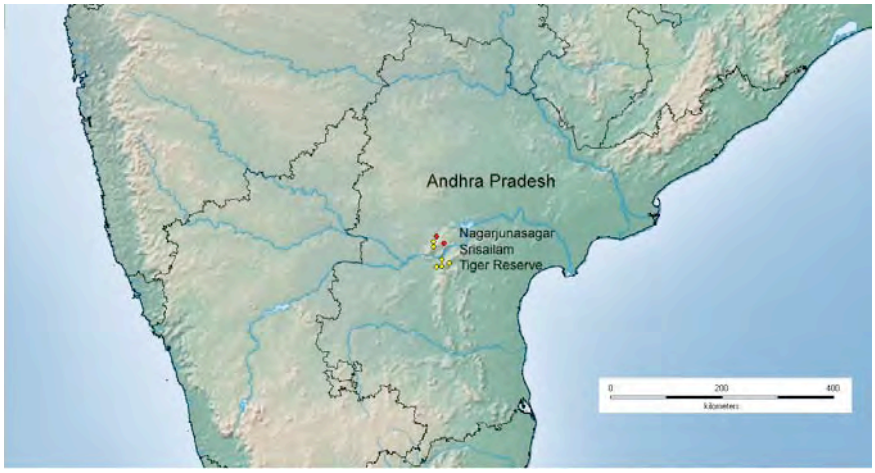


Fig. 1. Distribution of Indian Giant Squirrel *Ratufa indica* in Nagarjunasagar Srisailam Tiger Reserve; past records (yellow circles) and recent records (red circles).

While conducting a short survey to document biodiversity in the Reserve between 12th and 15th January 2012, we observed two species of macaque, two species of langur, one species of mongoose, one species of tree shrew, three species of squirrels, one species of rat and one species of deer. Besides this, a rich avian diversity was also observed. Through this note we report new site records of two Indian endemic species of non-volant small mammals in the Nagarjunasagar Srisailam Tiger Reserve, Andhra Pradesh.

Fig. 2. Indian Giant Squirrel *Ratufa indica* near Mallela Theertham, Nagarjuanasagar Srisailam Tiger Reserve, Andhra Pradesh

Indian Giant Squirrel *Ratufa indica* (Mammalia, Rodentia, Sciuridae)

The Indian Giant Squirrel (*Ratufa indica*) is a Vulnerable species and is known to inhabit the tropical and subtropical forests of the Western Ghats, Eastern Ghats and the forests of the Godavari River basin and also the tropical forests of Jharkhand and Madhya Pradesh (Molur *et. al*. 2005). In the Reserve, this species has been reported from Bairluty, Rollapenta, Peddacheruvu and Peddachama in Kurnool District and Kolhapur, Appapur and Farahabad in Mahabubnagar District (Molur *et. al.* 2005) (Fig. 1). During the survey, we sighted two Indian Giant Squirrels, one at Mallela Theertham (16o16' N, 78o51' E) feeding on the tender leaves and fruit of fig trees (Fig. 2) and the other at Uma Maheshwaram (16°21' N, 78°43' E) (Fig. 3), moving through the tree canopies. Interestingly, both these sites are highly disturbed due to tourism. Earlier surveys in these areas did not yield any sightings. The Indian Giant Squirrel has been earlier sighted feeding on trees adjacent to roads both at Bairluty and Rollapenta between 1998 and 2002, and were perceived as shy individuals, fleeing on detecting human presence but showing no reaction to passing vehicles. Contrary to this, the individuals sighted recently seemed more tolerant towards human presence.

[1]Biodiversity Research and Conservation Society, Hyderabad, Andhra Pradesh – 500011, India.
[2]Department of Zoology, Osmania University, Hyderabad, Andhra Pradesh – 500007, India. *Email: hyd2masawa@gmail.com

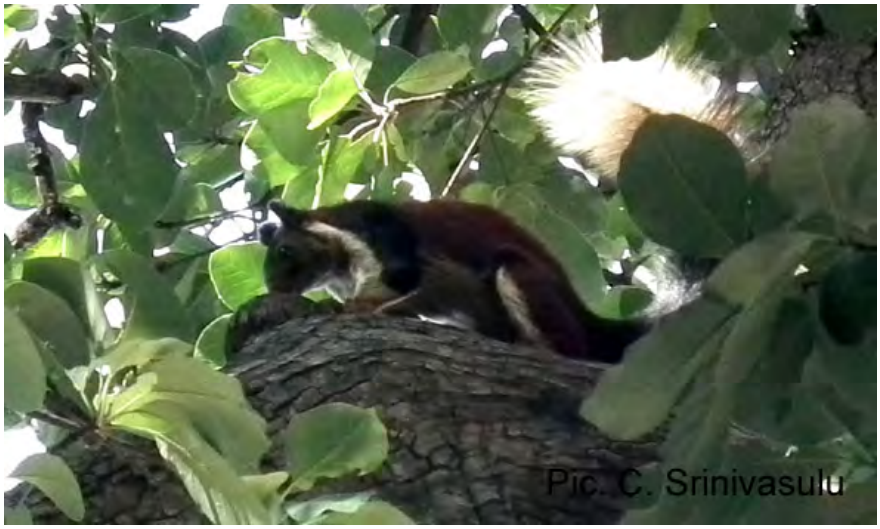


Fig. 3. Indian Giant Squirrel *Ratufa indica* near Uma Maheshwaram, Nagarjuanasagar Srisailam Tiger Reserve, Andhra Pradesh

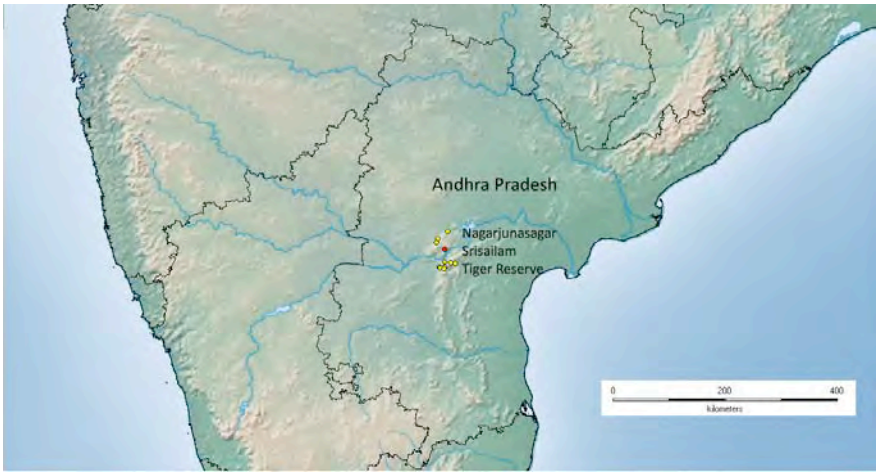


Fig. 4. Distribution of Indian Tree Shrew *Anathana ellioti* in Nagarjunasagar Srisailam Tiger Reserve; past records (yellow circles) and recent records (red circles).

Indian Tree Shrew *Anathana ellioti* (Mammalia, Scandentia, Tupaiidae)

The Indian Tree Shrew (*Anathana ellioti*) is a near threatened species and is known to inhabit the tropical and subtropical forests of the Western Ghats in Maharasthra, Kerala and Tamil Nadu, Eastern Ghats of Tamil Nadu, Andhra Pradesh and Orissa, the forests of the Godavari River basin in Maharasthra and Andhra Pradesh and a few sites in Madhya Pradesh and Jharkhand (Molur *et. al*. 2005). In the Reserve, this species has been reported from Bairluty, Chintala, Peddamanthanala, Peddacheruvu, Rollapenta, Thummalabailu in Kurnool District, Chinnamanathanala in Prakasam District and Farahabad, Kolhapur, Padra and Uma Maheswaram in Mahabubnagar District (Molur *et. al*. 2005) (Fig. 4). During the survey, we sighted one Indian Tree Shrew in a valley (16°10′ N, 78°49′ E) between Domalapenta and Vatavarlapally while perched on a curbstone next to a culvert on the side of the road. We could not photograph this individual as it escaped into the dense undergrowth.

Acknowledgements

As acknowledges Ms. Sirisha Kishore and other faculty of St. Peter's High School, Secunderabad for encouragement; CS acknowledges DBT, Government of India for research grant and facilities extended by Osmania University, Hyderabad.

References

Champion, H.G. & S.K. Seth (1968). *A Revised Survey of Forest Types in India*. Manager of Publications, Government of India, New Delhi.

Srinivasulu, C. (2001). Chital (*Axis axis Erxleben*, 1777) herd composition and sex ratio on the Nallamala Hills of Eastern Ghats, Andhra Pradesh, India. *Zoo's Print Journal* 16(12): 655–658.

Srinivasulu, C. & B. Srinivasulu(2008). Nallamala Hills, Andhra Pradesh: A biodiversity conservation priority area in southeastern India. *Current Science* 95(6): 703–704.

Molur, S., C. Srinivasulu, B. Srinivasulu, S. Walker, P.O. Nameer & L. Ravikumar (2005). *Status of South Asian Non-volant Small Mammals: Conservation Assessment and Management Plan (CAMP) Workshop Report*. Zoo Outreach Organisation/ CBSG/ South Asia, Coimbatore, 618pp.

Analysis of tree - Grizzled Squirrel interactions and guidelines for the maintenance of Endangered *Ratufa macroura*, in the Srivilliputhur Grizzled Squirrel Wildlife Sanctuary

Juliet Vanitharani* and Kavitha Bharathi. B*

Abstract

The Grizzled Giant squirrel *Ratufa macroura* is one of the giant arboreal squirrel inhabited the riverine forest of Srivilliputhur Grizzled Squirrel Wildlife Sanctuary, located between 9º 21′ to 9º 48′N and 77º 21′ to 77º 46′E. The sanctuary was declared in the year 1989 just to protect this inhabitant. An ecological study for the maintenance of endangered *R. macroura*, in the Srivilliputhur Grizzled Squirrel Wildlife Sanctuary was made between the years 2008 and 2010. Grizzled giant squirrel being a canopy dweller largely depends on the tree canopy continuity for their movement and breeding.

The nesting and feeding behaviour observations infer the survival of this Giant squirrel mainly depend on certain group of trees in the dry deciduous and riverine forests of this sanctuary. But the riverine habitats along the sanctuary are generally patchy in forest coverage. The study has identified 35 interactive native tree species of the Giant squirrel. These squirrels do seed dispersal of their feeding trees via dropping seeds as they cruise the canopy. If the squirrel preferred tree species are planted in the fragmented and degraded forest areas that will enhance not only the habitat restoration of the endangered species but also natural renovation of forest environment for other dependent biodiversity.

Introduction

Srivilliputhur forests shares eastern watershed of the Western Ghats, consisting varied forest types in high hills and valleys situated between lat. 9°21′ to 9°48′N and long.77°21′ to 77°46′E. It is home for the endangered, grizzled giant squirrel *Ratufa macroura*. The forest area spreads over 480 square kilometers and were declared as Srivilliputhur Grizzled Squirrel Wildlife Sanctuary in December 1989, named after the endangered grizzled giant squirrel (Tamil Nadu Forest Department 2007; Viruthunagar district Administration 2012) .

Plate 1: Digital documentation of Grizzled Giant Squirrel Feeding, resting and nesting behaviour in Srivilliputhur Grizzled Squirrel Wildlife Sanctuary

The grizzled giant squirrel *R. macroura* is one among the four giant squirrels of the world. This animal is native to India and Sri Lanka (Ipsita 2010). The common name of this squirrel came from the grey to brown colouration highlighted with white at the top of the tail, giving it a grizzled appearance (Prater 1980). This grayish brown squirrel weighs around 2kg and in the size of a small cat. It measures about 735mm from nose to tail with the tail being 360 to 400mm

***Bat Research Laboratory, Zoology Department and Research Centre Sarah Tucker College (Autonomous) Tirunelveli, Tamil Nadu, INDIA. E-mail: jvanitharani@gmail.com/ brlstc2011@gmail.com**

long (Nowak 1991). They construct drays at forked branches where the crowns of neighboring trees meet. The home range of an individual is between 0.197 ha. and 0.611 ha. (Joshua 1992).

Distribution Status

In India, the grizzled giant squirrel has scattered distribution in the Western and Eastern Ghats. According to IUCN (2010), India has only an estimated population of less than 500 mature *R. macroura*. Habitat loss and hunting continue to reduce its numbers significantly (Joshua and Johnsingh 1992, 1994, Molur *et al.* 2005). The restricted seven isolated habitats of the squirrel's, riverine forests are given in Map1.The 7th site occurring in ranges between the plains and elevation below 800m MSL at Alagar koil and Senbagathoppu valley area of the sanctuary enjoys more than 50% of the India's giant squirrel population (TNFD 2007, Vanitharani *et al.* 2011). Studies of Joshua (1992), Paulraj *et al.* (1992), Paulraj and Kasinathan (1993) have estimated that the Periyar-Agasthyamalai population has around 300 individuals including those distributed in the Srivilliputhur Grizzled Squirrel Wildlife Sanctuary. The Anamalai population totals about 300 individuals (Joshua *et al.* 2008) and their distribution range spreads across Chinnar Wildlife sanctuary, Kerala, numbering about 150–200 individuals (Ramachandran 1993, Senthilkumar *et al.* 2007), and the rest in Anamalai Tiger Reserve, Tamil Nadu (Kumar *et al.* 2002). Besides, a few individuals have been reported from Palani Hills of the Western Ghats (Davidar 1989, Sharma 1992). In the Eastern Ghats, a small population is reported from Kanakapura forest division, in southern Karnataka (Karthikeyan *et al.* 1992, Kumara and Singh 2006, Baskaran *et al.,* 2011). Even this limited population is being declining by 30% in the last 25 years (Molur *et al.* 2005) and is presently listed as Near Threatened in the IUCN Red List (Joshua *et al.* 2008). Placed in Appendix II of CITES to regulate its international trade and is also included under Schedule I (Part I) of the Indian Wildlife (Protection) Act (1972). The status of the Indian population of this squirrel is Vulnerable, mainly due to the shrinkage of its habitat (Tikader 1983).

Tree-Grizzled Squirrel Interactions

Grizzled giant squirrel being an arboreal mammal depends on forests and also possesses many other co-evolutionary relationships with the forest plants. The habitat of *R. macroura* requires such specific tree composition for their survival. They are critically dependent on mature forests that provide tree tissues and seeds as food, stems and canopies as launch sites, cavities and canopies as nest sites. Arboreal mammals are dependent on the spatial structures of the forest for nesting. Therefore, the presence of nests in an area reflects the quality of the habitat around it and also indicates the degree of usage of the area by the species (Datta and Goyal 2008). The giant squirrel constructs globular nests or drays using leaves and twigs, multiple in numbers within their home range (Srinivas *et al.* 2008).

Still these endangered species lacks an updated comprehensive database about their ecology, distribution and population status across its habitats. Being an endangered species, it definitely deserves the attention of conservationists (Paulraj 1991).

Materials and Methods

The study was conducted between May 2008 and Feb 2010 by fixing two quadrates in the endangered squirrel's habitat, of dry deciduous and riverine forests of the sanctuary. Observations were carried out to determine the tree-grizzled squirrel interaction using the line transects method. Each transects had a length of 2km within the quadrates (5km^2). The squirrel's interactive tree species were identified as 'focal tree' species. A small sample twig from the focal tree species was collected for tree species identification and a herbarium is maintained for future reference. The vernacular names of the tree species were recorded and their scientific names were ascertained. Direct observation on focal plant species were carried out during the active forage time. The observations were recorded from a spot about 10-20m away from the focal plant using a pair of binoculars. Feeding and nest building activities with the focal trees were documented during the extended watches (a minimum of 1 hour)

Result and Discussion

Arboreal mammals are depending on the spatial structure of the forest for nesting. These squirrels are known to prefer areas with good food availability and canopy connectivity to live and build their nests. Digital recording of Grizzled giant squirrel's feeding; resting and nesting were made during the study period at Srivilliputhur Grizzled Squirrel Wildlife Sanctuary (Plate 1). Squirrels usually prefer trees significantly larger in all characteristics with large girth at breast height (gbh) and taller height with number of branches for nest building. According to Ramachandran (1992) such biased selection towards matured trees with greater canopy continuity could facilitate easy movement to and from the nest in all the directions, a major advantage to escape from predators and to move to other parts of the home range for foraging and other activities. Observed nesting and foraging trees are listed under Table 1. It is apparent that the composition of tree species and structural attributes of the forests play a major role in the usage of habitat by the giant squirrel (Ramachandran 1992)

The grizzled giant squirrel (*R. macroura*) play an important role as a seed disperser to their foraging trees via dropping seeds as they cruise over the canopy, the key tree species like *Artocarpus heterophyllus, Artocarpus hirsuta, Ficus benghalensis, Ficus religiosa, Ficus racemosa, Tamarindus indica, Mangifera indica, Lannea coromandelica, Morinda tinctoria, Syzygium cuminii, Eriodendrum pentadrum, Polyalthia suberosa, Aglaia elaeagnoidea, Chassalia curviflora* and *Sapindus emarginatus* are the main dependant member in the dry deciduous and reverine forests of Srivilliputhur Grizzled Squirrel Wildlife Sanctuary. During the extended watch near some of these key tree species, the squirrels were observed to eat tender leaves of *T.indica* and *Bauhinia purpuria*. Joshua (1992) and Ellerman (1961) also reported similar feeding habits of the squirrel. Ripe fruit pulp of *M. indica, Artocarpus spp., Ficus* fruits and *Tectonia grandis* flowers are also the most significant contributor to the diet of these squirrels. The present study has recorded these squirrels interact with a total of 35 native tree species of the sanctuary. Of which 37% (15 species) of their interacting trees are used both as nesting and foraging trees. During the non-fruiting season or during the scarcity of the fruits, grizzled giant

Table 1: Encountered Nesting and Foraging Trees of Grizzled Giant Squirrel *Ratufa macroura* in Srivilliputhur Wildlife Sanctuary.

S.No	Botanical Name	Family	Nesting	Feeding
1	*Lannea coromandelica*	Anacardiaceae	√	
2	*Mangifera indica*	Anacardiaceae	√	√
3	*Sterospermum chelonoides*	Bignoniaceae	√	
4	*Cullenia exarillata*	Bombaceae	√	√
5	*Eriodendron pentandrum*	Bombaceae	√	√
6	*Cordia obliqua* Willd	Boraginaceae		√
7	*Tamarindus indica* L.	Caesalpiniaceae	√	√
8	*Terminalia arjuna* (Roxb.exDC)	Combretaceae	√	√
9	*Terminalia bellirica* (Gaertn) Roxb.	Combretaceae	√	√
10	*Terminalia chebula* Retz	Combretaceae	√	√
11	*Terminalia tomentosa*	Combretaceae	√	
12	*Mallotus phillipensis*	Euphorbiaceae		√
13	*Azadirachta indica*	Meliaceae	√	
14	*Melia azadirachta*	Meliaceae	√	
15	*Acasia cassia*	Mimosaceae		√
16	*Acacia latronem*	Mimosaceae		√
17	*Acacia planiformis*	Mimosaceae		√
18	*Albizia amara* (Roxb.)Biov.	Mimosaceae	√	√
19	*Albizia lebbeck* (L.) Wild	Mimosaceae	√	√
20	*Artocarpus heterophyllus*	Moraceae		√
21	*Artocarpus hirsuta*	Moraceae		√
22	*Ficus bengalensis*	Moraceae	√	√
23	*Ficus racemosa*	Moraceae	√	√
24	*Ficus religiosa*	Moraceae	√	√
25	*Syzygium cumini*	Myrtaceae	√	√
26	*Butea monosperma* (Lam) Taub.	Papilionaceae		√
27	*Dalbergia latifolia*	Papilionaceae	√	
28	*Pterocarpus marsupium* Roxb	Papilionaceae	√	
29	*Chasalia curviflora*	Rubiaceae		√
30	*Sapindus emarigandus*	Sapindaceae	√	
31	*Schleichera oleosa*	Sapindaceae	√	√
32	*Grewia tiliaefolia*	Tiliaceae	√	√
33	*Gmelina arborea*	Verbenaceae	√	
34	*Tectona grandis*	Verbenaceae	√	
35	*Vitex altissima* Linn.f.	Verbenaceae		√
36	*Bridelia squamosa*	Phyllanthaceae	√	

squirrel devour the bark and leaves of some of these key tree species.

Grizzled giant squirrel being a canopy dweller largely depends on the tree canopy continuity for their movement, nesting and breeding (Joshua 1992, Thorington and Cifelli 1989, Vanitharani *et al.* 2011). Giant squirrels are known to build nests in several trees, sometimes even within a small area (Prater 1980). Of the 35 squirrel interacting key tree species within the sanctuary, the squirrels preferred only 25 of them for nest building. It is noteworthy that the tree species *Pterocarpus marsupium, Sterospermum chelonoides, S. oleosa, Bridelia squamosa, Tamarindus indica, T. arjuna* and *Mangifera indica* are seen with multiple nests. In this sanctuary, the squirrel interaction analysis shows that they nested in deciduous trees significantly more than on the evergreen trees. *S. oleosa* was the most preferred tree species for nesting followed by *Mangifera indica*. The high preference for *M. indica* and *S. oleosa* which are found mostly along the rivers and streams could be due to the dense canopy cover, and higher canopy height and contiguity that could offer better protection and way to escape from the predators. Nagarajan *et al.* (2011) suggested that many arboreal dwellers prefer this type of habitat. According to Kanoje (2008) in the Sitanadi Wildlife sanctuary, the giant squirrel's most common nesting trees were *Terminalia tomentosa* and *S.oleosa*. The other major species of nesting trees were *S. cumini, T. indica* and *Terminalia* spp. He has also mentioned in his study area 77.68% of the

nests were found on deciduous trees while 22.32% were located in the evergreen forest.

Guidelines for the maintenance of *Ratufa macroura*

Grizzled giant squirrel shows restricted distribution mostly in riverine habitats. But the riverine habitats along the sanctuary are generally patchy in forest coverage. Restoration of the habitat in the gap and maintenance of canopy continuity through afforestation of preferred tree species like *T. indica* and *M. indica* can enhance the population size of the grizzled giant squirrel as well as the other faunal diversity. In addition commercial exploitation of *T. indica* fruits in large scale by the local people and government sectors, reducing anthropogenic pressure, grazing pressure along the riverine habitats will help to achieve the purpose. Human interference through various means pressures within the sanctuary threatens the well being of the habitat used by the giant squirrels. Strict legislation and management actions against the cattle pens that are along the gallery of the sanctuary will also enhance the long-term survival of grizzled giant squirrel species. Still this Threatened species lacks an updated comprehensive database about the distribution and population status across its habitat. Being a Threatened species, it definitely deserves the attention of conservationists.

Conclusion

The present observations attribute that grizzled giant squirrel prefer areas with good food availability and canopy connectivity to live and build their nests. The current study has identified 35 native and interactive plant species of the *R. macroura*. Understanding the species distribution and its resource requirements are essential for its long-term conservation plans. The present study has come out with few suggestions by stating that, increasing the giant squirrel's interactive tree species in the affected forest cover of the sanctuary will enhance the conservation of these endangered squirrel as well as other dependent fauna and flora of the sanctuary. The studies also accurately forecasted the existing threat impacts and the caused disturbance on the native flora and fauna of the sanctuary and also indicate that it is essential to conserve the reverine forest habitats of the sanctuary. Habitat fragmentation leads to geographic isolation, reduction in genetic diversity, and a decline in the population size of the dependent species (Agetsuma 1995). Habitat fragmentation alters the spatial structure and composition of the habitat, which is a primary determinant of the distribution of a species. The change in habitat structure and composition results in behavioural changes such as changes in the home range, dietary pattern, time-activity budget, nesting pattern and habitat usage of the species. The ability of a species to persist at sites after disturbance depends on its ability to modify its activity patterns, foraging and dietary preferences to withstand the changes in forest structure and composition. In this study, mostly the riparian areas of the sanctuary are considered potentially suitable for the conservation of the grizzled giant squirrel than the surrounding matrix habitat of the sanctury. Reducing anthropogenic and a grazing pressures along the riverine habitats will also help achieve the purpose. Keeping this in mind the present study has suggested the plantation of the 36 focal tree species in the fragmented and degraded forest areas that will enhance not only the natural forest restoration but also the habitat of the endangered species.

References

References

Agetsuma, N. (1995). Dietary selection by Yakushima macaques (*Macaca fuscata yakui*): The influence of food availability and temperature. *International Journal of Primatology* 16: 611–627.

Baskaran, N., K. Senthilkumar & M. Saravanan (2011). A new site record of the Grizzled Giant Squirrel *Ratufa macroura* (Pennant, 1769) in the Hosur forest division, Eastern Ghats, India and its conservation significance. *Journal of Threatened Taxa* 3(6): 1837–1841.

Datta, A. & S.P. Goyal (2008). Responses of diurnal tree squirrels to selective logging in western Arunachal Pradesh. *Current Science* 95: 895–902

Davidar, P. (1989). Grizzled Giant Squirrel *Ratfa macroura* - distribution in Kudirayar. *Journal of the Bombay Natural History Society* 86(3): 437.

Ellerman, J.R. (1961). The fauna of India including Pakistan, Burma and Ceylon. *Mammalia - 2nd Edition, Rodentia.* The Zoological Survey of India, Calcutta, 3:884.

Herlekar, I.R. (2010). Effect of canopy fragmentation on the patterns of habitat use of the Grizzled Giant Squirrel *Ratufa macroura* in Cauvery Wildlife Sanctuary, Tata Institute of Fundamental Research, Karnataka, India.

IUCN (2010). Red List of Threatened Species Version 2010.1 downloaded on May 27, 2010. www.iucn.org/redlist.

Joshua, J. (1992). Ecology of the endangered Grizzled Giant Squirrel (*Ratufa macroura*) in Tamil Nadu, South India. PhD Thesis. Bharathidasan University, Tiruchirapalli, Tamil Nadu.

Joshua, J. & A.J.T. Johnsingh (1992). Status of endangered Grizzled Giant Squirrel and its habitats, pp. 151 -159. In: Singh, K. & J.S. Singh (eds.). *Tropical Ecosystems: Ecology and Management*. Willey Eastern Ltd., New Delhi.

Joshua, J. & A.J.T. Johnsingh (1994). Impact of biotic disturbances on the habitat and population of the endangered Grizzled Giant Squirrel *Ratufa macroura* in South India. *Biological Conservation* 68: 29–34.

Joshua, J., de A Goonatilake Wildpts & S. Molur (2008). *Ratufa macroura*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4. <**www.iucnredlist.org**>. Downloaded on 06 June 2011.

Kanoje, R.S (2008). Nesting sites of Indian giant squirrels in Sitanadi Wildlife Sanctuary,India. *Current Science* 95(7): 882–884

Karthikeyan, S., J.N. Prasad & B. Arun (1992). Grizzled Giant Squirrel *Ratfa macroura* Thomas and Wroughton at Cauvery valley in Karnataka. *Journal of the Bombay Natural History Society* 89(3): 360–361.

Kumar, M.A., M. Singh, S.K. Srivastava, A. Udhayan, H.N. Kumara & A.K. Sharma (2002). Distribution patterns, relative abundance and management of mammals in Indira Gandhi Wildlife Sanctuary, Tamil Nadu, India. *ournal of the Bombay Natural History Society* 99(2): 184–210.

Kumara, H.N & M. Singh (2006). Distribution and relative abundance of giant squirrel and flying squirrel in Karnataka, India. *Mammalia* 70: 40–47.

Molur, S., C. Srinivasulu, B. Srinivasulu, S. Walker, P.O. Nameer & L. Ravikumar (2005). Status of non-

volant small mammals*: Conservation Assessment and Management Plan (C.A.M.P) Workshop Report*. Zoo Outreach Organization/CBSG-South Asia, Coimbatore, India, 618pp.
Baskaran, N., S. Venkatesan, J. Mani, S.K. Srivastava & A.A. Desai (2011). Some aspects of the ecology of the Indian Giant Squirrel *Ratufa indica* (Erxleben, 1777) in the tropical forests of Mudumalai Wildlife Sanctuary, southern India and their conservation implications. *Journal of Threatened Taxa* 3(7): 1899–1908
Nowak, R.M. (1991). *Walker's Mammals of the World.* Fifth Edition. Johns Hopkins University Press, Baltimore.
Paulraj, S. (1991). Grizzled Giant Squirrel in the final throes of extinction process. *Zoos' Print* 6(10): 1–2.
Paulraj, S., N. Kasinathan & K. Rajendran (1992). Studies on the biology of Grizzled Giant Squirrel part I. population, feeding, home range and activity pattern. Research Report, Tamil Nadu State Forest Department.
Paulraj, S. & N. Kasinathan (1993). Scanty known Grizzled Giant Squirrel (*Ratfa macroura*) of India: status and conservation. *Indian Forester* 119: 828–833.
Prater, S.H. (1980). The book of Indian animals, Bombay Natural History society, Mumbai.
Ramachandran, K.K. (1992). Certain aspects of ecology and behaviour of Malabar Giant Squirrel *Ratufa indica* (Schreber). *PhD Thesis.* Department of Zoology, University of Kerala, 191.
Ramachandran, K.K. (1993). Status survey and distribution of endangered Grizzled Giant Squirrel in Chinnar Wildlife Sanctuary, Kerala, India. *Indian J. Forestry* 16(3): 226–231.
Senthilkumar K, G. Agoramoorthy & M.J. Hsu (2007). Population size, density and conservation status of Grizzled Giant Squirrel in Chinnar Wildlife Sanctuary, India. *Mammalia* 71(1): 89–94.
Sharma, N. (1992). Status of and ecology of Grizzled Giant Squirrel (*Ratfa macroura*) in the Palani Hills. *M.Sc Dissertation*, Pondicherry University.
Srinivas, V., P.D. Venugopal & S. Ram (2008). Site occupancy of the Indian Giant Squirrel *Ratufa indica* (Erxleben) in Kalakad-Mundanthurai Tiger Reserve, Tamil Nadu, India. Special editing: Arboreal squirrel. *Current Science* 95(7): 889–894.
Tamil Nadu Forest Department (2007) "Srivilliputhur Grizzled Squirrel Wildlife Sanctuary". http://www.forests.tn.nic.in/wildbiodiversity/ws_sgsws.html
Thorington, R.W. Jr & R.L. Cifelli (1989). The usual significance of the giant squirrels (Ratufa), pp. 212–219. In: Daniel J.C. & J.S. Serrao (eds.). *Conservation in Developing Countries: Problem and Prospects*. *Proce. Centenary Seminar of the Bombay Natural History Society.* Oxford University Press.
Tikader, B.K. (1983). *Threatened Animals of India.* Zoological Survey of India, Calcutta, 307pp.
Vanitharani, J., B.B. Kavitha & V.I. Margaret (2011). Probe in to the conservation status of *Ratufa macroura* through the analysis of Plant-Animal interaction in the Srivilliputhur Grizzled Squirrel Wildlife Sanctuary *J. Adv. Biotech.* 10(10): 67–69.
Viruthunagar District Administration (2012). http://virudhunagar.nic.in/ forest. html. "Shenbagathopu Grizzled Squirrel Sanctuary".

A New Distribution Record of the Japanese Pipistrelle (*Pipistrellus abramus* (Temminck, 1840); Mammalia, Chiroptera) in India

Bhargavi Srinivasulu[1], Chelmala Srinivasulu[1*], Harpreet Kaur[1] and Aditya Srinivasulu[2]

Abstract: A new distribution record of the Japanese Pipistrelle (*Pipistrellus abramus* (Temminck, 1840); Chiroptera, Mammalia) is reported basing on fresh material collected from Hyderabad, India. Identification is confirmed based on morphology and a fragment of mtDNA cytochrome b (492 bp). The present record extends the range of the Japanese Pipistrelle further south in India, where it was known only from two historical records.

Published in *Acta Zoologica Lituanica*, 2011, Volume 21, Number 4, Pp. 253-257, ISSN 1392-1657, DOI: 10.2478/v10043-011-0029-8

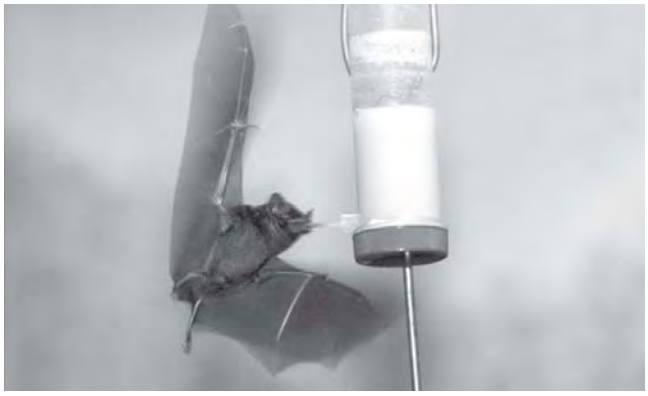
[1]Wildlife Biology and Taxonomy Lab., Department of Zoology, University College of Science, Osmania University, Hyderabad, Andhra Pradesh – 500007, India
[2]Biodiversity Research and Conservation Society, Swarnadhamanagar, Old Bowenpally, Hyderabad, Andhra Pradesh – 500011, India [*]– corresponding author: e-mail: csrinivasulu@osmaniawildlife.org

Diet and Feeding (from Bats in Captivity)

Susan M. Barnard*

Note from Editor:
Susan Barnard used to give me shelter when I was travelling around USA, poor as a church mouse, seeing zoos and attending zookeeper and other conferences. Susan is one of the amazing and phenomenal zoo people that remained a zookeeper cleaning cages and doing other such works for the sheer love of her animals, that is bats. Susan also ran a rescue operation for bats when they entered private residences and freaked out the owners. She converted many a human to be if not loving, at least tolerant of bats, and spread the message that bats are some of our most useful animals. Susan did not have a Ph.D. or M.Sc. or any scientific background, but she learned to be a bat scientist and did many advanced scientific projects involving different aspects of bats.

Today Susan claims to be retired because she is not working at the zoo. She is living in a simple house beside a lake in a forested area where she has to watch out for snakes and certain other animals. She also has, or is in the process of writing her iconic 4 Volume set of Bats in Captivity. I am proud to be her friend and colleague and pleased that she permitted me to reprint a couple of chapters from her books. If you are not a captive bat person, please see that people you know are involved with captive bats at any level from sweeper of bat cages to director. And ask your institution to buy all four. Bats in Captivity by Susan Barnard.
Sally Walker



Introduction
Old World fruit bats (Megachiroptera) have food habits similar to many of the New World fruit bat species. Ripe fruits are the primary food in their diets, but depending on the species, other plant material is consumed in varying amounts as well, including pollen, nectar, various developmental stages of flowers (Bhat, 1994; Law, 1992a,b; Marshall, 1985; Racey and Nicoll, 1984; Wiles and Fujita, 1992), leaves (Lowry, 1989; Marshall, 1985; Richards and Prociv, 1984), twigs, bark, seed pods, cones, and sap (Courts, 1998; Mickleburgh *et al.,* 1992). In addition, Old World fruit bats have been reported to eat carrion (van Deusen, 1968) and fish (S. Mistry, cited in Mickleburgh *et al.,* 1992). They also deliberately ingest insects (Courts, 1997, 1998; Funakoshi *et al.,* 1993; Roberts and Seabrook, 1989; Parry-Jones and Augee, 1991a,b). The foods consumed by mega-chiropterans are chewed and crushed against their ridged palates, allowing the nutrient-rich liquid portion to be extracted and swallowed, while the fibrous portion is spit out.

Diet
Nutrition
Protein is a nutrient of primary interest in formulating diets for captive fruit bats because fruit is low in protein. Nevertheless, Herbst (1986) showed that fruits eaten by *Carollia perspicillata* (a New World species) contained enough protein to maintain non-reproductive individuals (without having to resort to folivory or over-ingesting energy; Delorme and Thomas; 1996), and Korine and Arad (1994) found the same to be true for *Rousettus aegyptiacus,* an Old World species. Furthermore, over-ripe

***106 Spooner Road, Hawthorne, FL 32640, USA.**

Table 1. Diet fed to captive fruit bats at Basically Bats, Inc.

Per Kg of diet (mix fresh daily):

Dried Fruits
10-30g of one fruit per night (e.g., apricots, dates, figs, prunes, raisins).

Fresh Fruits
4-5 different fruits per night (e.g., apple, apricot, banana, blueberry, cataloupe, cherimoya, grape, guanabana, guava, honeydew, Japanese persimmon, kiwi, loquat, mango, nectarine, papaya, peach, pear, plum, star fruit, raspberry, scuppernong, strawberry, tomato, or non-toxic, native fruits when available).

Juice
80 ml any flavor of Juicy-Juice® or other 100% juice product (offer frozen for enrichment 1-2 x per wk.).

Leafy Green Vegetables and Herbs
100g of 1-3 types per night, chopped (basil, beet, cabbage, cilantro, clover, collard, coriander, dandelion, kale, kudzu, mint, mustard, oregano, parsley, spinach, turnip, watercress, or non-toxic native plants when available).

Edible Flowers
5-10g per night (bachelor button, butterfly bush, bee balm, carnation, chrysanthemum, crape myrtle, daisy, dandelion, daylily, dogwood, eucalyptus, gardenia, hibiscus, honeysuckle, lavender, marigold, nasturtium, pansy, passion flower, pineapple sage, rose, snapdragon, sunflower, tulip, viola, violet, wisteria, or non-toxic native flowers when available). Note: When flowers are not available, increase the leafy green vegetables by 5-10g.

Supplement Powder
Mix together:
1 part Rep-Cal® calcium supplement[1] (without Vitamin D or phosphorus)
1 part - Super 14™ fatty acid supplement[2]
1 part-Vionate® vitamin/mineral supplement[3]
2 parts - Vege Fuel® protein supplement[4]
Feed 1 tsp. 2-3 x/wk. (mix well with fruit and vegetables; do not mix in juice).

fruits, which are preferred by pteropodids, contain more free amino acids than ripe or under-ripe fruits (Thorpe, 1991). Thorpe also suggested that more nutrients (e.g., amino acids) are extracted as a consequence of chewing fruit, possibly because of elevated levels of salivary enzymes. It appears that fruit bat evolution has selected for a low requirement and high extraction and retention for nitrogen (Delorme and Thomas, 1999). Moreover, Tedman and Hall (1985) suggested that a longer intestine in fruit bats (in comparison to that of insectivorous bats) increases the nutrient absorption surface, thereby enhancing nitrogen uptake.

Coupled with the physiological strategies that permit megachiropterans to cope with low-protein foods (Delorme and Thomas, 1999; Tedman and Hall, 1985; Thorpe, 1991), some species eat plant parts rich in protein and minerals. Free-ranging fruit bats also eat a wide variety of fruits to help balance their diets. To offset the lower quality of agriculturally grown fruits (as compared to wild fruits; Nelson *et al.,* 2000), small amounts of easily digestible supplements can be added to the diet. For nutritional values of selected agriculturally grown foods. By paying close attention to food quality, variety, supplementation, presentation, and/or distribution within the enclosure, nutritional disorders can be reduced or avoided altogether.

High protein cereals and primate chow are commonly used to supplement fruit bat diets. Such protein sources are not utilized by fruit bats in the wild, and they add mass to the diet that could otherwise be offered as fruit. A natural and enriching source of protein can be provided in the form of leafy green vegetables, flowers, pollen, and/or a small amount of easily dissolved powdered supplement containing vitamins, minerals, and essential amino and fatty acids. Live mealworms can also be added to the pteropodid diet (Pope, 1998), either as a fat/protein source, if the bats are willing to eat them, or as a source of psychological stimulation. Over a 20-year period at the Basically Bats' facility in Atlanta, GA, captive fruit bats raised young and lived healthy lives on a diet containing approximately 90% fruit, which ranged between 3.5% and 7% protein on a dry matter basis (Table 1).

The amount of food a bat requires depends on the species, its age, individual health, and the amount of activity it receives. The American Zoo and Aquarium Association (AZA) Bat Taxon Advisory Group (TAG) (1995) reported that an average active adult bat may consume a total of 50-120% of its body weight per day on an as fed basis, increasing that amount to 150% per day for lactating females.

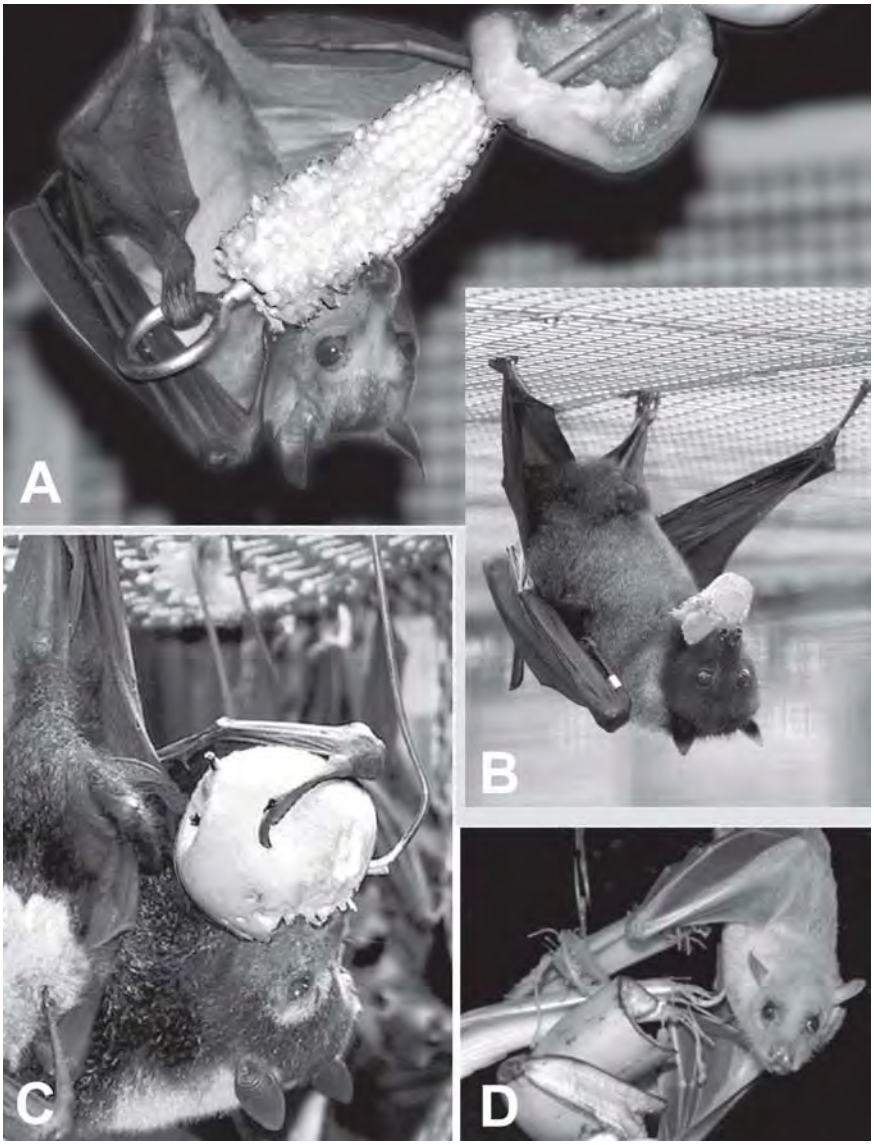


Fig. 1. Whole, fresh fruits and vegetables should be presented to long-term captive fruit bats as part of their regular diet, and as enrichment. Photos A and D courtesy of Dawn Vezina, The Organization for Bat Conservation; photo B © Dana LeBlanc, Lubee Bat Conservancy; photo C courtesy of Jenny Maclean, Tolga Bat Rescue and Research.

Water

Some free-ranging megachiropterans are known to drink sea water (Nelson, 1989; Ratcliffe, 1961), ostensibly to obtain salt and other minerals in their diets. Bats in captivity may be offered salt solutions in addition to freshwater on the basis of these observations. When *Pteropus poliocephalus* and *P. alecto* were given a choice between freshwater and saltwater (at half the concentration of sea water), the bats drank 2 to 8 times more saltwater than freshwater (Nelson, 1989). However, when the salt solution equaled or exceeded the salt concentration of sea water, the bats drank up to 9 times as much freshwater. If wild megachiropterans drink sea water to obtain minerals, why do these bats also drink salt solutions in captivity, assuming that minerals are included in the diet? Perhaps wild and captive pteropodids drink salty water simply because they like the taste. If this is true, then salt provides enrichment. Bats in the genus *Pteropus* do not appear to be harmed when mineral and salt are provided in the form of hamster wheels. The author observed that salt wheels lasted approximately half as long as mineral wheels.

Mineral wheels are red in color and contain sodium chloride, manganous oxide, ferrous carbonate, magnesium oxide, cobalt carbonate, zinc oxide, and natural and artificial flavors. Depending on the manufacturer, the salt wheel may contain salt only or salt with a few micro-minerals. Mineral and salt wheels can be purchased at most pet stores or online (see *Products Mentioned in Text).*

Pteropus giganteus bats housed at Basically Bats used water in an unusual way. Several times weekly, the bats scurried up and down the mesh sides of their enclosures between the newspaper-lined floors and the water bowls. They tore off sections of newspaper and dipped them in the water. Then they chewed the wet paper until it formed "spit balls." It is not known why the bats adopted this behavior, but they may have been extracting water from the paper in the same way they extract the liquid portion of fruit, or perhaps they were engaging in a form of play (e.g., see Caroll, 1979).

Source: Modified from Barnard (1995, 2009).
[1]*Guaranteed analysis:*
Calcium - 35% min., 41% max.

Ingredients:
100% natural phosphorous-free oyster shell calcium carbonate.
[2]*Guaranteed analysis (per 454g):*
Crude protein - 27%; methionine - 0.7% min.; Crude fat - 18%; crude fiber - 1.5%; ash - 10% max.; selenium -0.7 ppm min.; zinc - 1800 ppm min.; Vitamin A - 21,000 IU min.; Vitamin E - 150 IU min.; Vitamin B_6 - 24 mg. min.

Ingredients:
Corn oil, soybean oil, soybean flour, dextrose, Vitamin A acetate, zinc methionine, dl-alpha-tocopheryl acetate, pyridoxine hydrochloride, calcium silicate, mixed tocopherols, citric acid, ascorbic acid (preservative), artificial flavorings.

[3]*Guaranteed analysis (per Kg):*
Vitamin A - 220,000 IU; Vitamin D_3 - 22,000 IU; Vitamin E - 119.9 IU; Vitamin B_1 - 39.6 mg; Vitamin B_2 79.2 mg; Vitamin B_6 9.98 mg; Vitamin B_{12} 0.15 mg; niacin - 275 mg; folic acid - 2.2 mg; choline chloride - 5,720 mg; ascorbic acid - 2,494.8 mg; calcium pantothenate-110 mg; calcium-94,802.4 mg (9.5% min.), 113,762 mg (11.4% max.); phosphorus -47,828 mg (4.79%); salt (NaCl) - 4,994 mg (0.5% min.), 14,982 mg (1.5% max.); iodine - 22 mg (0.0022%); iron - 550 mg (0.055%); cobalt - 5.5 mg (0.00055%); copper - 55 mg

(0.0055%); magnesium - 423.06 mg (0.0424%); manganese - 75.68 mg (0.0076%).

Ingredients:
Degermed corn meal, dibasic calcium phosphate, calcium carbonate, sodium chloride, ferrous carbonate, magnesium oxide, niacin, calcium pantothenate, riboflavin, butylated hyroxytoluene (preservative), di-atocopheryl acetate, Vitamin A palmitate, thiamin monitrate, manganous oxide, cupric sulfate, calcium iodate, pyridoxine hydrochloride, cobalt carbonate, folic acid, D-activated animal sterol, cyanocobalamin.

[4]*Analysis (per 36 g):*
Total fat (no saturated or trans fat) - 1 g; Protein -31 g;folate-71 mcg; biotin - 11 mcg; calcium-71 mg; iron 6 mg; phosphorus - 284 mg; sodium - 500 mg; potassium - 55 mg; L-glutamic acid - 5960 mg; L-aspartic acid - 3620 mg; L-leucine - 2550 mg; L-arginine - 2380 mg; L-phenylalanine - 1630 mg; L-serine - 1630 mg; L- proline 1600 mg; L-valine 1560 mg; L-isoleucine - 1520 mg; Glycine - 1310 mg.

Food Presentation
Methods recommended for presenting food to fruit bats range from blended diets to offering fruits whole. There are pros and cons for both methods. The blended diet prevents bats from selecting only the fruits they like, which also prevents the bats from receiving an imbalance of nutrients (Dierenfeld *et al.,* 2000). Snell (1994) warned that blending fruit could possibly cause rectal prolapse because it forces fruit bats to ingest large quantities of fibrous material that leads to too much bulk in what they eat. Trupkiewicz *et al.* (Chapter 13, Volume 1) reported a possible connection between diet and rectal prolapses in a zoo colony of *Pteropus rodricensis.* Moreover, excess amounts of dietary fiber from homogenizing fruits can bind dietary minerals such as iron, zinc, and calcium, preventing their absorption (George, 1990).

Although free-ranging bats feed on whole fruits, providing long-term captives living in groups with only whole fruits may allow bats to pick and choose their favorite foods, and timid bats may be prevented from approaching whole fruits and

Fig. 2. Fruit juice can be placed in a small plastic container (arrow), which is then placed in a food pan. Photo by the author.

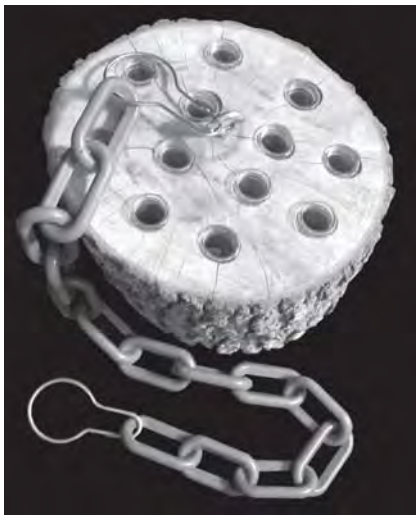


Fig. 3. In addition to offering fruit juice with the regular diet, it can also be offered in an enrichment device as shown here (see also Fig. 5-32). Photo by the author; enrichment device supplied by the Lubee Bat Conservancy, Gainesville, FL.

vegetables by aggressive cage mates, all of which could lead to nutritional problems over time. Furthermore, dietary supplements would have to be delivered in ways other than on the food. For example, they would have to be mixed in fruit juices, which every bat in a group may not receive. Therefore, when feeding long-term captive bats, it is best to chop fruits and vegetables into bite-sized pieces that are appropriate for a particular species. Whole fresh fruits and vegetables (Fig. 1) can also be offered, but primarily as a way to provide psychological enrichment. When offering food as enrichment to bats, it should be incorporated into the daily dietary budget to prevent the animals from becoming obese.

Fruit juice can be served in small plastic containers that are placed in food pans (Fig. 2). A more psychologically enriching presentation is to freeze the juice in ice cube trays and mix the frozen juice cubes with

Fig. 4. Fruit bats should not be presented food on cage floors, but in containers or other items hung from cage ceilings. Shown here is a food bowl hung from a wicker basket that is attached to the cage ceiling. This set-up helps to maintain bats' claws. Photo by the author.

the rest of the food. For more "adventuresome" bats, the juice can be poured into an enrichment device (Fig. 3) and hung from the cage ceiling with a plastic chain, thereby challenging the bats to figure out how to get to the juice.

When possible, food should be presented in ways to ensure that timid and geriatric bats have access to a balanced diet, and that active and aggressive bats are psychologically challenged. In situations where bats are housed in enclosures that do not permit flight, food can be presented in ways that make the animals "work," which helps to exercise and enrich them. For example, whole or sectioned fruits and vegetables can be hung on plastic chains. At the Lubee Bat Conservancy in Gainesville, Florida, flying foxes learned that they could obtain juice and food hanging from chains by pulling up the chain. In order to make bats work for their food, they should not be allowed to reach fruits and juices from the mesh cage siding.

Feeding problems
Most captive megachiropterans are maintained in groups because of their social nature. Whether groups are large or small, there are always bats that are more aggressive than others. These individuals may receive larger portions of food, whereas timid bats may not receive enough. This is especially true when mixing species in a single enclosure. Free-ranging fruit

bats do not become obese from over-eating because they are active and utilize the energy they consume. In captivity, however, some pteropodids (e.g., *Pteropus giganteus)* become obese.

In cases of extreme obesity, overweight bats must be separated from the group at mealtimes and their food intake reduced. In most situations, visual barriers and/or multiple feeding stations help to ensure that all bats in a group receive adequate food and a balanced diet.

At Disney's Animal Kingdom in Florida, the problem of feeding and territoriality among captive flying foxes was solved by incorporating specially designed feeding stations shaped like an H, E or X into the bat enclosures. For specific information on these feeders, the reader should review Chag *et al.* (2004).

Additional Notes

- Food and water containers should not be placed on enclosure floors, but in containers (Fig. 4) hung from the cage ceiling to prevent fecal and urine contamination.
- Only plastic chains are recommended for hanging food and fruit juices in enclosures because metal chains can injure bats (D. LeBlanc, pers. comm.).
- The reader should review Chapter 5 for ideas on food presentation and enrichment.

Products mentioned in text

Juicy-Juice®: Nestlé USA, Inc., 4300 West 73rd Street, Anderson, IN 46013 USA. Available in most grocery stores.
Mineral and Salt Wheels: Available at most pet stores or online (e.g., http://www.rabbitmart.com).
Rep-Cal® Calcium: Rep-Cal Research Labs, P.O. Box 727, Los Gatos, CA 95031 USA.
Super 14™: Farnam Companies, Inc., 301 West Osborn Road, Phoenix, AZ 85013 USA.
Vege Fuel®: Twinlab® Corporation (Ideasphere, Inc.), 600 East Quality Drive, American Fork, UT 84003 USA.
Vionate®: Gimborn Pet Specialties, LLC., 4280 N.E. Expressway, Atlanta, GA 30340 USA.

References

Agaie, B.M., A. Salisu & A.A. Ebbo (2007). A survey of common toxic plants of livestock in Sokoto State, Nigeria. *Scientific Research and Essay,* 2:40–42.

AZA Bat TAG. (1995). *Fruit Bat Husbandry Manual* (Fascione, N., ed.). American Zoo and Aquarium Association Bat Taxon Advisory Group, Kensington, MD and The Lubee Foundation, Inc., Gainesville, FL. 39 pp.

Barnard, S.M. (1995). *Bats in Captivity.* Wild Ones Animal Books, Springville, CA. 194 pp.

Barnard, S.M. (2009). Maintaining bats for captive studies. In: *Ecological and Behavioral Methods for the Study of Bats,* 2nd ed. (Kunz, T.H. and Parsons, S., eds.). Johns Hopkins University Press, Baltimore, MD. Pp. 329–372.

Bhat, H. (1994). Observations on the food regimen and feeding behaviour of *Cynopterus sphinx* Vahl (Chiroptera, Pteropodidae) at Pune, India. *Mammalia,* 58: 363–370.

Carroll, B. (1979). The general behavior repertoire of the Rodrigues fruit bat *(Pteropus rodricensis)* in captivity at the Jersey Wildlife Preservation Trust. *Dodo,* 1973: 51–59.

Chag, M., B. Pope & E. Trumbly (2004). HEX stations for Old World fruit bats: A solution to feeding-territoriality in captive flying foxes. *Animal Keepers' Forum,* 31: 118–126.

Courts, S.E. (1997). Insectivory in captive Livingstone's and Rodrigues fruit bats, *Pteropus livingstonii* and *P. rodricensis* (Chiroptera: Pteropodidae): An adaptation for obtaining protein. *Journal of Zoology* (London), 242: 404–410.

Courts, S.E. (1998). Insectivorous habits of fruit bats. *Pteropus* (The Lubee Foundation Technical Bulletin 4), April: 1998.4pp.

Delorme, M. & D.W. Thomas (1996). Nitrogen and energy requirements of the short-tailed fruit bat *(Carollia perspicillata):* Fruit bats are not nitrogen constrained. *Journal of Comparative Physiology,* 166B: 427–434.

Delorme, M. & D.W. Thomas (1999). Comparative analysis of the digestive efficiency, nitrogen and energy requirements of the phyllostomid fruit-bat *(Artibeus jamaicensis)* and the pteropodid fruit-bat *(Rousettus aegyptiacus). Journal Comparative Physiology,* 169B:123–132.

Dierenfeld, E.S., J. Dempsey, M. Maslanka & M. Delorme (2000). Eclectic chiropteran cuisine: From fruits, fish and flowers to blood and bugs! *American Zoo and Aquarium Association Annual Conference Proceedings.* Pp. 353–358.

Funakoshi, K., H. Watanabe & T. Kunisaki (1993). Feeding ecology of the northern Ryukyu fruit bat, *Pteropus dasymallus dasymallus,* in a warm-temperate region. *Journal of Zoology* (London), 230: 221–230.

George, H. (1990). Grey-headed flying foxes. In: *Care and Handling of Australian Native Animals: Emergency Care and Captive Management* (Hand, S.J., ed.). Surrey Beatty and Sons, Pty, Limited in association with the Royal Zoological Society of New South Wales, NSW, Australia. Pp. 159–169.

Hall, L. & G. Richards (2000). *Flying Foxes: Fruit and Blossum Bats of Australia.* University of New South Wales Press, Ltd., Sydney, NSW. 135 pp.

Herbst, L.H. (1986). The role of nitrogen from fruit pulp in the nutrition of the frugivorous bat, *Carollia perspicillata. Biotropica,* 18:39–44.

Korine, C. & Z. Arad (1994). Nitrogen requirements and energy balance of the fruit-bat *Rousettus aegyptiacus. Bat Research News* (abstract), Spring: 29.

Law, B.S. (1992a). The maintenance of nitrogen requirements of the Queensland blossom bat *(Syconycteris australis). Physiological Zoology,* 65:634–648.

Law, B.S. (1992b). Physiological factors affecting pollen use by Queensland blossom bats *(Syconycteris australis). Functional Ecology,* 6: 257–264.

Lowry, J.B. (1989). Green-leaf fractionation by fruit bats: Is this feeding behaviour a unique nutritional strategy for herbivores? *Australian Wildlife Research,* 16: 203–206.

Marshall, A.G. (1985). Old World phytophagous bats (Megachiroptera) and their food plants: A survey. *Zoological Journal of the Linnean Society,* 83: 351–369.

Mickleburgh, S.P., A.M. Hutson & P.A. Racey (1992). *Old World Fruit Bats: An Action Plan for their Conservation.* International Union for Conservation of Nature and Natural Resources Species Survival Commission, Newbury, UK. 252 pp.

Morton, J.F. (1962). Ornamental plants with toxic and/or irritant properties. II. *Proceedings of the Florida State Horticultural Society,* 75: 484–491.

Nelson, J.E. (1989). Pteropodidae. In: *Fauna of Australia,* Vol. 1B (Walton, D.W. and Richardson, B.J., eds.). Australian Government Publishing Service, Canberra, ACT, Australia. Pp. 852–856.
Nelson, S.L., M.A. Miller, E.J. Heske & G.C. Jr. Fahey(2000). Nutritional consequences of a change in diet from native to agricultural fruits for the Samoan fruit bat. *Ecogeography,* 23: 393–401.
Nyhagen, D.F., S.D. Thurnbull, J.M. Olesen & C.G. Jones (2005). An investigation into the role of the Mauritian flying fox, *Pteropus niger,* in forest regeneration. *Biological Conservation,* 122: 491–497.
Parry-Jones, K. & M.L. Augee (1991a). Food selection by grey-headed flying foxes, *Pteropus poliocephalus,* occupying a summer colony site near Gosford, New South Wales. *Wildife Research,* 18: 111–124.
Parry-Jones, K. & M.L. Augee (1991b). The diet of flying foxes in the Sydney and Gosford areas of New South Wales based on sighting reports, 1986-90. *Australian Zoology,* 27: 49–54.
Perkins, K.D. & W.W. Payne (1978). *Guide to the Poisonous and Irritant Plants of Florida.* Florida Cooperative Extension Service, Institute of Food and Agricultural Science, University of Florida, Gainesville, FL. 91 pp.
Pope, B. (1998). Insectivorous habits of fruit bats. *Pteropus* (The Lubee Foundation Technical Bulletin), 1998: 3–4.
Racey, P.A. & M.E. Nicoll (1984). Mammals of the Seychelles. In: *Biogeography and Ecology of the Seychelles Islands* (Stoddart, D.R., ed.). Springer, New York, NY. Pp. 607-626.
Ratcliffe, F.N. (1961). Flying foxes drinking sea water. *Journal of Mammalogy,* 42: 252–252.
Richards, G.C. & P. Prociv (1984). Folivory in *Pteropus. Australian Bat Research News,* 20:13–14.
Roberts, P. & W.A. Seabrook (1989). A relationship between black rats *(Rattus rattus),* Seychelle fruit bats *(Pteropus sychellenis aldabrensis)* and the coccoid *(Icerya seychellarum)* (Insecta, Homoptera) on Aldabra Atoll, Seychelles. *Journal of Zoology* (London), 218: 332–334.
Snell, J. (1994). *Standards Recommended for the Care and Exhibition of Flying-Foxes.* Ku-Ring-Gai Bat Colony Committee, Inc., Sydney NSW Australia. 22 pp.
Sowemimo, A.A., F.A. Fakoya, I. Awopetu, O.R. Omobuwajo & S.A. Adesanya (2007). Toxicity and mutagenic activity of some selected Nigerian plants. *Journal of Ethnopharmacology,* 113: 427–432.
Tedman, R.A. & L.S. Hall (1985). The morphology of the gastrointestinal tract and food transit time in the fruit bats *Pteropus alecto* and *P. poliocephalus* (Megachiroptera). *Australian Journal of Zoology,* 33: 625–640.
Thorpe, I.C. (1991). *A Report on some Observations of Rodrigues Fruit Bats in Captivity: Feeding Hierarchies and the Changing Fitness of Captive Rodriques Fruit Bats.* Unpublished report, Jersey Wildlife Preservation Trust (now Durrell Wildlife Conservation Trust), Jersey, Channel Islands.
Van Deusen, H.M. (1968). Carnivorous habits of *Hipsignathus monstrosus. Journal of Mammalogy,* 49: 335–336.
Wiles, G.J. & M.S. Fujita (1992). The food plants and economic importance of flying foxes on Pacific islands. In: *Pacific Island Flying Foxes: Proceedings of an International Conference* (Wilson, D.E. and Graham, G.L., eds.). United States Fish and Wildlife Service, Biological Report 90, Washington, DC. Pp. 24–35.

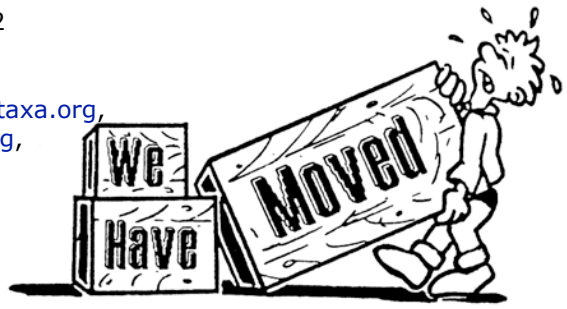
We have moved ....

Our New Address Is:
Zoo Outreach Organization (ZOO) / Wildlife Information & Liaison Development (WILD)
96, Kumudham Nagar, Vilankurichi Road, Coimbatore 641035, Tamil Nadu, India

Our New Phone Numbers are:
Ph: +91 422 2665298, 2665450. Fax: +91 422 2665472
Email: zooreach@zooreach.org

www.zoosprint.org, www.zooreach.org, www.southasiantaxa.org, www.pterocount.org, www.southasianprimatenetwork.org, www.threatenedtaxa.org

Best wishes
ZOO Crew



Rearing Insects for Bat Food

Susan M. Barnard*

Introduction

A variety of insects and other arthropods are reared commercially as food for captive animals. These food sources can be indispensable for maintaining bats in captivity, whether one is dealing with a large zoo collection or just a few individuals maintained by a bat rehabilitator. In either case, it may be more cost effective to rear insects on site than to purchase them from commercial suppliers. Having insect cultures on site also helps ensure an uninterrupted food supply, and offering bats several kinds of insect foods greatly enriches their diets. On the other hand, some insects and other arthropods can be extremely labor intensive to culture, and the effort to rear them may not be worth the cost and work. Thus, bat workers need to decide whether raising insects and other arthropods on site is practical for them. The information given in this paper describes protocols for rearing insects easily on site, where it is practical and cost effective to do so.

The insects described below exhibit a range of body sizes and exoskeleton hardness. They can be fed at different stages in their life cycles to satisfy all sizes of bats and diet preferences that include hard- or soft-bodied insects. Freeman (1981) ranked the invertebrate prey of bats on a qualitative scale of 1 (softest) to 5 (hardest) to arrive at an "average hardness scale" of invertebrates eaten by free-ranging insectivorous bats. Where it is known, the hardness rating is given for the food insects discussed below.

It should be noted also that some commonly reared arthropods (e.g., centipedes and scorpions) eaten in the wild by certain bat species may injure captive animals when bats and these arthropods are confined in the same enclosure. The insects included in this paper are known to be safe as bat food when rearing instructions are followed, and they are inexpensive and relatively easy to culture.

Yellow Mealworms (*Tenebrio molitor*)

Hardness Rating: 5

Yellow mealworms are the larval stage of the mealworm beetle *(Tenebrio molitor),* a darkling beetle of the family Tenebrionidae (order Coleoptera). Darkling beetles eat both fresh and decaying vegetation. These insects undergo complete metamorphosis, that is, they have egg, larval (Fig. 1), pupal (Fig. 2), and adult (Fig. 3) stages, each of which is morphologically quite different from the others. Females lay from 275 to 1,000 white, bean-shaped eggs in their lifetimes. The eggs hatch in approximately 1 week. The tough-skinned larvae molt between 9-20 times, growing to about 1 in. (2.54 cm) long over a 3-month period. The pupal stage lasts 2 weeks. The emerging adult undergoes several color changes, starting with light beige, darkening to red, brown, and finally to black.

Fig. 1. Mealworms (*Tenebrio molitor* larvae). Photo by the author.

Fig. 2. *Tenebrio molitor* pupae. Photo used with permission from Ask a Biologist (askabiologist.asu.edu).

Darkling beetles are hard-shelled, and several free-ranging bat species feed on them, including *Myotis evotis, M. volans, Antrozous pallidus,* and *Eumops perotis*. Mealworms provide primarily protein and fat, some minerals (e.g., zinc, copper, and iron), and some vitamins, such as riboflavin and thiamine *(Food Insects Newsletter,* 1996). What mealworms may lack in other nutrients can easily be supplemented in their culture medium.

Because mealworms are pests of flour, meal, grain, and related products, they are extremely easy to rear. However, mealworms are intermediate hosts for several parasites, including tapeworms *(Hymenolepis* spp.), and they should never be cultured from wild stock.

Fig. 3. *Tenebrio molitor* beetle. Photo ˝Entomart (http://www.entomart.be/).

Fig. 4. Mealworm culture with mite trap. Mites are typically purchased with mealworms. To prevent them from dispersing into the surrounding environment, the culture container can be placed in a bowl of water. Illustration from Barnard (1995).

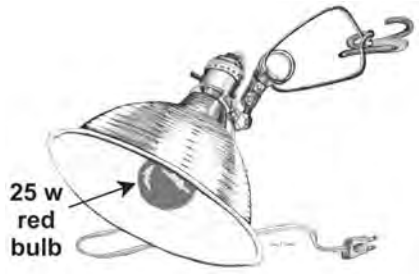


Fig. 5. Utility lamp with red bulb used to maintain warmth for insects being cultured. Illustration from Barnard (1995).

Materials required to culture mealworms:

- Mealworm starter culture (e.g., from Southeastern Insectaries, Inc.).
- Appropriately sized culturing container with cover (e.g., wide-mouth gallon jar; see also Fig. 2-2).
- Metal window screen (enough to cover a hole made in the jar lid), or cheesecloth when using wide-mouth gallon jars as culturing containers.
- 25W red incandescent bulb.
- Clamp-on portable lamp.
- Mite trap (e.g., container of water).
- 10-12-in. (25-30 cm) specimen forceps.

Culture medium (per 2,500 mealworms):

- 1½ cup oats.
- 1½ cup wheat bran.
- 1½ cup cornmeal.
- ¼ cup Vionate® vitamin/mineral powder.
- ¼ cup calcium carbonate powder (e.g., Rep-Cal®).
- ½ sweet potato or apple.
- 2-3 large leaves of leafy greens* (e.g., collards**, spinach, cabbage, mustard greens, kale).

*All fruits and vegetables must be fresh and free of pesticides. Replace leafy green vegetables before they become dry.

**Preferred leafy green vegetable.

Thoroughly mix the dry ingredients in the container. Add the mealworms and gently swirl them into the medium. Place the vegetables on top of the culture medium and cover the container with a porous material such as cheesecloth or screen mesh. Because proper ventilation is essential to prevent mold, avoid placing solid lids on culture containers. As the number of mealworms increases, the number of culture jars or the size of the container(s) must be increased.

Ground monkey chow, dry dog food, laboratory rodent chow, and chick starter have all been used for growing mealworms. However, these commercial animal diets often contain arthropod pests that can contaminate a culture. A medium intended for human consumption is less likely to contain such contaminants. Nevertheless, grain mites *(Tyrophagus* spp.) that are commonly found in stored food are always a potential problem because their eggs may adhere to mealworms when they are purchased as a starter culture. Although arthropod pests such as grain mites are not usually harmful to bats, they may compete for nutrients that would otherwise be available to the bats. Mites infesting a mealworm culture can develop large populations. Placing the mealworm container in water (Fig. 4) prevents mites from dispersing into the surrounding area. If mites or other pests become a problem, freeze and discard the infested colony.

Place mealworm colonies in fresh medium several times a year. Pour ALL loose contents from the old container into a clean one. Discard only the moist, hard sediment on the bottom. Never discard old potatoes or apples because mealworms lay eggs in them. To prevent the adults from eating the eggs, thin the colony if it becomes overcrowded. A colony is overcrowded when it is no longer productive.

The ideal rearing temperature for mealworms is 77-84°F (25-29°C). Appropriate temperatures can be achieved by placing a clamp-on portable lamp (Fig. 5) with a 25W red bulb over the culture.

Separating large quantities of mealworms from the substrate, shed skins, and dead mealworms by hand can be time-consuming. Therefore, except in rare instances, culturing large numbers of mealworms should be left to commercial suppliers. Small cultures can be sorted by pouring the mealworms and coarse debris onto a clean, loosely woven dishcloth, which is laid on a paint grid in a flat pan, such as a kitty-litter pan (Fig. 6). Set the pan 1-2 feet from a 60W lamp. The live mealworms will crawl under the dishcloth to avoid the light, leaving the debris on the surface of the cloth where it can be discarded or returned to the culture container. As some bat species forage on crop pests, which are well nourished from their plant diet, boost the nutrient content of the mealworms by allowing them to feed on dark leafy greens for about 3 hours prior to offering them to bats as food.

Avoid sifting mealworms through a colander because this procedure may limit the size of the mealworms required to provide sufficient dietary roughage. Also, avoid feeding *Tenebrio* adults to bats because this stage of the insect's life cycle contains toxic quinones (Ladisch *et al.,* 1967).

Blattaria (Cockroaches)

Cockroaches are among the least popular insects, being scavengers in homes, restaurants, and other public places where they can find moisture, warmth, and organic debris on which to feed. In the wild, they also scavenge in forest litter. Cockroaches undergo incomplete metamorphosis; that is, the life cycle includes eggs, nymphs (which closely

Fig. 6. A) Kitty litter pan with paint grid. B) *Tenebrio molitor* can be sorted from the growing medium and other debris if they are placed on loosely-woven fabric, such as a dishcloth, which is then placed on a paint grid. Photos from Barnard (1995).

resemble adults, but are at first smaller), and adults. Eggs are contained within leathery, bean-shaped capsules. The numbers of capsules and eggs produced by females vary by species. The length of time for nymphs to emerge from the capsules depends on humidity and temperature. Nymphs are white to pale yellowish-white in color, small in size, and without wings upon hatching, but increase in size with each molt. Molts occur at intervals of several weeks until adults emerge after the last molt.

Many free-ranging bats include cockroaches in their diets such as *Idionycteris phyllotis, Eptesicus fuscus, Lasiurus borealis, Chalinolobus gouldii, Micronycteris hirsuta,* and *Hipposideros* spp. When cockroaches are fed to bats, they can be removed from the rearing container with long forceps.

A cockroach species that is native to one country or region may be considered an undesirable alien in another country. Therefore, bat keepers wishing to culture non-native cockroaches should check on legislation and permit requirements concerning the transport and maintenance of these insects. The following cockroaches are routinely cultured for animal food, classroom study, and zoological display.

German Cockroach *(Blatella germanica)*
The most common cockroach found in human dwellings throughout the world is the German cockroach. German cockroaches are approximately ½ -in. (1.27 cm) long, brown, and have two dark streaks on their thoraxes (Fig. 7). Both sexes have wings, but rarely use them. Females produce 3 or 4 egg capsules in their lifetime. Each capsule contains approximately 30 eggs. Capsules are carried by females from 24 to 40 days until the eggs hatch. Nymphs develop into adults in 2 to 3 months, and there are 2 to 3 generations per year.

Fig. 7. German cockroach (*Blatella germanica*). Photo courtesy of the University of Florida.

Fig. 8. Oriental cockroach (*Blatta orientalis*). Photo courtesy of the University of Florida.

Oriental Cockroach *(Blatta orientalis)*
The Oriental cockroach (Fig. 8) is second only to the German cockroach as a home invader and is extremely common in human habitations. Oriental cockroaches range in length from 1 in. (2.54 cm) to ¼ in. (3.18 cm). Females are slightly longer than males. Both sexes are dark brown to black, and only the males have fully developed wings. Females produce 8 egg cases in their lifetimes, each containing an average of 16 eggs. Females carry egg cases for a short time, after which they place them in warm, sheltered areas. Nymphs hatch in 2 to 3 months. The life cycle takes approximately 13 months to complete.

American Cockroach *(Periplaneta americana)*
The American cockroach (Fig. 9) may have come from Africa long before it was described, but it is well established in the southern United States today. American cockroaches are large, growing to 1½ in. (3.81 cm) long. They are reddish-brown in color, and both sexes possess wings and are good fliers. Females produce a large number of egg capsules in their lifetimes, each of which they carry for a short time. Females then camouflage the capsules with debris and deposit them in pits that they dig themselves. Hatching nymphs are grayish-brown in color and wingless. The life cycle of the American cockroach may be as long as 2½ years.

Brown-banded Cockroach *(Supella longipalpa)*
The brown-banded (Fig. 10) cockroach probably originated in Africa. It is another species that is typically bred

Fig. 9. American cockroach (*Periplaneta americana*). Photo courtesy of the University of Florida.

Fig. 10. Brown-banded cockroach (*Supella longipalpa*). Photo courtesy of the University of Florida.

Fig. 11. Discoid cockroach (*Blaberus discoidalis*). Photo published under the terms of the GNU Free Documentation License.

Fig. 12. Madagascar hissing cockroach (*Gromphadorina portentosa*). Photo taken at the Atlanta Botanical Gardens by an anonymous photographer, and published under the Wikipedia Public Domain.

for animal food and also lives in human dwellings. The brown-banded cockroach resembles the German cockroach in appearance and is similar in size (e.g., ½ in.; 1.27 cm). Brown-banded cockroaches have 2 brownish-yellow stripes across the base of their wings, which are more visible on nymphs than adults. Both sexes possess wings and are active fliers. The wings of males cover the abdomen completely, whereas the wings of the female do not. Egg capsules are glued to various surfaces, and each one contains an average of 18 eggs. The lifecycle is approximately 200 days.

Discoid Cockroach *(Blaberus discoidalis)*

The discoid cockroach (Fig. 11) is native to tropical South America. Discoid cockroaches grow as long as 3 in. (7.6 cm). Their large size makes them inappropriate food for most insectivorous bats. However, adult discoid roaches make excellent food for any insectivorous or carnivorous bat that is large enough to over-power them (e.g., *A. pallidus, Hipposideros commersoni, H. diadema* and *Macroderma gigas).* Small bats can be offered nymphs, which are ¼ in (0.64 cm) long at birth.

Discoid cockroaches are ready to reproduce by 4-6 months of age when maintained at the temperatures suggested below. Females carry their egg cases in pockets on the backs of their abdomens until the eggs hatch, thus appearing to be delivering live young.

Males and females can be distinguished by their body size and the length of their wings. Males are generally smaller than females, with wings that extend past the tip of the abdomen. The wings of females do not reach the tip of the abdomen. Although adult discoid cockroaches are winged, they do not fly.

Madagascar Hissing Cockroach *(Gromphadorina portentosa)*

As the name implies, the Madagascar hissing cockroach (Fig. 12) is native to the island of Madagascar, where it inhabits rotting logs. It has the ability to produce an audible hissing sound by forcing air through a pair of modified spiracles (openings in the abdomen used for breathing). Although hissing cockroaches lack wings, they are excellent climbers, able to scale smooth surfaces. Hissing cockroaches are large, reaching a length of 2-3 in. (5-7.6 cm). Males have two horn-like protrusions on the pronotum (the first segment of the thorax) and "hairier" antennae than females. The pronatal humps are used in combat with other males to defend territories (Fraser and Nelson, 1984). Females retain their egg cases inside the body until the young hatch and emerge, giving the appearance that they give birth to live young. Nymphs reach maturity in 5-10 months, depending on the temperature. Adults may live for 2-3 years.

Materials required to culture cockroaches:

- Cockroach (of choice) starter culture (e.g., from Carolina Biological Supply Company).
- Containers of appropriate size with lids (e.g., 20-30-gal. *glass* aquarium/ terrarium with a tight-fitting, wire mesh lid).
- Soil mix (enough to cover bottom of container 1-2 in. [2.54-5.1 cm] deep).
- Round sponges.
- Culture dishes (appropriate size for rearing container; 2.5 in. [6.4 cm] to 4.5 in. [11.4 cm]).
- Cardboard centers from paper towel rolls or cardboard egg containers.
- Flat dishes for food (e.g., 20 x 100 mm Petri dishes).
- 25W red incandescent bulbs.
- Clamp-on portable lamps.
- 10-12-in. (25-30-cm) forceps.

Suggested food:*

- Dried dog or cat food, flaked fish food, or other high protein dry food mixed with a small amount of wheat germ (20% of dry diet).
- Apples and/or pears.
- Carrots.
- Sweet and/or red potatoes.
- Leafy greens (e.g., collards, spinach, celery leaves, clover).

*All fruits and vegetables must be fresh and free of pesticides. Replace leafy green vegetables before they become dry.

Because most cockroaches can fly to some degree and are able climbers, they should be housed in smooth-sided containers with tight-fitting lids. A glass aquarium or terrarium works best for culturing cockroaches. The aquarium top should be made of metal screen and be tight-fitting. Avoid using cloth mesh as cockroaches may chew through this material. A thin layer of petroleum jelly should be applied to the inside rim of the container to prevent those cockroach species that climb from escaping when the container top is off. Depending on the cockroach species, a 20-30-gal. aquarium is suitable for housing from 10-30 starter cockroaches. To maintain a healthy cockroach colony,

avoid allowing these insects to exceed the carrying capacity of their containers.

A soil mix, like potting soil, should be sprinkled on the container floor to a depth of 1-2 in. (2.54-5.1 cm). Cardboard paper towel roll centers or egg cartons serve as hiding places (see Fig. 23b).

Most cockroaches require warm temperatures, approximately 75-86 °F (24-30°C). They will not survive constant temperatures above 90 °F (32°C), and they develop too slowly at temperatures below 70°F (21°C). Tropical cockroaches, such as discoid and Madagascar hissing cockroaches, require temperatures between 80-90°F (27-32°C). Appropriate temperatures can be maintained with a clamp-on portable lamp containing a 25W red bulb (see Fig. 5). Cockroaches are nocturnal and should not have a well lit environment.

Cockroaches are omnivorous. Feeding them ground dry foods is preferable to wet foods, but cockroaches also require fruits and vegetables in their diets. Fruits and vegetables can be placed in a flat dish separate from the dry food. Cannibalism can be prevented by making sure that fresh food is always available.

Water is optional, *provided that* cockroaches have a constant supply of fresh fruits and vegetables (Dunn, 1993). However, water that is offered may be consumed, and is also used by female cockroaches to aid in bringing forth their nymphs. A shallow bowl containing moist (not drenched) sand can be made available for this purpose. Misting roaches and their bedding should be avoided.

If water is provided for drinking, it should be presented in a small culture dish containing a sponge that fits the dish snugly (Fig. 13). Nymphs and small cockroaches will drown if the sponge does not fill the dish completely. A round sponge of appropriate size can be purchased, or a square sponge can be cut to fit the dish. Sponges must be free of detergent, which is often added during manufacturing.

Wet sponges harbor bacteria that can cause illness in a cockroach colony; therefore, sponges must be rotated often. To kill bacteria living in a sponge, first remove any cockroach nymphs that may be on it, and then place it in boiling water for 1-2 minutes. It should be noted that hissing cockroaches cling tightly to some materials. Avoid forcing them off items like sponges or nets because their legs can be broken off in this way.

It is important that cockroaches are not confined in a wet environment, but one in which the air surrounding them contains enough moisture to allow for proper molting. A warm-mist humidifier, such as those used to increase humidity for bats, can be placed in the room where insect cultures are maintained.

Cockroaches should be purchased from a reputable insect supplier. They must never be captured from the wild for culturing. Wild insects harbor endo and ectoparasites that can be transmitted to bats.

Some cockroaches are burrowers, and bedding from the rearing container needs to be sifted carefully for nymphs and eggs before being changed (approximately once a month). Leave empty egg cartons in the container as hiding places for young nymphs. All spent substrate material should be placed in a freezer for at least 72 hours prior to being discarded.

Milkweed Bug *(Oncopeltus fasciatus)*
Hardness Rating: 4
In the wild, the reddish-orange and black milkweed bug (order Hemiptera) (Fig. 14) lives on milkweed plants *(Asclepias* spp.), feeding on the seeds in late summer and early fall. Milkweed bugs pierce seeds and inject salivary enzymes with their long proboscises. Males and females are sexually dimorphic. Males have two thick black bands across the ventral abdomen, whereas females have one black band and two black dots. Metamorphosis is incomplete. In the wild, females lay clusters of yellow eggs in crevices between milkweed pods. A female may lay 30 eggs daily, or 2,000 in her lifetime. At 84 °F (29 °C), the yellow eggs turn orange by the time they hatch in 4 days. The orange, pinhead-sized nymphs suck juices from the milkweed seeds. Nymphs reach adulthood in approximately 30 days after 5 molts. They are winged on the last molt, but seldom fly in captivity. Adult milkweed bugs live approximately 1 month.

Fig. 13. To prevent cockroaches from drowning, water should be provided in a bowl containing a wet sponge. Photo by the author.

Fig. 14. Milkweed bug (*Oncopeltus fasciatus*). Photo by Greg Hume, (CC) Creative Commons.

Fig. 15. Water bottle and homemade wick for providing milkweed bugs water. Photo by the author.

Under captive conditions, milkweed bugs have adapted to sucking juices from cracked sunflower seeds. Milkweed bugs reared on sunflower seeds do not sequester the cardiac glycosides in their bodies that they obtain from milkweed seeds (Duffey and Scudder 1972; Scudder & Duffey, 1972), which make them unpalatable as food for bats.

In captivity, females lay their eggs in the crevices of cheesecloth or cotton. The life cycle of captive milkweed bugs is the same as it is in nature when the ambient temperature is maintained as described above.

Milkweed bugs belong to the family Lygaeidae, commonly called seed bugs. At least 33 free-ranging bat species are known to feed on seed bugs, including *E. fuscus, Pipistrellus minus, Myotis lucifugus, L. borealis,* and *Lasionycteris noctivagans* (see Appendix 2-1).

Milkweed bugs are easy to maintain and require little space. It is necessary to obtain enough wide-mouth gallon jars (or other appropriately large containers) to raise the desired number of bugs.

Materials required to culture milkweed bugs:

- Milkweed bug starter culture (e.g., from Carolina Biological Supply Company).
- At least 2 wide-mouth gallon jars.
- Cheescloth or fiberglass screen for jar lids.
- Rubberband to secure lids.
- Paper towels.
- Mite traps (bowls of water).
- Small culture dishes (e.g., 2½ in. [6.4 cm] in diameter for egg laying).
- Cotton balls.
- 2 oz. (60 ml) dropper bottles without droppers, or baby food jars with holes punched in lids for water.
- Wicks (cotton).
- Flat dish (e.g., 15 x 60 mm Petri dish) for seeds.

Suggested Food:

- Raw, unsalted, *cracked* sunflower seeds.

Place crumpled paper towel on the bottom of a wide-mouth gallon jar to provide a substrate on which the bugs can crawl. Place a small bottle of water in the rearing container for moisture, with at least 1 in. (2.5 cm) of wick protruding. The water in the bottle should be spring water, not tap water (M. Haugen, Carolina Biological Supply Company, pers. comm.). The desired wick size can be purchased, or a twisted piece of paper towel can be used. The author uses a finger cut from a clean cotton glove (Fig. 15). All other items in the rearing container must remain dry. Wicks must always be kept clean. Paper towel wicks should be discarded after use, and cotton wicks can be placed in boiling water for a few minutes to kill bacteria.

Raw, cracked, unsalted sunflower seeds serve as food for both the nymphs and adult milkweed bugs. The seeds can be placed in a small flat dish (e.g., a 15 x 60 mm Petri dish; Fig. 16), or plastic jar lid. The wide-mouth gallon jar should be covered with cheesecloth held in place with a rubber band. To prevent the culture from becoming contaminated with arthropod pests, the jar should be placed in a bowl of water. To view the complete milkweed rearing set up, see Fig. 17.

For egg laying, female milkweed bugs should be provided with a dry cotton ball or piece of cheese cloth stuffed in a small container (Fig. 18). To reduce

Fig. 16. Method for providing milkweed bugs sunflower seeds. Photo by the author.

Fig. 18. Either cotton (A) or cheesecloth (B) can be placed in a small bowl for milkweed bugs to lay their eggs. Photo by the author.

Fig. 17. Set up for culturing milkweed bugs. The culture jar should be placed in a bowl of water to prevent arthropod pests from contaminating the milkweed bug culture. Photo by the author.

Fig. 19. A) wax moth (*Galleria mellonella*) larva (a.k.a. waxworm); B) adult wax moth. Photos from Barnard (1995).

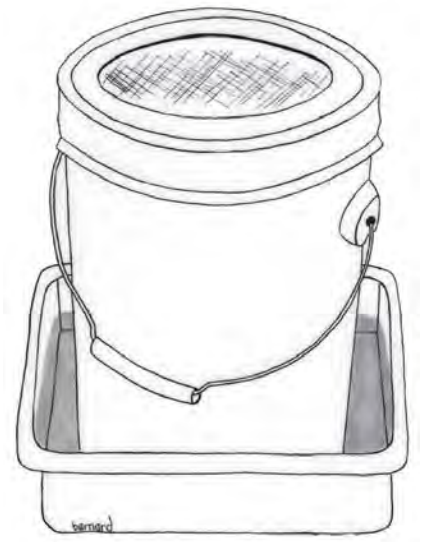


Fig. 20. Set up for culturing greater wax moth larvae. Note the pan of water used as a trap to prevent arthropod pests from contaminating the culture. Illustration from Barnard (1995).

cannibalism, and to increase the number of bugs being reared, collect the eggs daily, and place them in a new wide-mouth gallon jar.

Change all rearing materials as necessary. Seeds shrivel after the juices have been extracted by the milkweed bugs, and they should be replaced with a fresh supply. When placing crumpled paper toweling in wide-mouth gallon jars, be sure that they are situated so that the bugs always have access to water, food, and egg-laying jars.

Greater Wax Moth *(Galleria mellonella)*

Hardness Rating: 2

Waxworms are the larvae (Fig. 19a) of the greater wax moth, *Galleria mellonella* (Fig. 19b) (order Lepidoptera; family Pyralidae). The wax moth is found in most of the world, but is an introduced species in Australia. *Galleria* moths are pests in bee hives, where they lay their eggs. As the larvae develop, they feed on honey and the wax combs. To prevent being stung and thrown out of the hive, the larvae feed at night. By day they hide in silken tubes of their own construction.

The wax moth undergoes complete metamorphosis. Females lay between 300 and 1,000 eggs in their lifetimes, and the eggs hatch in 5-8 days at 75-81 °F (24-27 °C). Depending on the temperature, waxworms develop in 1-5 months, growing most rapidly at temperatures between 81-90 °F (27-32 °C). Young larvae are white in color. They molt approximately 7 times as they darken to a golden-gray or brown, with black tipped feet and small black heads. Prior to pupation, larvae are about 25 mm long. The pupal stage lasts about 10 days in warm weather. The adult moth is ¾ in. (2 cm) long with a wing-span of slightly more than 1 in. (2.54 cm). Wax moths can be sexed by the rear margins of their wings, which are relatively straight in females and indented or scalloped in males.

Free-ranging bats known to feed on pyralids include *Eptesicus serotinus, Hipposideros pomona, Nyctalus noctula, Nycteris thebaica, Pipistrellus pipistrellus, Plecotus auritus,* and *Rhogeessa minutilla.* For additional information on the types of insects bats eat.

Materials required to culture waxworms:

- Waxworm starter culture (e.g., from Grubco. Inc.).
- 5-gal. plastic container with tightly sealing lid.
- Metal window screen (enough to cover a hole made in the container lid).
- Cardboard centers from paper towel rolls.
- Mite trap (container of water).
- Lamp with 60-100W red incandescent bulb.
- Clamp-on portable lamp.

Culture medium (modified from Dutky et al., 1962):

- 1-lb. box Gerber's® high protein baby cereal.
- ¾ cup glycerin.
- ½ cup sugar.
- ½ cup tap water.
- 12 drops Avitron® multivitamins.
- 2 tbsp. calcium carbonate (e.g., Rep-Cal®).

Mix ingredients together thoroughly.

Waxworms must adapt to the specific diet being fed to them. Therefore, whatever diet one choses to rear these insects, it is best to stay with it. The author has reared wax moth colonies successfully on the diet listed above.

To begin a colony, place ½ lb. of culture medium on the bottom of the rearing container along with the waxworm starter culture. Waxworms do not require water. Place the centers from paper towel rolls inside the rearing container to provide places where larvae can pupate. Metal, glass, or hard plastic are the best products for rearing containers. Waxworms can chew through wood and soft plastics. Cover the container with a tightly fitting lid. To provide ventilation, cut a large hole in the lid. Cover the hole by gluing or taping metal window screen over it. To prevent pest infestation, and to contain migrating waxworms, place the container with the culture in water (Fig. 20). Although wax moth cultures thrive in darkness, it is necessary to provide appropriate heat. This can be done by placing the culture in a closet with a clamp-on lamp containing a 60-100W **red** bulb. Set the lamp about 6 to 8 in. (15-20 cm) from the culture, taking care not to allow the lamp to melt any plastics being used.

Check the culture daily for larvae big enough to feed to bats. When mature larvae are ready to pupate, they crawl into crevices or hollow depressions to spin cocoons. Mature larvae can be found inside the cardboard centers of paper towel rolls, where they can be harvested easily.

To prevent a colony from becoming overcrowded, waxworms can be collected and stored in wood chips, which can be held in a refrigerator for short periods of time (1-3 weeks) prior to feeding to bats. Adult moths can also be fed to bats, but avoid feeding too many because they are necessary to continue the culture. Also, adults do not eat, and therefore they are not as nourishing as the larvae.

Waxworms should be fed to bats primarily as enrichment. Unlike most insects, waxworms are higher in fats than proteins and can cause obesity in animals that eat them as a steady diet.

When the medium becomes riddled with larvae and cocoons, fresh medium should be added. Remove any portions of the colony that appear moldy. Surplus culture medium can be stored in the refrigerator for several months when sealed tightly in a plastic bag.

It is best to maintain more than one colony of waxworms. If problems occur, this allows one colony to be destroyed and discarded without shutting down production. If a wax moth culture becomes overcrowded, it can be destroyed by pouring boiling water over it: *Galleria* moths are injurious to bee hives, and they should not be released to the wild.

House Cricket *(Acheta domesticus)*
Hardness Rating : 3
The house cricket is a member of the insect family Gryllidae (order Orthoptera). House crickets are originally from the Middle East and northern Africa.

House crickets undergo incomplete metamorphosis, and their life cycle lasts approximately 3 months. The eggs are small, banana-shaped, yellowish or white in color, and are laid singly. Females are distinguished from males by long needlelike ovipositors that extend from the ends of their abdomens (Fig. 21). Each female can lay up to 2,600 eggs during her lifetime. At room temperature, eggs hatch in 2-3 weeks. Newly hatched nymphs are about the same size as the egg. Various cricket sizes are shown in Fig. 22. Some commercial insect distributors allow crickets to be ordered by size.

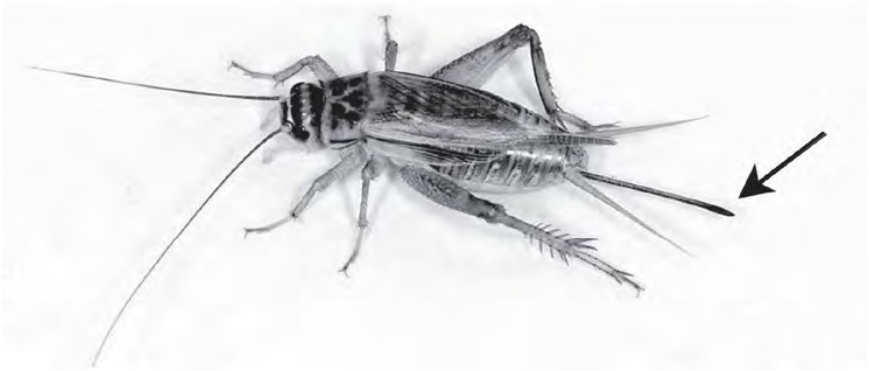


Fig. 21. Female house cricket (*Acheta domesticus*). Note the ovipositor (arrow). Photo courtesy of Joseph Berger, Bugwood.org.

Free-ranging bats known to feed on crickets include *E. fuscus, L. noctivagans, Lasiurus cinereus semotus, L. borealis, Nyctinomops macrotis, Myotis thysanodes, M. lucifugus, M. evotis, M. volans, Otonycteris hemprichii, Tadarida brasiliensis,* and *E. perotis.*

Storage and Feed-off bin
Materials required to maintain approximately 250-500 crickets:
- Cricket starter culture (e.g., from Grubco, Inc.).
- Appropriate container (e.g., 1.5 ft. [46 cm] deep by 2-3 ft. [61-91 cm] long by a *minimum* of 2 ft. (61 cm) high, with a tightly fitting top).
- Potting soil for bedding.
- 1-pint poultry water dispenser, or other appropriate water dispenser.
- Flat dish for dry food.
- Paper towels for water dispenser.
- Cardboard egg containers (usually shipped with the crickets) or other material in which crickets can hide.
- Lamp with 60-100W incandescent bulb.
- Cricket collecting funnel.

Suggested food:
- Dry dog food (powdered).
- Fruits (all types).
- Garden vegetables (all types).
- Fresh leafy greens (e.g., collards, clover, grass).

A cricket bin can be constructed of ½ - or ¾ -inch plywood (Fig. 23a). The walls of the bin should be sanded to a very smooth finish, followed by 1 or 2 applications of high-gloss paint (crickets cannot climb on this surface). The bin lid can be constructed of wood with a cut-out for metal window screen for ventilation. Other containers of appropriate size are suitable for rearing crickets, but it is essential that they be deep and the sides smooth to prevent the insects from escaping. The feed-off bin is solely for cricket storage because

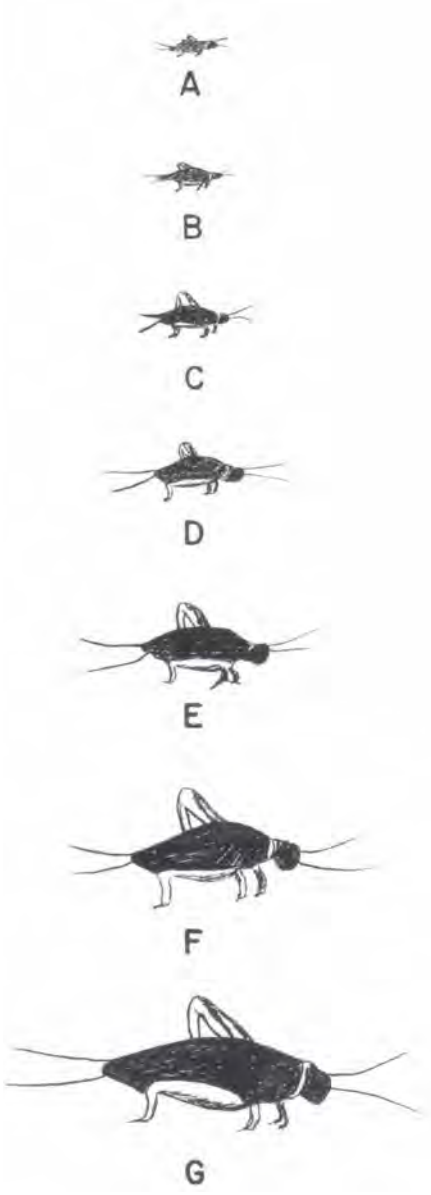


Fig. 22. Actual cricket sizes available commercially: A) pin head, 1/8 in. (0.3 cm); B) 1 week old, 3/16 in. (0.5 cm); C) 2 weeks old, 1/4 in. (0.6 cm); D) 3 weeks old, 3/8 in. (0.95 cm); E) 4 weeks old, 1/2 in. (1.3 cm); F) 5 weeks old, 3/4 in. (2 cm); G) adult, 1 in. (2.5 cm). From Barnard (1986, 1995).

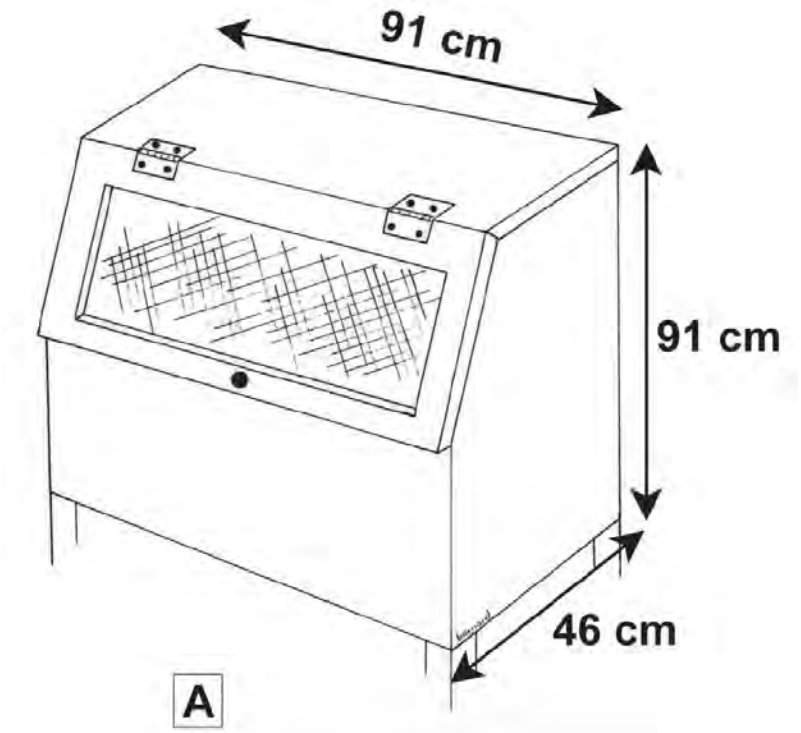


Fig. 23. A) one of many container types used to culture crickets. Shown is a plywood box with a metal screened lid; B) interior of the box showing egg cartons, heat lamp, game bird food, poultry water dispenser, and hay on container floor to serve as the substrate. A) illustration from Barnard (1986, 1995); B) photo from Barnard (1995).

Fig. 24. Poultry water dispenser used to feed crickets. Paper towels are placed in the base of the dispenser to prevent crickets from drowning. Illustration from Barnard (1986, 1995).

crickets cannot be refrigerated for more than 24-48 hours.

Approximately 2 inches of dry potting soil should be spread over the bottom of the cricket bin. The substrate must be kept dry. The combination of high moisture and low light levels may cause contaminants like fungus to grow. Egg cartons should be leaned against the wall of the bin to serve as hiding places and for ease of cricket collection. Place powdered, dry dog food, water, and fruits and vegetables in the center. Feeding dog food to crickets helps to prevent cannibalism because of its high protein content. When using a poultry water dispenser (Fig. 24), line the bowl with enough paper towels to prevent the crickets from drowning. They obtain water from the soaked towels. A lamp should be placed over the screened top of the bin to provide warmth. The life of adult crickets can be extended if the temperature in the storage/feed-off bin is maintained at about 70 °F (21 °C). A light:dark cycle of 16:8 hours is best for crickets. Avoid exposing bins to direct sunlight.

To prevent the bin from becoming infested with mites, ants, or other pests, it may be necessary to place each leg of the bin, or table legs on which the bin is placed, in a container of water or cooking oil, or to ring each leg generously with petroleum jelly. The water dispenser should be cleaned and paper towels replaced when necessary. Replace fruits and vegetables every 2 to 3 days with a fresh supply. Replenish the dog food as necessary. The bedding should be kept dry and changed every 1 to 2 weeks. To do this, remove the food and water. Place the egg cartons at one end of the bin and wait until the crickets have migrated to them. Change one half of the bedding, transfer the egg cartons to the other end of the bin, and repeat the cleaning process. Replace the water, greens, and dog food when finished.

When collecting crickets from the bin, insert a funnel into a collecting jar, or other type of collecting container, and shake the crickets from the cardboard egg containers. A funnel can be crafted by cutting out the bottom of an empty bleach bottle or plastic milk jug. Because adult crickets live only about 2 weeks, use them as soon as possible. Before feeding crickets to bats, remove their jumping legs to assist the bats in catching them. For a diverse diet, feed in combination with other insects.

Breeding and Rearing

Materials required to breed and rear crickets:

- 2 10-gal. aquaria (1 for breeders; 1 for hatchlings).
- Misting bottle for misting eggs.
- 2 or more shallow soup bowls for egg laying.
- 2 lamps with 25-40W incandescent bulbs for heating.
- 2 flat dishes (e.g., 100 x 20 mm Petri dishes) for dry food.
- 2 small culture dishes (2.5 in.; 6.4 cm).

- Sponges for water (round and detergent-free).
- 2 cardboard egg containers or other appropriate material for hiding.
- Potting soil.
- Newspaper.

Suggested food:

- Powdered dog food or chick starter.
- Fruits and vegetables (the same as for adults).

Line the bottom of one aquarium with newspaper and the other with 1 to 2 inches of potting soil. Place 2 to 3 dozen crickets from the feed-off bin at a sex ratio of 3-4 males to 6-8 females into the aquarium lined with newspaper. This will be the breeding aquarium. Also, place a cardboard egg container and food and water dishes in each aquarium. The water dishes should contain well-soaked sponges (see Fig. 13. Be sure to review the information on sponge care under *Cockroaches* above). In a corner of the breeding aquarium, place a bowl filled with potting soil that is not packed tightly. It should be loose enough to allow a female's ovipositor to penetrate to about ½ inch while laying eggs. Be sure the soil is kept damp, not wet. This can be achieved with a misting bottle. Cover the aquarium with a tightly fitting screen lid, and place it next to a lamp to maintain a temperature range of 80-90 °F (26-32 °C). To collect the cricket eggs, once a week pour the moistened soil from the bowl into the aquarium reserved for raising the hatchlings. After the first eggs have been placed in the second aquarium, maintain the aquarium in the same manner as the adult cricket bin, but with one difference; the temperature should be maintained at 80 °F (26 °C). The substrate containing eggs must be kept damp. It is important not to mix the hatchlings with adults, as the adults may eat the nymphs. Additional aquaria can be used to separate hatchlings according to size. When hatchlings are approximately ½ in. (1.27 cm) or larger (see Fig.22), they can be placed into the feed-off bin with the adult crickets.

Products Mentioned in Text

Aquaria/Terraria (20-30 gal., glass): Available at pet supply stores; see also Connecticut Valley Biological Supply Company, 82 Valley Road, Southampton, MA 01073 USA; http://www.connecticutvalleybiological.com/glass-aquaria-c-322_325 .html?zenid=5fe84c8774b3 a4ef6677cccc.

Avitron® Multivitamins: Available at pet supply stores; see also Pet Food Direct™, 189 Main Street Harleysville, PA 19438 USA; http://www.petfooddirect.com/Product/5426/Lambert-Kay-Avitron-Vitamins-for-Birds-and-Small-Animals. Calcium Carbonate: see Rep-Cal® below.

Cheesecloth: Available at department stores; see also Sur La Table, P.O. Box 840, Brownsburg, IN 46112 USA; http://www.surlatable.com/product/id/124345.do?mr:trackingCode=D260AEDC-D781-DE11-B7F3-0019B9C043EB&mr:referralID=NA.

Clamp-on-Portable Lamp (#34906): Available at hardware stores; see also Amazon.com; http://www.amazon.com/34906-Clamp-On-Portable-Lamp/dp/B001UL03V4.

Cockroaches for Culturing: Carolina Biological Supply Company, 2700 York Road, Burlington, NC 27215 USA; http://www.carolina.com/category/living+organisms/animals.do.

Crickets for Culturing: Grubco Inc., P.O. Box 15001, Hamilton, OH 45015 USA; http://www.grubco.com/.

Culture Dishes (2.5 in. #741000; 3.5 in. #741002; 4.5 in. #741004, depending on rearing container size): Carolina Biological Supply Company, 2700 York Road, Burlington, NC 27215 USA; http://www.carolina.com/.

Dropper bottle (2 oz.; 60 ml): Available at pharmacies; see also The Science Company, 95 Lincoln Street, Denver, CO80203 USA; http://secure.science company.com/2-oz-Clear-Dropper-Bottles-Pk4-P6320C695.aspx.

Fiberglass Screen: Available at hardware stores; see also Amazon.com; http://www.amazon.com/New-York-Wire-33105-Fiberglass/dp/B0035AMMDA.

Forceps (10 in.; NC-10345): The Science Company, 95 Lincoln Street, Denver, CO 80203 USA; http://secure.science company.com/Specimen-Forceps-Tweezers-10-inch-P16031C618.aspx.

Funnel for Collecting Crickets (Plews/Lubrimatic PLW75-072): Available at hardware stores; see also ToolTopia.com, 125 Freestate Blvd., Shreveport, LA 71107 USA; http://www.tooltopia.com/plews_lubrimatic-75-072.aspx?utm_source=nextag&utm_medium=cse&utm_term=PLW75072&utm_campaign=nextag_r1.

Glass Wide-mouth Gallon Jar (128 oz., SKU#A4128C): Fillmore Container Company, Inc., 2316 Norman Road, Lancaster, PA 17601 USA; http://www.fillmorecontainer.com/Jars/128-oz-Widemouth-Jar-CT.htm.

Glycerin: Available at pharmacies; see also True Foods Market, 192 West 1480 South Orem, UT 84058 USA; http://www.truefoods market.com/product_info.php/products_id/3993.

Mealworms for Culturing: Southeast Insectaries, Inc., 606 Ball Street, Perry, GA 31069 USA; http://southeastern insectaries.com/custom3.html.

Milkweed Bugs for Culturing: Carolina Biological Supply Company, 2700 York Road, Burlington, NC 27215 USA; http://www.carolina.com/.

Petri Dish (16 x 60 mm, #741154): Carolina Biological Supply Company, 2700 York Road, Burlington, NC 27215 USA; http://www.carolina.com/.

Petri Dish (20 x 100 mm, #714460): Carolina Biological Supply Company, 2700 York Road, Burlington, NC 27215 USA; http://www.carolina.com/.

Plastic Container (5-gal. with tight-fitting lid): Available at hardware stores; see also Uline® 2200 S. Lakeside Drive, Waukegan, IL 60085 USA; http://www.uline.com/BL_8150/Plastic-Pails-And-Lids.

Potting Soil: see soil mix below.

Poultry water dispenser: Available at feed and seed stores; see also Hawthorne Country Store, 675 West Grand Avenue, Escondido, CA 92025 USA; http://shop.hawthornecountrystore.com/browse.cfm/poultry/feeders-waterers/plastic-mason-jar-waterer-base-in-colors/4,1952.html?AFF=BASE.

Red Incandescent Bulb (25W): Available at hardware stores and supermarkets; see also Light Bulbs Etc, Inc., 14821 W. 99th Street, Lenexa, KS 66215 USA; http://www.lightbulbsdirect.com/Merchant2/merchant. mvc?Screen=PROD&Product_Code=25ACR&Category_Code=HolGRIncan&Product_Count=12.

Rep-Cal® Calcium (without phosphorous or Vitamin D3, #220 or 225): Rep-Cal® Research Labs, P.O. Box 727, Los Gatos, CA 95031; http://www.repcal.com/supp.htm.

Soil Mix: Available at garden supply stores; see also Amazon.com; http://www.amazon.com/Miracle-Gro-Organic-Potting-Mix-7298665/dp/B000BZ1HXI.

Sponge (sea wool): Florida Sponge Company, P.O. Box 1012, Pinellas Park, Florida 33780 USA; http://www.floridasponges.com/seawool.htm.

Sunflower seed: Available at pet supply or seed and feed stores; see also PETCO Animals Supplies, Inc. 9125 Rehco Road, San Diego, CA 92121 USA; http://www.petco.com/product/5524/PETCO-Black-Oil-Sunflower-Seed.aspx. Vionate® Vitamin/Mineral Powder (Product No. 99440): Available at pet supply stores; see also Gimborn Pet Specialties, LLC, 4280 N.E. Expressway, Atlanta, GA 30340 USA.
Waxworms for Culturing: Available from most insect suppliers; see also Grubco Inc., P.O. Box 15001, Hamilton, OH 45015 USA; http://www.grubco.com/.
Wick (cotton): Available at hardware stores; see also Amazon.com; http://www.amazon.com/Lamplight-Farms-4-Inch-Cotton-3-Pack/dp/B001B07AE2.
Window Screen (metal): Available at hardware stores; also available at Metro Screenworks, Inc., 4111 S Natches Court, Suite A, Englewood, CO 80110 USA; call 1-800-413-2579 to place an order for a partial roll or cut piece.

Acknowledgements
I thank Dietrich Schaaf for his helpful comments on the manuscript.

References
Barnard, S.M. (1986). Feeding captive insectivorous bats: Maintenance of food colonies. *Animal Keepers' Forum,* 13: 81–87.
Barnard, S.M. (1995). *Bats in Captivity.* Wild Ones Animal Books, Springville, CA. 194 pp.
Duffey, S.S. & G.G.E. Scudder (1972). Cardiac glycosides in North American Asclepiadaceae, a basis for unpalatability in brightly colored Hemiptera and Coleoptera. *Journal of Insect Physiology,* 18: 63–78.
Dutky, S.R., J.V. Thompson & G.E. Cantwell (1962). A technique for mass rearing the greater wax moth (Lepidoptera: Galleriidae). *Entomological Society of Washington,* 64: 56–58.
Dunn, G.A. (1993). *Caring for Insect Livestock: An Insect Rearing Manual.* Young Entomologists; Society, Inc., Lansing, MI. 96 pp.
Food Insects Newsletter. (1996). Raising mealwoms. Volume 9, Issue #1; http://www.hollowtop.com/finl_html/mealworms.htm, accessed July 2010.
Fraser, J. & M.C. Nelson (1984). Communication in the courtship of the Madagascan hissing cockroach: Normal courtship. *Animal Behavior,* 32: 194–203.
F**reeman, P.W. (1981).** Correspondence of food habits and morphology in insectivorous bats. *Journal of Mammalogy,* 62:166–173.
Ladisch, P.K., S.K. Ladisch & P.M. Howe (1967). Quinoid secretions in grain and flour beetles. *Nature,* 215: 939–940.
Scudder, G.G.E. & S.S. Duffey (1972). Cardiac glycosides in the Lygaeinae (Hemiptera: Lygaeidae). *Canadian Journal of Zoology,* 50: 35–42.

Background Reading
In addition to the literature cited above, the following sources were reviewed; accessed July 2010:
Carolina Arthropods Manual. 1982. Carolina Biological Supply Company, Burlington, NC. 35 pp.
Pesticide Education Resources. 2009. Cockroach Control Manual. University of Nebraska, Lincoln, NE. 63 pp.
Strzelewicz, M.A., Ullrey, D.E., Schafer, S.F., and Bacon, J.P. 1985. Feeding insectivores: Increasing the calcium content of wax moth (Galleria mellonella) larvae. *Journal of Zoo and Animal Medicine,* 16:25-27.
Tarshis, I.B. 1961. Breeding cockroaches for feeding purposes. In: *The International Zoo Yearbook,* Vol. III (Jarvis C. and Morris, D., eds). The Zoological Society of London by Hutchinson of London, England. Pp. 105-107.
Van Den Sande, P. and Van Den Bergh, W. 1976. Insect colonies and hydroponic culture as a source of food for zoological gardens. *International Zoo Yearbook,* 16:57-62.
The following URLs were accessed July 2010.
http://www.accessexcellence.org/RC/CT/roach.php.
http://en.wikipedia.org/wiki/American_cockroach.
http://en.wikipedia.org/wiki/Brown-banded_cockroach.
http://en.wikipedia.org/wiki/Discoid_cockroach.
http://en.wikipedia.org/wiki/Galleria_mellonella.
http://en.wikipedia.org/wiki/German_cockroach.
http://en.wikipedia.org/wiki/Madagascar_hissing_cockroach.
http://en.wikipedia.org/wiki/File:Oncopeltusfasciatus.jpg.
http://en.wikipedia.org/wiki/Oriental_cockroach.
http://ento.psu.edu/extension/factsheets/brown-banded-cockroaches.
http://insected.arizona.edu/milkrear.htm.
http://www.amentsoc.org/insects/caresheets/crickets.html.
http://www.ca.uky.edu/ENTOMOLOGY/entfacts/ef002.asp.
http://www.ca.uky.edu/entomology/entfacts/ef007.asp.
http://www.ca.uky.edu/ENTOMOLOGY/entfacts/ef011.asp.
http://www.life.illinois.edu/ib/109/Insect%20rearing/milkweedbug.html.
http://www.progeckos.com/caresheets/cricket.htm.
http://www.progeckos.com/caresheets/discoid.htm.
http://www.topline-2000.com/roach/hiscare.html.

Bat conservation initiatives in Tanahun District of Western Nepal

Laxmi Karki*

Bats are the most relatively inconspicuous because they are active by night, hidden by day and wary of human contact. People had misconception regarding bats and valued less. They were killed in alarming rate due to absence of knowledge in the project area. Earlier the habitat of this creature and its fruit plants were deforested by local people for fuel wood and timber, as well as many caves are used by livestock header. They used fire in the cave for removing bat, and making shelter for their livestock and themselves. Habitat had been destructed due to unmanaged tourism, deforestation and killing them for curing some disease. Especially conservation of bats hinders when the real value of the bats is not perceived well.

Workshop on bats

With the objective to create awareness among the school students and community people about importance of bats series of awareness programs were conducted between September 2010 - August 2011 in Tahanun District of Western Nepal by airing a Radio program, distributing brochures, Wall papers in schools, Interviews and Workshop.

Students were distributed brochure on bats

The project area selected was Tanahun district (27^0 74' - 28^0 13' Lat, 83^0 94' - 84^0 56' Lon, Altitude 200 – 2325 msl, Area 1,546 Sq. Km), situated in the Western Development Region of Nepal. This area was selected because of the roosting site of *Ia io* which is critically endangered and only reported to be found from Tanahu district in Nepal. Following survey (Chaudhary, A., (2011)) and Ghimire et al. (2010)) did not report existence of *Ia io* from the study area. Tanahun district have lot of tourist importance caves and generate some income for the society with the entrance fee from the tourist. Visual encounter surveys had been conducted and bat had been identified roosting in following caves respectively Byas Cave, Siddha Cave Bimalnagar, Parasar Cave, Millennium Cave, Siddha Cave Bhanumate. Siddha cave is main tourist destination in the area which is also the roosting site of *Ia io*. 7 Species (*Rhinolophus affinis, Rhinolophus pusillus, Rhinolophus macrotis, Rhinolophus pearsonni, Hipposideros armiger, Ia io, Miniopterus schreibersii)* are reported to be found roosting within the district (Csorba et al. (1999)).School children and Community people are the main target group who can play an important role in the conservation of these species. School children are the future pillar for bio diversity conservation and if these groups are made aware about the ecological and economical role of bat through school teaching program, then we can assure the survival of threatened species in the long run. Community people are one who make frequent use of the bat habitat knowingly or unknowingly.

Conservationist, youth clubs, facilitators, government officials (Forest; Wildlife; Soil and Watershed Management) and political leaders are the responsible bodies to play active role in biodiversity management. If these bodies also know the ecological and economical value of bats, then we can be sure for the long term survival of this species. Because it is very essential to create understanding about nature conservation among

***Conservation and Awareness Dept., Natural Resources Research and Conservation Center (NaReCon)**
Email: narecon@yahoo.com

people and it will be effective if it is started from grass root level (Adhikari and Karki, 2010).

So this program was really targeted to the school students through direct school teaching programs in 12 school and workshop with the local leaders for the management of the bats habitat. Local people were made aware using F.M. Radio media to cover around 2 million people in and around project areas. Published brochure and wall paper will aware more students and local people in the long run.

1. F.M Radio Program production and lunch

Eight episodes of F.M. radio program "**Prakriti ra Sampada" (Nature and Resources)** on bats were launched from radio station "Radio Tanahun" every Sunday evening from 5.30 to 6 pm in Nepali language. The coverage of this station covers inhabitants of more than 2 million people (http://www.radiotanahun.com/detail). Episodes were designed in such a way that even local people who were illiterate could make picture in their mind. First episodes included really basic information on bats, but on further episodes species description, their habitat character, etc were broadcasted. Feedback was collected from people on the content broadcasted during the program and improvements were done. Some time the information were totally new for them which need more clarification and more information to make them clear on the topic. But some time some biology graduates found those information very general and were requesting more scientific input in episodes. So, balance was kept not to lose any of our listeners. Quality of materials broadcasted, peoples expectation in next episodes, etc were asked during feedback session. Various interesting information to listeners were included in every episodes along with summary of some bat research in and around Tanahun district.

Pre and post feedback were collected from listeners. Before launching the first episode, people expectation and knowledge survey was done. During the program their feedback that were received during formal/informal field visit, telephone and letters. Pre survey of the listeners was done by field visit in many part of the project site. Their knowledge , belief and misconceptions was collected and during each episodes such misconceptions were clarified and their positive knowledge and belief were given encouragement. The content of overall episodes was mainly concentrated on what is bat? Why and how to conserve them? Ecological and Economical importance of bats in the society; Status of bat research; Organization working on bats in Nepal and project site; role in pollination, insect predation, seed dispersal; safety measures during bat watching; guidance to local tourists during cave visit; roosting sites and feeding areas in project site; status of their roosting sites; why they hang upside down?

One episode covered an interview with IUCN SSC Bat Specialist Group, Nepal representative Mr. Hari Adhikari from Germany which was taken through the use of Skype. He informed all the listeners about the actual status of bats in Nepal and removed misconception from peoples mind. Various interviews from cave management committees, bat cave guides, local people, and conservationist were also included in various episodes to make the program livelier. During this interview, interviewee explained the importance of bats in the region and their status in the project area. Local people voice and their memory on status of bats in past was included and broadcasted. These things grew interest of local people and their participation in sending feedback was increased.

Post survey done in the field by asking various information with local people and found that the level of misconception was relatively low. Recent bachelor thesis submitted by Anand Chaudary in Forestry college in Pokhara, Nepal also states that most of people were giving credit to the F.M Radio program (Chaudhary, A., (2011)).

During these episodes, we came across the information on various roosting sites of bats which were not really publically known. Thus covering huge areas with the strong signal of F.M. Radio and more that 2 million listeners. These 8 episodes contributed a lot for changing people's knowledge on bats and their status(Chaudhary, A., (2011)).

2. Program among students and local people

Conservation of any species in long run cannot be successful without participating students. Students are the decision maker in future. With this objective in mind 12 schools were selected in the project area and 40 students from each school were selected from Grade 5 to 10 for the school teaching program. School that are near the caves and bat habitat were selected. Five schools were selected under this project and seven during regular awareness camp of Natural Resources Research and Conservation Center (NaReCon). NaReCon have been conducting regular awareness programs on bats using volunteers in Tanahun, Palpa, Rupendehi and Kaski districts. Students were selected with the help of the teachers. Criteria were set 1) Active, interested and talent student in class 2) Leadership qualities and information sharing ability 3) Representing various areas of the project site 4) Girls were given equal opportunity to be selected. These criteria were given to teachers so they could select their students whom they know to have at least 2 criteria fulfilled. These selected students were busy for the whole day with interactive program. Students from Institute of Forestry College and few representatives from Society for Wildlife Research and Conservation (SOWREC) and BAT FRIENDS were involved in teaching students. As the class was crowded with 40 students, these tutors were engaged to make students understand every topic discussed during the day. During the short time it was not possible to include each and every student from the school. So, based on the criteria, it was assumed that these 40 students will be engaged later to discuss with other students from their class about what they learned from this one day discussion.

Three videos were shown from projector on bats pollination, insect predation and seed dispersal. It was found that students learned and remembered more on the topic which was added with videos and photos. So it was found that these videos were more effective in sharing information.

Power point presentations as well as hand written materials were prepared to use based on the situation. These materials were mainly related to importance of bats on ecology and economy as well as various games and role play prepared by ZOO. In remote schools, hand written

materials were used due to lack of electricity and in some urban areas which had access to electricity both Power point presentation and hand written materials were used. Students were given Brochure on bats prepared during this project as well as other education kits supplied by NaReCon and Zoo Outreach Organization (ZOO).

Students were grouped and art, essay and quiz competition were conducted wherever possible. Winner group were awarded small prize in each competition. It was found that students grabbed much information on bats and added information what they had known from their family during essay competition. During the end of the program students were asked to compose a song on bats and sing on their own style.

3. Workshop

May 15, 2011:

Workshop was conducted near the Siddhacave in Bimalnagar Tanahun. Forest ranger, District forest officer, Local leaders, Caves care takers, Cave management committee members, Youth club representative, Local NGOs working on wildlife were participated in that program. It was arranged by the Government representative and wildlife expert from Institute of Forestry. Information on bats was circulated through the use of videos, PowerPoint slides presentation and manuscripts. Participant presented their own initiatives for bat conservation in their area and discussion was done on those initiatives to make it more efficient and broadly applicable. Big management plans which need huge funding in the long run were not agreed. As there is no sustainable future funding source, so only those activities which is possible using local budget and local resources were agreed at the end. In the mean time, strict rules are set for cave visitors and fines are fixed based on the habitat and species disturbance they make during their visit. Commitment from the participant to include steps for bat conservation in their organization activities and in their management plans was achieved.

4. Publication

1000 copies of color format Brochure was published in Nepali language and distributed to all the participant during this project. Around 500 brochure were given to students in twelve schools during school teaching program. Photos of bats that were taken during the whole project were kept in the brochure. It was also provided to all the participant during formal and informal interviews, field visit to caves, tourist encountered during cave visit.

Various awareness materials were downloaded from website of organization mainly working on bats (Zoo Outreach Organization, Bat Conservation International, Bat Conservation Trust, NaReCon and Lubee Bat Conservancy) and translated in Nepali language to broadcast in the F.M Radio program. After airing Radio program during this project, these materials were also provided to the other radio station for including that information in other biodiversity related programs. During school teaching program, students were guided to prepare the wall paper on bats. Interesting information on bats were collected and written as well as bat photo were printed on wall paper. Every school was provided with the color and paper for preparing the wall paper. This wall paper in each school will create awareness among other students.

5. Project outcomes evaluation

Pre and Post information level survey was done among the participants during the school teaching program and interview with the listener of F.M program to know the level of change in knowledge regarding bats. Around 98 people were interviewed and 200 students were involved in the pre and post survey. It was found that knowledge on bats increased by around 76% among the participants. Active involvement of cave guides, cave management representatives, government bodies, NGOs and media people during interviews and workshop as well as feedback to FM radio program was achieved in the project site during this program. This was first program in itself regarding bats in their area, so people were happy to know ecological and economic importance of bats for them in their daily life and remove unscientific misconception which they had from generations. Cave management committee were in process to include safety measures for bats during cave visit and fine tourists who void the rules and regulation made by cave management committee.

Acknowledgement

I would like to thank Mr. Hari Adhikari (Member- IUCN / SSC Bat Specialist Group) and Raj Kumar Koirala (Institute of Forestry) for their guidance throughout the completion of this project and project assistants Kina K.C and Nischal Adhikari (NaReCon), Rakesh Kunwar (Society for Wildlife Research and Conservation (SOWREC)), Nirojman Shrestha, Anand Chaudhary and Bimala Paudel (BAT FRIENDS) for their valuable help during this project. I am indebted to Oregon Zoo and Natural Resource Research and Conservation Center (NaReCon) for their financial support. Without their funding, this program would not have been possible. Heartful thanks to Zoo Outreach Organization for educational materials and Radio Tanahun for creating radio episodes. I would also like to thank the reviewer for his precious comments and suggestion to make this article better than earlier.

References

Adhikari, H. & L. Karki (2010). Research and Conservation Awareness of Bats in Palpa District of Nepal. *Small Mammal Mail* 2(1): 33-35.

Csorba, G., S.V. Kruskop & A.V. Borissenko (1999). Recent records of bats Chiroptera) from Nepal, with remarks on their natural history. *Mammalia* 63(1): 61-78.

Chaudhary, A. (2011). Species Identification and local people's perception towards bat (A case study from Tahanun District). A thesis submitted to Institute of Forestry, Pokhara Campus, Tribhuvan University for the partial fulfillment of the requirement of B.Sc Forestry degree, November 2011.

Ghimire, R., S. Acharya & S.B. Thapa (2010). *Monitoring of Chiropteran Status in Tanahun District*. Small Mammals Conservation Club, Central Department of Environmental Science, Tribhuvan University, Kirtipur, Kathmandu and Small Mammals Conservation and Research Foundation, New Baneshwor, Kathmandu, Nepal, iv+35pp.

Distribution and movement of *Pteropus giganteus* in Tirunelveli and Tuticorin districts of Tamil Nadu, India

Sudhakaran, M.R.,[1] and D.P. Swami Doss[2]

Abstract

We studied the distribution, roost characteristics and dynamics of *Pteropus giganteus* in Tirunelveli and Tuticorin districts of Tamil Nadu, India. A total of 21 roosting sites were observed. Roost site selection, roosting tree selection, formation of main camps and non-breeding camps were observed. Out of the 21 roosts, 4 roosts were breeding roost. A population fluctuation was observed during the breeding and non-breeding seasons. Study made on the movement of *P. giganteus* revealed that, female bats move towards the main camps during the mating season and they move back to the non-breeding camps during the post-parturient and lactating periods.

Introduction

Distribution, survey and ecological studies are found to be important, because they not only bring out knowledge about the diversity of bat fauna but also on the habit and habitat requirements and the conservation strategies of bats (Bergallo *et al*. 2003). Bats spend over half of their lives subjected to selective pressures of their roost environment; thus it is not surprising that the conditions and events associated with roosting have played a prominent role in their ecology and evolution. Roosts provide sites for mating, hibernation and rearing young; they promote social interactions and they offer protection from adverse weather and predators. Conditions that balance natality and mortality and enhance survivorship are intimately linked to roost characteristics and are paramount to the success of a species. The roosting ecology of bats can be viewed as a complex interaction of physiological, behavioural and morphological adaptations and demographic response (Kunz 1982). The stability and availability of roost may influence the survival, reproduction and distribution of bats (Humphrey 1975; Bell *et al*. 1986).

Several species of bats are found to have a higher fidelity to its roost. Roost fidelity is mostly affected by the relative abundance and permanency of roost sites, the proximity and stability of food resources, response to predator pressure and human disturbance. Roost fidelity may change seasonally and it can be affected by reproductive condition, sex, age and social organization (Bradbury 1977). Roost fidelity appears to be highest during the maternity period (Humphrey 1975). Frugivorous bats exhibit migratory movements in search of food and seasonal changes especially in the tropical areas (Nelson 1965a).

Ecology related studies of megachiropterans are very few and found to be crucial considering the rate at which habitat available for them are being lost (Wilson and Engbring 1992). Tidemann *et al.* (1999) and Fenton *et al*. (2000) have projected the lacunae in the studies on habitat ecology and roosting behaviour of Megachiroptera and several other bats.

The present investigation was made to survey the distributional patterns of megachiropterans in the southern districts (*viz.*, Tirunelveli and Tuticorin) of Tamil Nadu and to study the roost characteristics, and population structure of the Indian flying fox, *Pteropus giganteus*.

Methodology

Survey on distribution of megachiropteran bats was conducted in the plains of Tirunelveli (08º 8′ and 09º 23′ N and 77º 09′ and 77º 54′ E) and Tuticorin (08º 45′ N and 78º 13′ E) districts of Tamil Nadu, South India for a period of one year from January 2009 to December 2009. Periodic visits were made to the bat roosting sites throughout the plains in the two districts. Bat roosts were located based on the local enquiries from the people. Field visits were made to observe the diurnal roosting sites of *P. giganteus* in the study area. The information regarding the lability of roost by bats were collected from the local people. Roosting tree dimensions such as the tree height, crown area (Crown area = r_1 X r_2 X r_3X r_4 / 4, where r_1 , r_2 , r_3 and r_4 are the circumference radius of the crown at four sides) and the tree species were recorded.

To study the population dynamics of *P. giganteus*, population structure of the colony was observed at regular intervals throughout the year. Sex ratio of the colony, colony size, and type of colony (Breeding camp/non-breeding camp) were also observed. Binocular (Super Zenith, Field 5º) and night vision scopes were used to observe the structure of the colony. By using evening dispersal count methods and direct count methods, total number of bats in the colony was counted and total population was estimated for individual month of the year at regular intervals. Male bats in the colony were differentiated by observing the genitalia and capturing them at foraging grounds using mistnets (Sudhakaran and Doss 2009).

Results

Distribution

P. giganteus was found in 15 roosts in the Tirunelveli district and 6 roosts in Tuticorin district (Table 1). The bats were found to roost in the trees of *Ficus benghalensis, Bassia latifolia* and *Terminalia arjuna* (Table 1).

Roost characteristics

Roost occupancy of *P. giganteus* varied from 5 years to more than 70 years. They were found to roost in the foliage of *Terminalia arjuna* (43.3%), *Bassia latifolia* (16.6%), *Ficus bengalensis* (10%), occasionally in *Ficus religiosa* (3.3%) and *Tamarindus indica* (3.3%) trees. All the roosting trees were found to be taller and with a greater crown area. The average height of *T. arjuna* was 61.82 ± 5.86 ft, with a crown area of 22.98 ± 3.91 ft (n=4). The average height of *F. benghalensis* was 61.5 ±

[1]Department of Zoology, Sri Paramakalyani College, Alwarkurichi, Tamil Nadu, India (corresponding author)
[2]Department of Animal Behaviour and Physiology, Madurai Kamaraj University, Tamil Nadu, India

Table 1: Distribution of *P. giganteus*

NO	DISTRICT	TALUK	PLACE	ROOSTING TREE
1	Tirunelveli	Nanguneri	Padmaneri	*Ficus bengalensis*
			Nanguneri	*Terminalia arjuna*
		Ambasamudram	Thirupoodaimaruthoor	*Terminalia arjuna*
				Bassia latifolia
			Kallidaikurichi	*Bassia latifolia*
			Sivasailam	*Terminalia arjuna*
			Pattamurukku	*Terminalia arjuna*
		V.K. Pudhur	V.K. Pudhur	*Bassia latifolia*
			Courtallam	*Bassia latifolia*
			Kadayam	*Terminalia arjuna*
			Tenkasi	*Terminalia arjuna*
			Karuppanathi	*Ficus bengalensis*
		Radhapuram	Panagudi	*Terminalia arjuna*
		Tirunelveli	Tirunelveli-town	*Ficus bengalensis*
			Sankar Nagar	*Ficus bengalensis*
			Rajavillipuram	*Terminalia arjuna*
2	Tuticorin	Ottapidaram	Akilandapuram 1	*Ficus bengalensis*
			Akilandapuram 2	*Ficus bengalensis*
			Attur	*Terminalia arjuna*
				Ficus bengalensis
		Srivaikundam	Eral	*Terminalia arjuna*
			Srivaikundam	*Terminalia arjuna*
			Murappanadu	*Terminalia arjuna*

6.33 sqft, with a crown area of 23.17 ± 4 sqft (n=10). The average height of *B. latifolia* was 63.3 ± 6.2 ft, with a crown area of 22.65 ± 3.96 sqft (n=12). The height of *F. religiosa* and *T. indica* was 60 ft and 62 ft, with a crown area of 20 sqft and 10 sqft respectively. When the size of the colony increases, the bats were found to use nearby trees as their roosting trees. All the roosts were mostly adjacent to water bodies, that is, nearer to rivers or ponds. A total of 19 roosts were found to be present on the banks of perennial Thamirabarani river (Plate 1, map).

Movement

A year round study was made on the population structure of *P. giganteus* in 21 roosts selected in the study area (Table 2). *P. giganteus* was observed to form two distinct types of roosting camps, one was a breeding camp and the other one was a non-breeding camp. A seasonal fluctuation in the population size of the colony was observed with a change in the ratio of female bats in breeding and non-breeding camps.

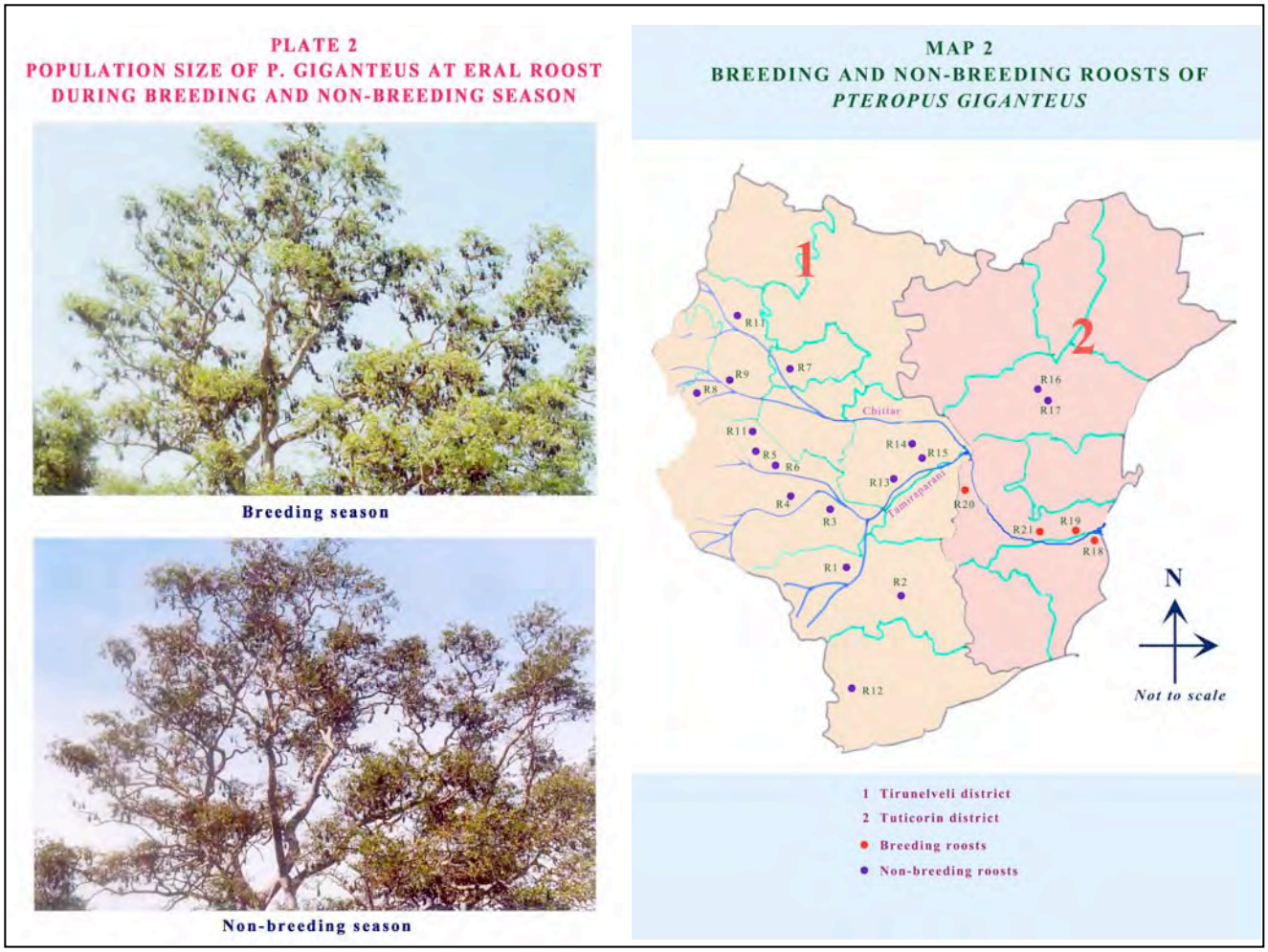


Plate and Map

Table 2: Population size of *Pteropus giganteus* in breeding and non-breeding camps Tirunelveli and Tuticorin districts, Tamil Nadu, India

NO	PLACE	MONTHS OF THE YEAR												CAMP TYPE
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
1	Srivaikundam	1000	950	1000	1150	2500	3000	7000	12000	16000	8000	5000	1500	B
2	Padmaneri	1300	1500	1000	850	1000	1000	1300	1000	400	550	1000	1200	NB
3	Thirupudaimaruthoor	1400	1200	1000	1200	1100	1050	900	1000	250	400	900	1300	NB
4	Kallidaikurichi	1000	1800	1600	1690	1400	1300	900	100	80	60	550	800	NB
5	Sivasailam	1100	1050	900	650	700	700	450	0	0	400	800	1000	NB
6	Papankulam	1300	1200	1000	950	800	850	700	500	350	650	800	1100	NB
7	V.K puthur	1500	1400	1400	1400	1200	1200	1000	800	800	1000	1000	1300	B
8	Nanguneri	1800	1400	1500	1400	1500	1500	1000	550	600	500	850	1500	NB
9	Panagudi	800	550	350	250	300	300	450	80	85	800	900	1250	NB
10	Courtallam	300	400	500	800	700	0	0	0	0	400	500	500	NB
11	Tenkasi	200	200	100	200	50	0	0	0	0	250	300	300	NB
12	Athur	1200	1450	1500	1400	1450	2000	1400	4500	1600	950	1000	1100	B
13	Eral	400	600	800	1000	1400	1600	1200	1500	2100	500	300	375	B
14	Murapanadu	600	650	700	780	850	850	850	500	450	600	700	800	NB
15	Akilandapuram I	150	200	250	200	250	200	150	34	0	50	100	100	NB
16	Akilandapuram II	800	0	100	50	0	0	0	0	200	250	50	100	NB
17	Tirunelveli Town	800	900	1000	1200	1400	1400	1500	600	220	400	500	700	NB
18	Karuppanathi	200	300	400	450	0	0	0	0	0	180	300	400	NB
19	Sankarnagar I	0	0	250	400	500	600	600	500	85	100	150	20	NB
20	Rajavillipuram	450	400	300	200	450	80	0	0	0	100	100	100	NB
21	Kadayam	400	450	450	100	80	100	0	0	0	20	80	150	NB
Total		16700	16600	16100	16320	17630	17730	19400	23664	23220	16160	15880	15595	

B – Breeding; NB – Non Breeding

Breeding camp is the roosting site where mating occurs. The aggregation of female bats in the breeding camp starts from the month of March and maximum number of female bats reaches in the month of August and September. Mating occurs in the month of August and September in the breeding camps, after mating season female bats were found to disperse to the non-breeding camps. Non-breeding camp is the roosting site where parturition occurs. Parturition occurs in the months of February and March. In non-breeding camps parturient and pregnant bats were found to be maximum in the months of October to March. Then a gradual decrease in the size of the colony appears from the month of March, where the female bats starts moving to the breeding camps after the completion of delivery. Female bats along with newborn young ones were evenly distributed in the breeding and non-breeding camps from the month of March. The population of male bats in breeding camps was high compared to non-breeding camps.

Study made on the roosting site of *P. giganteus* revealed that 4 roosting sites were observed as breeding camps, and they were at Srivaikundam, V.K. Puthur, Athur and Eral. The colony size was observed to be maximum in the months of August and September (mating season) in the breeding camps (Plate 1, photo). In Srivaikundam breeding camp, the population size reached around 16,000 individuals in the mating season, which is almost 69.57% of the total population size. In all the breeding camps, a maximum colony size was observed during the months of August and September. After mating season, female bats disperse to the non-breeding camp, where as in the breeding camps the male bats were mostly present along with a few juveniles and subadults. The percentage of male bat was higher during the month of November to May in Srivaikundam (88%), Athur (95%), Eral (89%) and V.K. Puthur (92%) breeding roosts.

A total of 17 bat roosting colonies were observed as non-breeding camps which includes, Nanguneri, Padmaneri, Thirupodaimaruthur, Kallidaikurichi, Pappankulam, Sivasilam, Pattamuruku, Panangudi, Courtallam, Tenkasi, Murappanadu, Akilandapuram 1 and 2, Tirunelveli town, Sankarnagar, Rajavillipuram and Kadayam. The proportion of female bats was higher in the months of January to March and October to December and a decrease in number of female bats was observed in the months of August to September in the non-breeding camps. During August and September, only male bats with a few subadult females were found in these colonies. In Akilandapuram roost during the month of August a (100%) all male bat population was observed (N=34). In colonies such as Courtallam, Tenkasi, Karuppanathi and Kadayam the roosting camps completely dispersed probably during the months of June, July and August and then the colony started building up only after September, i.e. after the end of mating season.

Discussion

Bats of the genus *Pteropus* are characterized as requiring a variety of geographic and ecological habitat characteristics (Pierson and Rainey 1992; Palmer and Woinarski 1999). Most of the roosting sites of *P. giganteus* were observed to nearer to the water bodies, 19 roosts were observed to be on the banks of river Thamirabarani. *P. scapulatus* and *P. gouldi* in Australia occurred along the river banks or water holes and occasional in open forests (Nelson 1965a,b). *P. conspicillatus* roosting sites are located near water, such as

lakes, river or along the coast and in a range of habitat types, such as riparian forest and mangroves as well as urban and sub-urban areas (Nelson 1965a; Lunney and Moon 1997; Hall 2002). Most of the roosting sites of *P. giganteus* were observed to be nearer to the human settlements. Even though the roost sites were nearer to human settlements, the roost sites are protected areas, such as nearer to police station, areas governed by local villagers, and in the base of the wild reserve forests, which make us to understand the nature of roost site selected by *P. giganteus* is to be protected sites, mainly free from hunting and other anthropogenic disturbances. Bates et al. (1994) reported that *P. giganteus* colonies could be located in close association with man and tend to be found in well-established trees in cities and villages.

In Tirunelveli and Tuticorin districts of Tamil Nadu, India the *P. giganteus* prefers to roost mostly on *T. arjuna* and *F. bengalensis*. Roost preference may be mainly due to the height of the tree (Brooke et al. 2000) and trees with large circumference of the crown (Barclay *et al.* 1988). *T. arjuna* and *F. bengalensis* are large trees, which may be useful for the bats to get protection, and to escapes from the predators as like of that in *P. mariannus* (Wiles *et al.* 1997).

Brooke *et al.* (2000) reported that Samoan flying fox select its roosting trees that were forming part of the bats diet and trees with leaves and branches that camouflage the bats to distinguish from enemies. Such an account was not congregate to the observation done in *P. giganteus* as a whole, only roosting trees of *F. bengalensis* and *B. latifolia* was observed to form a part of its diet whereas the most favoured tree roost *T. arjuna* was not in its diet. Most *Pteropus* species roost in the emergent trees often in areas with topographic features that offer protection from strong winds, assist in thermoregulation, and provide access to updrafts for easier flight (Cheke and Dahl 1981; Pierson and Rainey 1992; Richmond *et al*. 1998).

P. giganteus roost in colonies. Gregarious roosting serves many biological functions such as protection from predators and from adverse environmental conditions. In general, roosting influences foraging and facilitates successful foraging by communication about the location of feeding areas (Fleming 1982).

McCann (1934) reported the presence of two types of roost in *P. giganteus* one the breeding roost and the other non-breeding roost. Our study also revealed a similar pattern of roost types. In various *Pteropus* sp. also such formation of campsites was reported, the campsite depends on the foraging and breeding cycle as observed in *P. poliocephalus* (Nelson 1965a; Parry–Jones and Augee 2001), *P. livingstonii* (Granek 2002), *P. alecto* (Palmer and Woinarksi 1999; Vardon *et al*. 2001), *P. scapulatus* (Vardon et al. 2001), *P. samoensis* (Brooke 2001). Along with the foraging requirements reproductive success was also be the important factor for such types (Nelson 1965a). *P. poliocephalus* (Nelson 1965a) gather in numbers during its reproductive cycle, such kind of gathering was found in *P. giganteus*.

The breeding camp of *P. giganteus* was observed to be age-old camps and the population was observed to be higher in number than other colonies during mating seasons. Tidemann *et al*. (1999) reported such types of colonies mostly depend on the size, age-sex structure and pattern of occupation. They also reported that main camps are occupied by more than 1000 individuals and important for mating or parturition and the other type of camp, the satellite camp with less than or equal to 1000 individuals with an age-sex structure biased towards male and/or sub adults. Similar structural biased with sex-age and size was observed in *P. giganteus* where, the breeding camps are huge colonies, where mainly mating and parturition occurs. *Pteropus* species exhibit dramatic seasonal change in roost composition and colony size (Pierson and Rainey 1992; Granek 2002) and *P. giganteus* is no exception, with significant variation in roost sites recorded between the breeding and non-breeding roost. The main camps of *P. giganteus* were observed to increase during the timing of mating as in *P. alecto* and *P. scapulatus* (Vardon *et al.* 2001).

Tidemann and Nelson (2004) suggested that the competition for foraging opportunities might be the major factor evolving the bats to disperse to various roosting sites. Such a factor is also prevailing in *P. giganteus*, as the bat movements to non-breeding are mostly in the areas with high foraging opportunities. Hence the camp formation in *Pteropus* species is thought to be mainly of collective factors like to avoid competition for roosting, reproductive success and foraging opportunities.

References

Barclay, R.M.R., P.A. Faure & D.R. Farr (1988). Roosting behaviour and roost selection by migratory silver-haired bats (*Lasionycteris noctivagans*). *J. Mammal.* 69(4): 821–825.

Bates, P.J.J., D.L. Harrison & M. Muni (1994). The bats of western India. Part I. *Journal of the Bombay Natural History Society* 91(1): 1–15.

Bell, G.P., G.A. Bartholomew & K.A. Nagy (1986). The roles of energetics, water economy, foraging behaviour and geothermal refugia in the distribution of the bat, *Macrotus californicus*. *J. Biochem. Physiol*., B 156: 441–450.

Bergallo, H. G., G.E.L. Esberard, G.G.S. Mello & H. Bapista (2003). Bat species richness in Atlantic forest: What is the minimum sampling effort? *Biotropica*. 35(2): 278–288.

Bradbury, J.W. (1977). Social organization and communication, pp. 1-72. In: Wimsatt, W.A. (eds.). *Biology of Bats - Vol. 3.* Academic Press, New York, 651pp.

Brooke, A.P. (2001). Population status and behaviours of the Samoan flying fox (*Pteropus samoensis*) on Tutuila Island, American Samoa. *Jour. of Zool. (London)* 254: 309–319.

Cheke, A.S. & J.F. Dahl (1981). The status of bats on Western Indian Ocean Islands, with special reference to *Pteropus*. *Mammalia* 45: 205–238.

Fenton, M.B., M.J. Vonhof, S. Bouchard, S.A. Gill, D.S. Johnston, F.A. Reid, D.K. Riskia, K.L. Standing, J.R. Taylor & R. Wagner (2000). Roots used by *Sturnia lilium* (Chiroptera: Phyllostomidae) in Belize. *Biotropica.* 32(4a): 729–733.

Fleming, T.H. (1982). Foraging strategies of plant–visiting Bats, pp. 287–325. In: Kunz, T.H. (eds.). *Ecology of Bats*. Plenum Press, New York, London.

Granek, E. (2002). Conservation of *Pteropus livingstonii* based on roost site habitat characteristics on Anjouan and Moheli, Comoros Islands. *Biol. Conser.,* 108: 93–100.
Hall, L.S. (2002). Management of flying–fox camps: what have we learnt in the last twenty-five years, pp. 215–244. In: Eby, P. & D. Lunney (eds.). *Managing The Grey–headed Flying–fox As A Threatened Species in New South Wales.* Mosman, NSW: Royal Zoological Society of New South Wales.
Humphrey, S.R. (1975). Nursery roosts and community diversity of neartic bats. *J. Mammal*. 56: 321–346.
Kunz, T.H. (1982). *Ecology of Bats.* Plenum Press, New York.
Lunney, D. & C. Moon (1997). Flying–foxes and their camps in the rainforest remnants of north–east NSW, pp. 247–277. In: Dargavel, J. (eds.). *Australia's Ever–changing Forests III.* Canberra: Centre for Resource and Environmental Studies, Australian National University.
McCann, C. (1934). Notes on the flying fox (*Pteropus giganteus* Brunn). *Journal of the Bombay Natural History Society* 37: 143–149.
Nelson, J.E. (1965a). Behavior of Australian Pteropodidae (Megachiroptera). *Anim. Behav.* 13(4): 544–560.
Nelson, J.E. (1965b). Movements of Austrian flying foxes. (Pteropodidae, Megachiropera). *Aust. J. Zool.* 13: 53–73
Palmer, C. & J.C.Z. Woinarski (1999). Seasonal roosts and foraging movements of the black flying fox (*Pteropus alecto*) in the Northern Territory: using radio tracking in a landscape mosaic. *Wildlife Research*. 26: 823–838.
Parry–Jones, K.A. & M.L. Augee (1991). The diet of flying–foxes in the Sydney and Gosford areas of New South Wales, based on sighting reports 1986–1990. *Aust. Zool.* 27: 49–54.
Parry–Jones, K.A. & M.L. Augee (2001). Factors affecting the occupation of a colony site in Sydney, New South Wales by the grey-headed flying-fox *Pteropus poliocephalus* (Pteropodidae). *Aust. Ecol.,* 26, 47–55.
Pierson, E.D. & W.E. Rainey (1992). The biology of flying foxes of the genus *Pteropus*: a review, pp. 1-17. In: Pacific Island flying foxes: Proceedings of an international conservation conference.
Richmond, J.Q., S.A. Banack, & G.S. Grant (1998). Comparative analysis of wing morphology, flight behaviour, and habitat use in flying foxes (Genus: *Pteropus*). *Aust. Jour. Zool.,* 46: 283–289.
Sudhakaran, M. R. & D.P.S. Doss (2009). Netting technique, capturing and handling of *Pteropus giganteus*. *Small Mammal Mail* 1(2): 31–32.
Tidemann, C., M. Vardon, A. Loughland & P. Brocklehurst (1999). Dry season camps of flying foxes (Pteropus spp.) in Kakadu world heritage area, north Australia. *Journal of Zoology London* 247: 155–163.
Tidemann, C.R. & J.E. Nelson (2004). Long-distance movements of the Grey-headed flying–fox, *Pteropus poliocephalus*. *Journal of Zoology London* 263: 141–146.
Vardon, M.J., S.P. Brockelhurst, J.C. Woinarski, R.B. Cunningham, C.F. Donnelly & C.R. Tidemann (2001). Seasonal habitat use by flying foxes, Pteropus alecto and P. scapulatus (Megachiroptera), in Australia. *Journal of Zoology London* 253: 523–535
Wiles, G. J., J. Engbring & D. Otoved (1997). Abundance, biology, and human exploitation of bats in the Palau Islands. *Journal of Zoology London* 241: 203–227.
Wilson, D. E. & J. Engbring (1992). The flying fox *Pteropus samoensis* and *Pteropus tonganus*: status in Fuji and Samoa. In: Pacific island flying foxes: proceeding of an international conservation conference,(Wilson. D. W., and G. L. Graham, Eds.). USFWS Biological Report Washington, D.C., 90(23): 74–101.

Third Seminar on Small Mammals Conservation Issues

"SMALL MAMMALS VULNERABLE TO CLIMATE CHANGE"
May 15, 2012; Kathmandu, Nepal

Small Mammals Conservation and Research Foundation (SMCRF), New Baneshwor, Kathmandu, Nepal celebrates United Nations Decade on Biodiversity through Seminar on Small Mammals Conservation Issues as an annual event in collaboration and support from different NGOs and INGOs. SMCRF announces the Call for papers and posters for the **"Third Seminar on Small Mammals Conservation Issues, May 15, 2012".** We consider Bats, Rodents, Lagomorphs, Small Cats and Carnivores under Small Mammals. We request for papers and posters from interested national, regional and international researchers, conservationists, freelancers and university students in this field.

Please contact:
Seminar Organizing Committee
Hem Bahadur Katuwal, Sunil Thapa, Rama Karki
TSSMCI-2012
smcrfseminar@gmail.com
www.smcrf.org

Abstract Call: January 19, 2012
Deadlines
Abstract Submission: February 25, 2012
Abstract Acceptance Notification: March 1, 2012
Full paper Submission: April 2, 2012
Full Paper Acceptance Notification: April 20, 2012

Occurrence of Fulvous Fruit Bat *Rousettus leschenaultii* (Desmarest) (Mammalia : Chiroptera) in Radhanagari Wildlife Sanctuary, Maharashtra, India

S. S. Talmale*

Introduction

Chiroptera constitutes the second most diverse order of class Mammalia with a total of 1116 species under 202 genera of 18 families reported worldwide (Simmons 2005). In India, 117 species of bats under 39 genera of 8 families (Talmale and Pradhan 2009) have been reported. In the state of Maharashtra, 40 species of bats belonging to 20 genera under 8 families have been reported (Talmale 2007). The distribution of Fulvous Fruit Bat/Leschenault's Rousette is throughout the country. This species prefers roosting in caves and man-made constructions (Brosset 1962; Bates and Harrison 1997). The bat fauna of Western Ghats estimates to a total of 52 species including 6 species of fruit-eating bats (Korad et al. 2007). Though its population is abundant in particular colonies, only six colonies were reported from northern part of Western Ghats (Korad and Gaikawad 2008). The present paper reports additional roosting colony of the *Rousettus leschenaultii* from Radhanagari Wildlife Sanctuary in the northern part of Western Ghats.

Material and Methods

Faunistic surveys of Radhanagari Wildlife Sanctuary in Kolhapur District, Maharashtra State were conducted from 2007 to 2010 by the scientists of Zoological Survey of India, Western Regional Centre, Pune. The Radhanagari Wildlife Sanctury lies between 16°15'00" to 16°29'54" North Latitude and 73°54'00" to 74°00'00" East Longitude. The Sanctuary was declared in 1958 which was named as Bison Sanctuary. It is now known as Radhanagari Wildlife Sanctuary with an total area of about 351.16 sq km (as notified on 16th Sept. 1985). The Sanctuary area falls in 5B Western Ghat Mountain province under Western Ghat Biogeographic Zone (Code 5) (Rodgers et al. 2000). The forest type is mainly the West coast semi-evergreen and southern moist-mixed tropical deciduous forest and at some places with west coast tropical evergreen forests (Pande 2005).

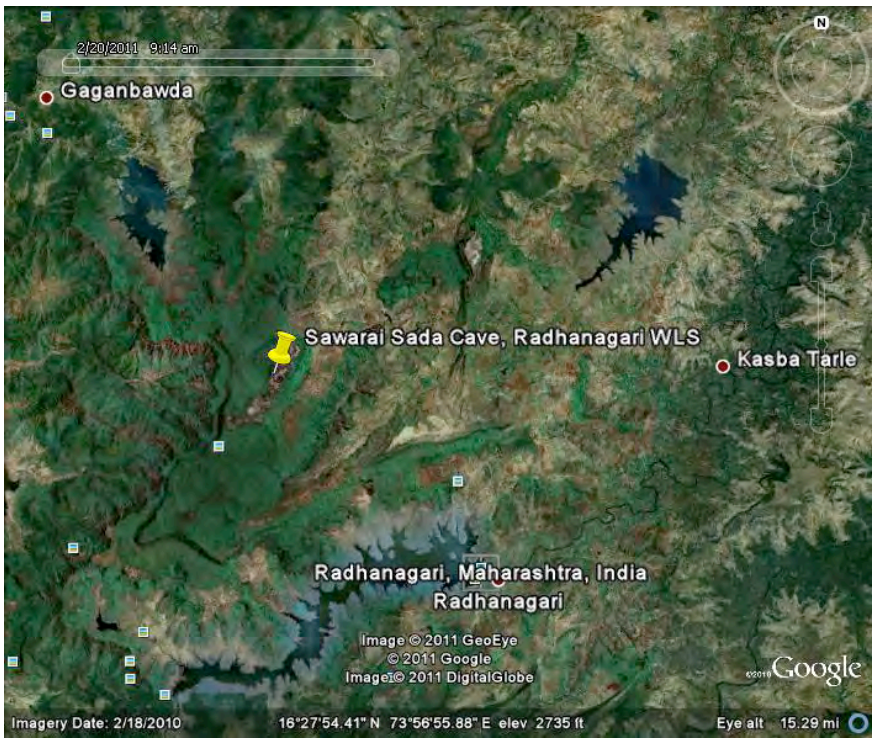


Image 1. Map showing location of Sawarai Sada Cave in Radhanagari Wildlife Sanctuary (Source : Google Earth 2011).

Image 2. Sawarai Sada cave located in Radhanagari Wildlife Sanctuary, Kolhapur, Maharashtra.

During the survey five specimens of Fulvus Fruit Bat (*Rousettus leschenaultii*) were mist netted from Sawrai Sada cave (16°27.513 N, 73°53.893 E) located in Radhanagari Wildlife Sanctuary (Image 1 & 2). The cave, about 5 x 5 x 5 meter in dimension, is formed of lateritic stone down to the floor and is located at the altitude of 3283 ft. Around 500+ individuals of the Fulvus Fruit Bat were observed in this cave (Image 3).

***Zoological Survey of India, Central Zone Regional Centre, 168-169, Scheme No. 5, Vijay Nagar, Jabalpur**
E-mail : s_talmale@yahoo.co.in

Image 3. Roosting site of Fulvous Fruit Bat, *Rousettus leschenaultii* (Desmarest) in the Sawrai Sada Cave

Image 4. Fulvous Fruit Bat, *Rousettus leschenaultii* (Desmarest) collected from Radhanagari Wildlife Sanctuary, Maharashtra

The specimens were fixed in 10% formaldehyde and after 4-6 hours of fixation, the specimens were washed under running water, semi-dried and finally preserved in 90% ethyl alcohol. External and craniodental measurements of the specimens were taken as per Bates and Harrison (1997) and Srinivasulu (2010). All measurements were taken in millimeter (mm).

Material examined: 1♀, S. G. Patil, 11.12.2007 (Regd. No. M/817); 2♂♂, 2♀♀, S. S. Talmale, 20.02.2010 (Regd. No. M/820).

Description *External*: A medium-sized fruit bat with a short tail (Image 4). Forearm length in the range between 74.9-85.3 mm. Ears naked, conical in shape with a notch at lower edge. Snout well haired and robust, nostrils protuberant and separated from each other by a deep groove. Large eyes. Dorsal colour light brown with a rufescent tone, ventral colour lighter. Back of neck and shoulders sparsely haired. ***Cranial*:** Skull robust, with elongated rostrum. ***Dental*:** Cheek teeth relatively narrow in relation to their length; first upper premolar greatly reduced, subequal in size with the first upper incisor. m^2 present. Upper toothrow (cm^2) ranges between 13.5-14.3 mm. Last lower molar elliptical.

Dental Formula:

$$i\ \frac{2}{2}\ \ c\ \frac{1}{1}\ \ pm\ \frac{3}{3}\ \ m\ \frac{2}{3} \times 2 = 34$$

The external, cranial and dental measurements of voucher specimens deposited in Zoological Survey of India, Western Regional Centre, Pune, are given in Table 1.

Abbreviations: Length of Head and Body (HB), Length of tail (Tl), Length of Hind-foot (HF), Length of forearm (FA), Length of tibia (TIB), Length of metacarpal (3mt or 4mt or 5mt), Length of Ear (E), Greatest length of skull (gtl), Condylo-canine length (ccl), Condylobasal length (cbl), Greatest zygomatic width (zb), Breadth of braincase (bb), Interorbital constriction (ic), Maxillary toothrow ($c\text{-}m^2$), Mandibular toothrow ($c\text{-}m_3$), Anterior palatal width ($c^1 - c^1$), Posterior palatal width ($m^2 - m^2$), Mandibular length (ml).

Discussion: The Fulvous Fruit bat is Least Concern (National) as per IUCN (Molur et al. 2002) and under Schedule V of the Indian Wildlife (Protection) Act, 1972 (amended up to 2006). Though the distribution of the species is throughout the country, its roosting sites were recorded from very few localities in northern part of Western Ghats in Maharashtra state. So the present locality record of this species from northern part of Western Ghats is worthwhile from conservation point of view for this particular species.

Table 1: External, cranial and dental measurements of the specimen studied (all measurements in millimeter)

	Mean	Range	SD	N
HB	110.2	95.0 –117.5	±8.99	5
Tl	13.4	12.0 – 15.0	±1.19	5
HF	20.02	18.1 – 20.3	±1.29	5
FA	79.56	74.9 – 85.3	±4.60	5
TIB	36.62	32.8 – 41.7	±3.46	5
5mt	50.06	47.0 – 54.3	±3.20	5
4mt	52.36	50.0 – 54.1	±2.32	5
3mt	52.58	48.8 – 57.5	±3.49	5
E	18.76	17.0 – 20.0	±1.27	5
gtl	37.6	36.8 – 38.8	±0.82	5
ccl	34.48	33.4 – 35.5	±0.89	5
cbl	36.23	35.3 – 37.4	±0.93	5
zb	22.15	20.95 – 23.4	±0.93	5
bb	15.2	14.5 –15.8	±0.47	5
ic	7.64	7.4 – 7.9	±0.24	5
$c\text{-}m^2$	14.03	13.5 – 14.35	±0.40	5
$c\text{-}m_3$	15.7	15.0 – 16.2	±0.53	5
$c^1\text{-}c^1$	7.35	7.1 – 7 .7	±0.24	5
$m^2\text{-}m^2$	10.98	10.6 – 11.4	±0.40	5
ml	29.16	28.2 – 30.0	±0.80	5

Acknowledgements: I am grateful to the Director, K. Venkatraman, Zoological Survey of India, Kolkata for sanctioning the tour. I am also thankful to Dr. Kailash Chandra, Scientist-F & Officer-in-Charge, Zoological Survey of India, Central Zone Regional Centre, Jabalpur and Dr. R. M. Sharma, Scientist-C & Officer-in-Charge, Zoological Survey of India, Western Regional Centre, Pune for providing facilities. Thanks are due to the Principal Chief Conservator of Forests, Nagpur, Maharashtra state for granting permission for collection and survey of the areas. I desire to express my sincere thanks to Dr. M. S. Pradhan, Scientist-E (Retd.) ZSI, WRC, Pune for critically going through the manuscript.

References :

Bates, P.J.J. & D.L. Harrison (1997). *Bats of The Indian Subcontinent*. Harrison Zoological Museum, Sevenoaks, Kent, U.K., 258pp.

Brosset, A. (1962). The bats of Central and Western India. Part I. *Journal of the Bombay Natural History Society* 59(1): 1–57.

Korad, V.S. & M.C. Gaikwad (2008). About frugivorous bats of northern Western Ghats. *Bat Net-CCINSA Newsletter* 9(1): 9–10.

Korad, V., K. Yardi & R. Raut (2007). Diversity and distribution of bats in the Western Ghats of India. *Zoos' Print Journal* 22(7): 2752–2758.

Molur, S., G. Marimuthu, C. Srinivasulu, S. Mistry, A.M. Hutson, P.J.J. Bates, S. Walker, K.P. Priya & A.R.B. Priya (eds.) (2002). *Status of South Asian Chiroptera: Conservation Assessment and Management Plan (C.A.M.P.) Workshop Report*. Zoo Outreach Organisation, Conservation Breeding Specialist Group South Asia, and Wildlife Information & Liaison Development Society, Coimbatore, India, viii+154pp+CD.

Pande, P. (2005). *National Parks and Sanctuaries in Maharashtra. Reference Guide.* Vol. 1: 1–212 and Vol. 2: 1–531. Published by Bombay Natural History Society, Mumbai.

Rodgers, W. A., H.S. Panwar & V.B. Mathur (2000). *Wildlife Protected Area Network in India: A Review-Executive Summary.* Published by Wildlife Institute of India, Dehradun, 44pp.

Simmons, N.B. (2005). Order Chiroptera. pp. 312-529. *In*: Wilson, D.E. and D.M. Reeder (eds.). *Mammal Species of The World: A Taxonomic and Geographic Reference*. *Third Edition, Volume 1*. Johns Hopkins University Press.

Talmale, S.S. (2007). (Unpublished). Studies on small mammal diversity in Maharashtra State. PhD Thesis submitted to University of Pune, 431pp.

Talmale, S.S. & M.S. Pradhan(2009). A checklist of valid Indian bat species (Chiroptera : Mammalia) 1–17pp. http://www.zsi.gov.in/checklist/Indian_Chiroptera.pdf

Plantation Programme at Biratnagar: A report

Sanjan Thapa*

Small Mammals Conservation and Research Foundation organized a plantation programme in collaboration and support from Mr. Bhim Pd. Ghimire at Chief District Office premises, Biratnagar on October 30, 2011. I had pledged for a plantation programme at Biratnagar during the Bat Conservation Educator Skills Training, 6-7 September 2008 at Kathmandu organized by Zoo Outreach Organization. Mr. Bhim Prasad Ghimire, a photojournalist at Kantipur Publication, Biratnagar branch shared me a concept of "Bat Garden" in Biratnagar. Then, Mr. Sagar Dahal, Mr. Kastauv Raj Neupane and Mr. Dibya Raj Dahal from SMCRF planned and organized this plantation programme.

Mr. Dibya Raj Dahal briefly explaining importance of bats and importance of this plantation programme

This site was selected for the plantation programme as there exists a bat colony. Then Chief District Officer inaugurated the simple programme by planting a guava tree. He delivered a short speech in which he stated that "he was satisfied with this kind of activities which could be beneficial both for bats and humans". Mr. Dibya Raj Dahal, SMCRF Eastern Nepal Incharge, briefly explained the importance of bats to human and importance of plantation for bats. Thirty invited participants including local journalists, school teachers and policemen planted 30 trees of guava and kadam, 15 each. At the end, posters and brochures regarding information on bats and their importance were distributed to the participants. The organizers selected only 30 trees so that they can maintain the plants well. Mr. Dibya Raj Dahal has been given the responsibility to look after the planted trees. Local newspapers widely highlighted this work.

Chief Guest inaugurating the programme

Poster distribution

***Small Mammals Conservation and Research Foundation, New Baneshwor, Kathmandu, Nepal. Email: sanjan_thapa@yahoo.com.**

Journey from BAT FRIENDS to Hungarian Natural History Museum

Hari Adhikari*

It was in Madan Pokhara Valley which is located in Palpa District of Western Nepal, where the roosting site of *Pteropus giganteus* is an attraction for me every time I visit my maternal uncle's home since 1995. Traders from Uttar Pradesh, India used to bring lot of utensil stuff to sell in that village and started settling there for business purpose. Earlier local people had some conflict with the roosting bats in their community as they used to make a lot of sound early in the morning. As traders demanded meat of these bats and asked small kids to kill them for which they used to pay five rupees each. It was a lot of money for kids at that time. So, few kids were really interested to kill these bats so as to have some money for chocolates.

This incidence taught me a lesson, "Children are like wet mud which can be given into any shape as society wish". I started thinking, if we can aware these kids in their earlier age towards conservation, then we can be sure for the conservation of biodiversity around us. As soon as I got admission in Institute of Forestry College in Pokhara Campus we initiated BAT FRIENDS (club of student in Forestry College) with encouragement from Zoo Outreach Organization (ZOO). I worked as a Coordinator for this club for more than a year. During that time we made around 48 school teaching programs in many parts of Nepal using members of this club and other forestry students who were interested on bats. We also launched some awareness programmes in Syangja District where based on literature and specimens collected, we knew that an endemic species of Nepal, *Myotis csorba*i was collected and identified by the Hungarian expedition during second half of last decade of 20th century. Along with this they confirmed the existence of 23 species and provided a checklist of 51 bats species known to date from the territory of Nepal.

Myotis csorbai initiated me more curiosity on bats of Nepal, it was somewhere in 1999 when this species was scientifically proved to be different species which was earlier misclassified as *Myotis longipes*. This gave me courage and enthusiasm to change the track of my activities on bats. So, with the hands on training on volant and nonvolant mammals conducted by ZOO in Kathmandu in 2007, Dr. Paul Racey taught us how to identify bats during mist netting and cave visits. Along with this, the next training in Madurai conducted by ZOO on echolocation and taxonomy of bats and month long working in lab in Kerala Agricultural University, it gave confidence to me for voucher specimen collections, species identification based on taxonomic keys and echolocation. I conducted some research on bats in Palpa, Rupendehi and Kaski districts and documented roosting sites of 8 species which were not recorded so far.

Removing entanged bat from the mistnet

I had a dream to see the specimens that were once collected from Nepal and preserved in museums around. As soon as I became member of IUCN/SSC Bat Specialist Group, I came in contact with many researchers in the world who knew, or had interest on Nepalese bat diversity. Dr. Gabor Csorba, after whom *Myotis csorbai* was named, was my first target to meet and see Nepalese specimens in his collection. After a year of communication we fixed some time convenient for both of us to see the specimens, learn about Nepalese bat diversity, and future direction for research on bats. As recent rules in Nepal do not allow even tissue of wildlife to be transported out of Nepalese territory for any reason, now the responsibility for research of bat species is on the shoulder of Nepalese bat researchers.

***Member, IUCN/SSC Bat Specialist Group, Coordinator, Natural Resources Research and Conservation Center (NaReCon)**
Email: harisubash2002@yahoo.com

Looking at preserved bat specimen at Hungary Museum

Dr. Gabor Csorba with Hari Adhikeri

Finally, my dream came true. I visited Hungarian Natural History Museum (Magyar Termeszettudomanyi Muzeum) in Budapest between 09 -11 January, 2012. As soon as I arrived to the museum, Dr. Csorba came to receive me at the reception and gave a briefing on the mammal collection made during the last 200 years in the museum. I was surrounded by the huge collection of varieties of bat specimens from Africa, Asia and Europe. Various species were preserved as wet and dry specimens. I was quite enthusiastic to see the specimens collected from the Indian Subcontinent, as in the absence of thorough research of bats in this subcontinent; we still don't know complete distribution of any species in the region. Species recorded from the border of India might exist in Nepal as well, as lack of research in Nepalese bats; we are not sure for the existence of those species from Nepalese territories. I took pictures of more than 15 species from wet and dry specimens who were already proved to be available from Nepal and the Indian borders.

I had an opportunity to see almost all species I was interested in. Hence this visit gave me encouragement for initiating national level voucher specimen collection of all bats species that exist in Nepal. This will not only help many researchers to know species of Nepal but also assist them to work on the specimens before they leave for survey of bats species in other regions of the country where bat research has not been conducted so far.

Acknowledgement

I would like to acknowledge Dr. Csorba for allocating his precious time from busy schedule and also providing free accommodation in the museum guest house. I am always indebted to ZOO for their every support and initiation for bat conservation in Nepal.

Awareness of people regarding the controlling of rodent pest

Kalyan Brata Santra[1*] and Chanchal Kumar Manna[2]

The rodents cause damage to several types of crops, fruits, trees, vegetables and household properties. Not only that they are the carrier and reservoirs of more than twenty dreaded diseases of man and domestic animals (WHO, 1974). Considering the severity of damages and carrier of diseases an extensive survey has been conducted in four Districts (Nadia, North 24- Paraganas, Hooghly and Burdwan) of West Bengal, India, in the year 1998 to 2000 to know the species diversity, their nature of damages, people awareness etc. These four Districts were situated in the Gangetic plain of West Bengal. Within these Districts (mainly some villages), fields, housing complexes, grocery shops and market complexes were selected for the collection of data. Nature of damages were assessed using various types of questionnaire on the local population (average 1000 people / District). In the field, burrows were counted and dug out. The amount of hoarded food materials by the rodents within burrows were collected and measured (Santra *et al*., 2001). All the data were calculated by "large sample test for equality of two proportions" and "frequency chi-squire test for large sample test" (Rao, 1952 and 1974). The present survey indicates that all the four Districts are badly rat infested. *Rattus* sp. *Mus* sp. and *Bandicota* sp. are found in these areas (Santra *et al*., 2001; Santra and Manna, 2008; and 2010).

All these four Districts are agriculture dependent. Paddy, wheat, potato, parwal, gourd, vegetables, jute, cabbage, cauliflower and brinjal are the main agricultural products. Paddy, potato and wheat were maximum damaged by the rodents. According to the farmers of the District Nadia paddy (8.62% to 9.5%) and potato (6.33% to 6.5%); in the District Hooghly paddy (8.43% to 9%) and potato (6% to 6.25%); in the District North 24-Parganas paddy (5.75% to 6.23%) and potato (4.5% to 5.3%) and in the Diatrict Burdwan paddy (5.75% to 6.5%) and potato (4.33% to 7.8%) were damaged by rodents among crops and vegetables. In addition to these items, wheat, jute, gourd, tomato, cauliflower and cabbage were also damaged by the rodents (Santra and Manna, 2008). This reports points out certain caution that rodents should be controlled.

For controlling the rodents, villagers of these districts used various types of traps (Fig. 1, 2 and 3) and rodenticides. In the District Nadia, people avoid to kill the rodents but in the Districts Hooghly and Burdwan, people used poison and in the District North 24-Parganas, they used different types of traps. Zinc phosphide was mainly used by the people. In the District North 24-Parganas, zinc phosphide was commonly used and in other Districts, zinc phosphide and other rodenticides were also reported. For the baiting purposes, puffed rice, chop and baits (made by wheat flour, sugar, oil etc.) were used. For experimental purposes 6-8 villages were selected in each districts and the baits of Zinc phosphide (2%) and Aluminium phosphide (2.5%) were used in the field and housing conditions to know the efficacy of these two well known rodenticides. The results indicates that Zinc phosphide is more effective than

Fig. 1. Wire made cage Trap

Fig. 2. Toothed rat-trap

Fig. 3. Bamboo made Trap

Aluminium phosphide in field and housing conditions (Santra et al., 2002). After application of the rodenticides, the people of the Districts Nadia and North 24-Parganas reported that the damages were reduced for certain period but people of the other two Districts reported that no decrease of damages were made by the rodents even after using the poisons (Table-1).

People of these four Districts are not aware of the transmission of various types of dreaded diseases by the rodents. However maximum villagers of these Districts are familiar with the plague and others type of disease (Table-2).

[1*]Department of Biological Sciences, Daulatpur High School (H.S.), Daulatpur, West Bengal, India.
Email: kalyan_117@rediffmail.com
[2]Endocrinology Laboratory, Department of Zoology, University of Kalyani, Kalyani, West Bengal, India

Table 1. Procedure for killing the rat, types of rodenticides used, mode of application of rodenticides and views of the villagers about the decline of rodent damage after application of rodenticides in the four Districts of West Bengal.

Districts	Procedure for killing the rats reported by the villagers (%)			Types of rodenticides used by the people (%)		Mode of application of the rodenticides by the people (%)			Whether damage is lesser due to the application of rodenticides (reported by the % of the Villagers) (%)		
	Trap	Poison	Avoidance	Zinc phosphide	Others	Bait	Puffed rice Or Chop	Fish fry	Decline	Not decline	Temporary relief
Nadia	36.75 ± 6.45*	3.48 ± 2.54	58.85 ± 7.24	8.64 ± 3.84	25.19 ± 5.80	14.0 ± 4.71	37.08 ± 6.82	5.39 ± 1.64	13.74 ± 7.52	20.15 ± 8.63	25.17 ± 5.74
Hooghly	19.82 ± 8.58	72.93 ± 17.87	10.00 ± 10.00	0	10.00 ± 10.00	66.16 ± 10.33	41.24 ± 14.23	2.00 ± 2.00	25.62 ± 8.16	53.81 ± 4.56	20.57 ± 18.17
North 24-Parganas	57.89 ± 29.93	33.33 ± 33.33	8.77 ± 6.79	14.53 ± 5.73	3.98 ± 2.03	34.71 ± 9.60	47.22 ± 23.73	3.51 ± 3.51	1.75 ± 1.75	0	73.68 ± 26.32
Burdwan	24.8 ± 2.72	71.58 ± 10.76	14.46 ± 9.45	1.39 ± 1.39	4.44 ± 4.44	49.62 ± 18.23	39.26 ± 7.26	0	2.22 ± 2.22	76.62 ± 8.44	0
X^2	1.070 NS	6.830 NS	4.150 NS	0.609 NS	1.470 NS	3.060 NS	0.077 NS	0.145 NS	1.430 NS	3.460 NS	3.120 NS

*Mean ± Standard error, NS : Not significant

Table 2. Relationship of the rodents with the plague disease and the measures taken by the people.

Districts	Report about the plague disease spread by the rats (%)			People familiar with Plague (%)		Protection taken by the People (%)		
	Yes	No	Unknown	Yes	No	Yes	No	Unknown
Nadia	1.57 ± 0.95*	9.08 ± 3.49	79.35 ± 8.57	50.02 ± 4.61	27.19 ± 6.25	9.68 ± 3.12	29.75 ± 8.18	59.34 ± 8.59
Hooghly	25.76 ± 8.29	21.78 ± 12.84	52.57 ± 12.28	89.55 ± 3.92	9.45 ± 4.08	10.87 ± 6.67	83.73 ± 7.21	5.40 ± 4.15
North 24-Parganas	0	47.78 ± 26.64	40.55 ± 29.76	78.95 ± 21.05	19.30 ± 19.30	1.75 ± 1.75	23.95 ± 8.34	74.30 ± 9.76
Burdwan	0	62.74 ± 31.55	33.33 ± 33.33	100 ± 00	0	5.88 ± 5.88	65.23 ± 26.44	28.89 ± 28.89
X^2	2.220 NS	3.890 NS	1.290 NS	1.408 NS	0.764 NS	0.312 NS	2.930 NS	3.190 NS

*Mean ± Standard error, NS : Not significant

For controlling the rodents and especially the rats, it is essential to have a clear cut idea about the ecology and species diversity of rats, killing procedure etc., but our survey reports reveals that the farmers of these Districts are not too much aware about the nature of damages of crops and vegetables by rodents, their killing procedure and mode of transmission of dreaded diseases. Therefore people should be aware about the rodent's pest immediately to control the rodent.

References:

Rao, C.R. (1952 & 1974). *Advanced Statistical Methods in Biometric Research*. John Willey Publication, 1952 and Hofner Publication, 1974.

Santra, K.B., M. Khalua & C.K. Manna (2001). Rodent population: Nature and extent of damages of agricultural crops depending upon different ecological conditions of the Gangetic plane of West Bengal. *Proc. Zool. Soc.* Calcutta. 54(1): 68–72.

Santra, K.B., C.K. Manna & M. Khalua (2002). Crop damage and rodent control. *Bangladesh. J. Zool.* 30(1): 71–76.

Santra, K.B. & C.K. Manna (2008). Studies of some aspects of rodent ecology in the four districts of the Gangetic plain of West Bengal, India. *Univ. J. Zool. Rajshahi Univ*. 27: 85–90.

Santra, K.B. & C.K. Manna (2010). Nature of damages caused by rodents in four districts of the Gangetic plain of West Bengal. *Small Mammal Mail* 2(2): 25–26.

W.H.O. (1974). *Ecology and Central Public Health Importance*. W.H.O. Technical Report, Series No. 553: 1–2.

GCRB (Group for Conservation and Research on Bat) in empowering the Bat conservation, Research and Education in Bangladesh

Shahneaz Ali Khan*, Amir Hossan Shaikat, Golam Yasin and Nurul Islam

Background

Bats constitute the second most species-rich order of mammals (Wilson and Reeder, 2005) consisting near 1105 species accounted globally and up to half of mammal species in tropical forests (Findley, 1993). Bangladesh supports 38 species of bats (Srinivasulu and Srinivasulu, 2005) including 3 fruits bat species where Indian flying fox is most common & widely distributed through the country (Khan, 2001). In recent decades, bat populations have experienced global declines, a trend linked to extensive, recent habitat loss (Mickleburgh *et al*., 2002). In Southeast Asia, 20% of bat species are predicted to become extinct by 2100 (Lane *et al.*, 2006). Although flying foxes are widespread species, they are facing high threats mainly due to loss of roosting trees, alteration of habitats, death causes by collision with electric cable & fishing net (which used by orchard owners), hunting for medicine & eating purpose and pesticide uses (Walker and Molur, 2003; Bates and Harrison, 1997; Khan MAR, 2001). Bats are the least studied mammalian groups in Bangladesh.

Most studies on bats in Bangladesh are mainly based on the checklist prepared by the neighboring countries. It has not been possible to estimate the number of species of bats in Bangladesh because of lack of basic distribution information. People have negative attitude towards conservation of bats. Fruit bats are considered as vermin or pests of different kinds of commercially available fruit in Bangladesh (Khan 2001). They have little knowledge about bat biology and its role in the ecosystem (Khan *et al.*, 2011). Nevertheless, the *Pteropus giganteus* act as a reservoir of Nipah virus (Breed *et al.*, 2006) and the deadly disease is hit in the north-western parts of Bangladesh since 2001 to date (Luby *et al.,* 2009). Henipavirus is circulating in the Pteropid bat (*Pteropus giganteus*) in the Northern part of India (Epstein *et al.*, 2008) which is very close to Bangladesh. Recently the GBV-D like hepatitis virus also isolated from the old wild Fruigivorus bats in Faridpur district of

Development of outreach material: Developing of general brochure (in native language) about contribution of Bat towards beautifying our nature (Concept: A. H. Shaikat, N. Islam and S. A. Khan)

Introducing New Year pocket calendar by emphasizing the key role of Bats in this planet (Concept: A. H. Shaikat, N. Islam and S. A. Khan)

***Asst. Prof., Dept. of Physiology, Biochemistry & Pharmacology, Chittagong Veterinary and Animal Sciences University, Khulshi, Chittagong-4202, Bangladesh. Email: sakhan_2008@yahoo.com**

Dr. S.A Khan receiving the signature from school children during campaign at Chittagong. On average 200 students were enrolled in the Bat conservation education program.

Bat conservation education program at Dulahazra safari park with Dr. Malekur Rahman (veterinarian).

Dr. Shahneaz Ali Khan with Dr. Golam Yasin educating the school going children about basic biology of Bat at Chokoria, Chittagong.

Bangladesh (Epstein *et al*., 2010). Infrared camera study reveals that the date palm juice is one of the predominant sites for the *Pteropus* sp. bat to explore their feed source (Khan *et al*., 2010). All of the above factors produce a negative image about bats in local community.

GCRB in Frontline

In these circumstances we established a nonprofit research group entitled "Group for Conservation and Research of Bat" in Bangladesh. This is the first volunteer group in Bangladesh who are dedicated to protect the Bat exclusively. Our mission is to protect the Bat population as well as wildlife in Bangladesh. Our aims are-

1. Improving people perception toward conservation of bats through myths elimination and conservation education.
2. Conducting research on taxonomy and diseases in bats from Bangladesh.
3. Creating network to collaborate with different institutes at home and abroad to promote bat conservation in Bangladesh.
4. Capacity building of potential researcher and students through field training.

GCRB in Action

Conservation education program

Our educational program to strengthen the community approach towards Bat conservation was launched in 2010. We conduct different educational, cultural programs to raise community awareness of Bat conservation through myths elimination. For this purpose several enthusiastic activities were undertaken (see photos).

Conclusion

This is the ever known non-profitable organization to develop and conduct such activities for enriching the eternal beauty of Bat by strengthening community approaches. We are unique to make involvement of energetic and self-motivated cohort of young volunteers who will lead such type of conservation work in Bangladesh as well as in the whole world in coming future. Our main aim is to blend various biological sciences in a common stream. It will be highly appreciable if the regarded persons along with other organizations working to conserve bat to get enrolled with us by thinking or donating.

Acknowledgment
It is our great pleasure to acknowledge here the contribution and significant effort of various funding agencies like Bat Conservation International (BCI), Whitley Wildlife Conservation Trust, Columbus Zoo and Aquarium, University Grants Commission (UGC), Bangladesh, Eco Health Alliance to conserve bat, the only flying mammals.
Find us http://www.facebook.com/gcrb.org.bd

References

Bates, P.J.J. & D.L. Harrison (1997). *Bats of the Indian Subcontinent.* Harrison Zoological Museum Publications, Sevenoaks, UK, 258pp.

Breed, A.C., H.E. Field, J.H. Epstein & P. Daszak (2006). Emerging henipaviruses and flying foxes – conservation and management perspectives. *Biol Conserv*. 131: 211–220.

Epstein, J.H., V.B. Prakash, C.S. Smith, P. Daszak, A.B. McLaughlin & G. Meehan (2008). Henipavirus infection in fruit bats (*Pteropus giganteus*), India. *Emerg Infect* Dis.14: 1309.

Findley, J.S. (1993). Bats: a community perspective. Cambridge University Press, Cambridge. in bats (order Chiroptera) in peninsular Malaysia. *Emerg Infect Dis*.7: 439–41.

Epstein J.H, P.L. Quan, T. Briese, K. Street, O. Jabado, S. Conlan, S.A. Khan, D. Verdugo, M.J. Hossain, S.K. Hutchison, M. Egholm, S.P. Luby, P. Daszak & W.I. Lipkin (2010). Identification of GBV-D, a Novel GB-like Flavivirus from Old World Frugivorous Bats (*Pteropus giganteus*) in Bangladesh. *PLoS Pathogens*; DOI: 10.1371/journal.ppat.1000972

Khan, M.A.R. (2001). Status and distribution of Bates in Bangladesh with notes on their ecology. Zoo's Print Journals 16(5): 479–483

Mickleburgh, S.P., A.M. Hutson & P.A. Racey (2002). A review of the global conservation status of bats. Oryx 36: 18–34

Khan, S.U., J. Hossain, E.S. Gurley, N. Nahar, R. Sultana, S.P. Luby (2010). Use of infrared camera to understand bats' access to date palm sap: implications for preventing nipah virus transmission. *EcoHealth* 7(4): 517–525

Srinivasulu, C. & B. Srinivasulu (2001). Bats of the Indian subcontinent. *Current Science* 80(11): 1378–1380.

Luby, S.P., M.J. Hossain, E.S. Gurley, B. Ahmed, S. Banu, S.U. Khan, N. Homaira, P.A. Rota, P.E. Rollin, J.A. Comer, E. Kenah, T.G. Ksiazek & M. Rahman (2009). Recurrent Zoonotic Transmission of Nipah Virus into Humans, Bangladesh, 2001–2007. *Emerg Infect Dis* . 15: 8.

Walker, S. & S. Molur (2003). *Summary of the status of South Asian Chiroptera.Extracted from the CAMP 2002 Report.* Zoo Outreach Organisation, CBSG, South Asia and WILD, Coimbatore, India

Wilson, D.E. & D.M. Reeder (2005). *Mammal Species of The World: A Taxonomic and Geographic Reference - Third Edition*. John Hopkins University Press, Baltimore.

Distribution of Bat brochure (written in native language) about role of Bat in ecology among the rural community people in Chapai Nawabgonj, Bangladesh.

Taxonomic status determination: Mist net survey at feeding site in a boroi orchard to teach and enrich the capacity building of handling of bat to GCRB volunteer

Celebration of Year of Bat 2011-2012: Seminar on Year of Bat 2011-2012 at Chittagong Veterinary and Animal Sciences University Conference room by DR. Amir Hossan Shaikat with other GCRB volunteer

Distribution of Indian Pangolin *Manis crassicaudata* Gray (Pholidota, Manidae) in Orissa: A Rescue Prospective

Satyanarayan Mishra[1] and Sudarsan Panda[2]

Abstract

It is very difficult to assess the distribution of pangolins in wild due to their nocturnal and burrowing habit. In the present study, the distribution of Indian Pangolin (*Manis crassicaudata* Gray 1827) is presented by following the rescue data maintained at Nandankanan Biological Park. The study revealed that out of 30 districts of Orissa, Indian Pangolins were known from 14 districts and detailed study for the rest of the districts is yet to be undertaken. The distribution of Indian pangolins in Orissa ranges from coastal areas of Bay of Bengal to the hilly forest areas of Eastern Ghats.

Introduction

Population of four species of Asian pangolins (Botha and Gaudin, 2007; Lim and Ng, 2008) including Indian pangolin (*Manis crassicaudata*) is thought to have declined significantly in many areas due to hunting and trade (Broad *et al.,* 1988). Two species of pangolins are found in India namely Indian Pangolin (*Manis crassicaudata*) and Chinese Pangolin (*Manis pentadactyla*) and little is known about the status and activity pattern of Indian pangolin throughout its range (Burton and Pearson, 1987). Pangolins are nocturnal and adapted to have a highly specialized diet of ants and termites (Prater, 2005). Few studies on ecology and behaviour of *Manis pentadactyla* (Shi, 1985; Heath and Vanderlip, 1988 and Wu *et al.*, 2003), *Manis javanica* (Samiadi *et al.*, 2008; Lim, 2008, Vijayan *et al.*, 2008) and *Manis culionensis* (Lim and Ng, 2008; Gaubert and Antunes, 2005) has been undertaken. The distribution of *M. crassicaudata* and *M. pentadactyla* overlap in Northern India (Roberts and Vielliard, 1971). *M. pentadactyla* occurs in Northern India to the Indian foothills of Nepal, Sikkim, the Naga hills of Assam (Ellerman and Marrison-Scott, 1951). Whereas, *M. crassicaudata* occurs throughout peninsular India (Prater, 2005). Its range extends as far west as Pakistan, east to West Bengal (India) and Yunnan (southwest China) south to Sri Lanka and north to Nepal (Roberts and Vielliard, 1971; Schlitter, 1993). It inhabits in plains and lower slopes (Prater, 2005); although one female was found at 2300 m elevation in Nilgiri, India (Hutton, 1949). There is not enough study undertaken regarding the distribution of Indian pangolins in Orissa. Molur et.al. (2005) mention about Khurda and Cuttack districts of Orissa in the distribution range of this species.

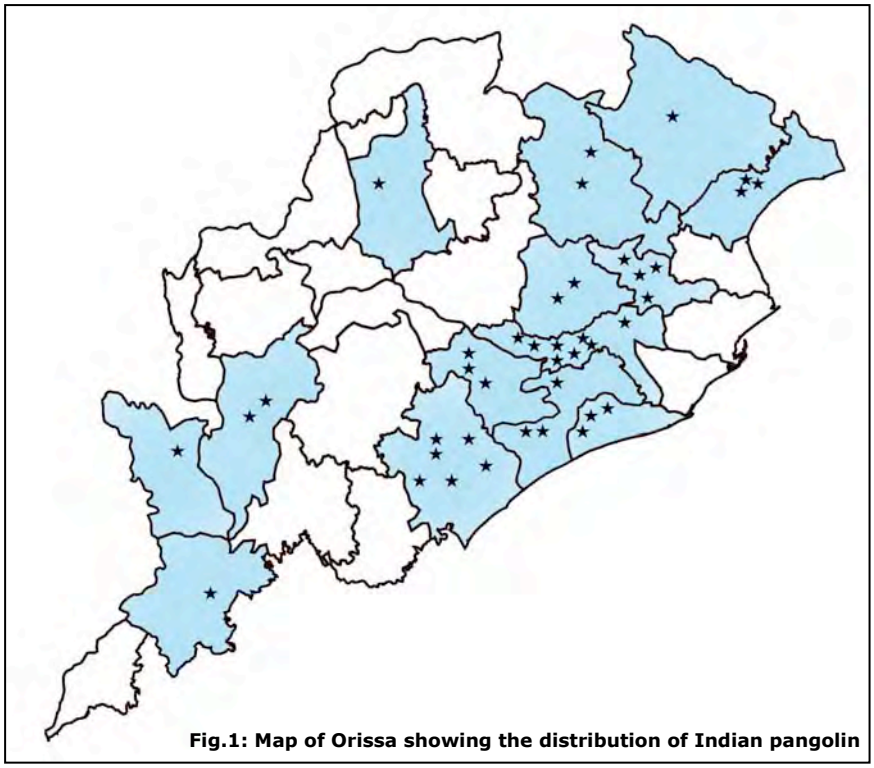


Fig.1: Map of Orissa showing the distribution of Indian pangolin

The present paper highlights the distribution of the Indian Pangolin in Orissa on the basis of the rescue data maintained at Nandankanan Biological Park, Bhubaneswar, Orissa, India. It also emphasizes the conservation initiatives taken up by Nandankanan Biological Park by constructing a Conservation Breeding Center for Indian Pangolins in an off-display area.

Methodology

Data on rescued pangolins were collected from the animal history records maintained at Nandankanan Biological Park, one of the premier zoos in the country which is situated amidst natural forest and the Kanjia Lake in the state of Orissa. The Biological Park covers an area of 3.62 sq. km (Anonymous, 2009). The Park received many rescued animals including Indian pangolins from many parts of the State.

The locality from which the Indian Pangolin rescued were documented and shown in the map to highlight the distribution of the species in Orissa. The data were verified with the Sanctuary Management records of Nandankanan Biological Park.

Results

Distribution of Indian pangolin in Orissa

The rescue data maintained at Sanctuary management of Nandankanan Biological Park and the animal history sheet of the Nandankanan hospital had shown the Pangolins have been received at the park from different localities of the State. The pangolins have been received both from coastal districts like Balasore, Bhadrak, Kendrapara and Puri as well as from the districts having the hilly forested areas like Nawarangpur, Kalahandi, Koraput, Mayurbhanj. It is recorded that out of 30 districts of Orissa, Indian pangolin was rescued over 14 districts (Fig. 1).

[1&2] **Nandankanan Biological Park, Bhubaneswar, Orissa. Email: satyanarayanster@gmail.com[1]; sudarsanpanda61@gmail.com[2]**

The maximum number of pangolins were rescued from Cuttack district (8 individuals) followed by Ganjam (6 individuals); Jajpur (4 individuals); Puri, Balasore, Nayagarh and Khurdha districts (3 individuals each); Dhenkanal, Kalahandi and Keonjhar districts (2 individuals each) and single individual were rescued from the districts of Mayurbhanj, Koraput, Sambalpur and Nawarangpur districts. From the above study it was found that about 77.5 % (n=40) individuals were rescued from the coastal and adjacent to coastal areas, whereas only 27.5 % (n=40) individuals rescued from far from coastal areas. This result has shown that the larger numbers of pangolins that were rescued from the coastal areas may be due to less forest cover in the coastal districts. In other words, the other districts from where the fewer individuals have been rescued are probably due to better forest cover which provides optimum habitat for the pangolins.

Table – 1: Rescue records of Indian Pangolin in Orissa

Sl. No.	Date	Source of Rescue	Sex	Name of District
1	16.07.1973	Dharmasala	Male	Jajpur
2	11.09.1973	*D.F.O., Nayagarh	Female	Nayagarh
3	03.11.1973	Puri area	Male	Puri
4	18.06.1976	Balugaon	Male	Nayagarh
5	22.06.1976	Chhatra Bazaar, Cuttack	Male	Cuttack
6	25.06.1976	Bahugaon, Puri	Female	Puri
7	22.10.1977	Jajpur Road	Male	Jajpur
8	16.09.1978	Denkanal Forest	Unidentified	Dhenkanal
9	18.09.1978	Nayagarh Area	Male	Nayagarh
10	17.08.1982	Jashipur	Female	Mayurbhanj
11	06.10.1983	D.F.O., Bhawanipatna	Male	Kalahandi
12	04.06.1984	Jaypur	Male	Koraput
13	01.01.1986	D.F.O., Cuttack	Male	Cuttack
14	20.09.1986	Khurdha Road	Female	Khurdha
15	15.08.1987	Nilgiri Forest	Male	Balasore
16	08.11.1988	Chilika	Female	Ganjam
17	02.01.1990	Ganjam area	Female	Ganjam
18	25.04.1990	Jaipur, Barang	Female	Cuttack
19	09.02.1991	Sambalpur	Female	Sambalpur
20	19.07.1991	Berhampur	Unidentified	Ganjam
21	30.10.1992	D.F.O., Keonjhar	Unidentified	Keonjhar
22	22.07.1993	Dhenkanal	Unidentified	Dhenkanal
23	30.07.1995	D.F.O., Balasore	Unidentified	Balasore
24	18.07.1996	D.F.O., Puri	Unidentified	Puri
25	27.07.1996	D.F.O., Athagarh	Unidentified	Cuttack
26	09.10.1996	Jajpur Road	Male	Jajpur
27	14.03.1997	D.F.O., Keonjhar	Unidentified	Keonjhar
28	26.07.1997	Jajpur	Female	Jajpur
29	26.10.1998	Oupada, Soro	Female	Balasore
30	11.08.1999	D.F.O., Chilika	Unidentified	Khurdha
31	16.07.2000	D.F.O., Bhanjanagar	Unidentified	Ganjam
32	26.03.2001	Sukinda	Female	Cuttack
33	14.04.2003	D.F.O., Khurdha	Male	Khurdha
34	29.12.2004	Dalijoda Range	Male	Cuttack
35	09.11.2007	Badamba, Ratapata	Female	Cuttack
36	02.01.2008	Berhampur	Female	Ganjam
37	02.01.2008	Berhampur	Female	Ganjam
38	17.09.2008	Nawarangpur	Female	Nawarangpur
39	20.09.2008	Bhawanipatna	Male	Kalahandi
40	28.12.2008	Cuttack area	Male	Cuttack

N.B.: *D.F.O. is for Divisional Forest Office

Discussion

Status of Indian Pangolin

Hunting and habitat destruction have made these scaled mammals one of the most vulnerable groups. Available information suggests that Indian Pangolin populations are increasingly under threat throughout their range due to domestic and international demand for live pangolin, skin, scales and meat. Pangolin scales are extracted after killing and skinning the animal. Scales from one adult animal weigh an average of 1kg. The biology of Indian Pangolin, with particularly low reproductive rates and a large distribution, make them vulnerable to over-exploitation. Considering the vulnerability, Indian Pangolin is included in the Schedule I of the Wildlife (Protection) Act, 1972, and thereby totally protected throughout the country. The species has been listed as Vulnerable by the IUCN. To control and monitor international trade, the species has also been included under Appendix II of CITES. This warrants serious conservation measures to save this species from extinction.

Conservation initiatives at Nandankanan Biological Park

Nandankanan Biological Park is one of the premier zoos in India over an area of 4.37 km^2 and harbouring 120 species of animals including 40 species of mammals, 56 species of birds and 24 species of reptiles. It was declared as a Wildlife Sanctuary in the year 1979. Thus integration of the *ex-situ* and *in-situ* conservation is the major thrust of the Park.

Conservation Breeding Center for Indian Pangolin (*Manis crassicaudata*) was constructed in an off-exhibit area of Nandankanan Biological Park and effectively came in to action in April 2009. Six prototype enclosures have been constructed separated by the chain-link mesh. The enclosures are made escape proof by providing the concrete base with the iron mesh. To facilitate the exhibition of natural

instinct, all the enclosures are filled with 1 m laterite soil. All the individuals are fitted with microchips and kept separately and allowed to mate after observing the association between the individuals of neighbor enclosures.

Conclusions

The population of Indian pangolins in the nature has been decreasing due to large scale poaching for the scales and meat. The conservation initiatives at Nandankanan Biological Park is definitely a much needed approach towards the *ex-situ* conservation of the species. Besides, captive breeding programmes, more studies need to be done to assess their population in the wild along with their biology. Although it is difficult to study the animals in the wild due to their nocturnal and secretive nature, the home range and other behavioural studies can be undertaken by relocating the captive population to their suitable habitat with the help of camera traps and radio-transmitter system. This will definitely help to understand the species in a better way.

Acknowledgements

The authors would like thank the animal keepers who are always taking care of the pangolins in the Pangolin Conservation Breeding Center, Nandankanan Biological Park. The help of the veterinary officers at Nandankanan is highly acknowledged for their support in regular monitoring and record keeping of the pangolins. We also acknowledge the Central Zoo Authority for their financial support to establish the conservation breeding center and given permission to undertake the study. The authors are very much thankful to Dr L.N. Acharjyo for his guidance and continuous support in the study.

References

Broad, S., R. Lusmoore & M. Jenkins (1988). *Significant Trade in Wildlife: A Review of Selected Species in CITES Appendix II, p.51 in Vol. I, Mammals.* International Union for Conservation of Nature, Gland, Switzerland, 183pp.

Burton, J.A. & B. Pearson (1987). *The Collins Guide to The Rare Mammals of The World*. The Stephen Green Press, Lexington, Massachusetts, 810pp.

Ellerman, J.R. & T.C.S. Marrison-Scott (1951). *Checklist of Paleoarctic and Indian Mammals 1758– 1946*. Trustees of British Museum, London, 810pp.

Heath, M.E. (1995). *Manis crassicaudata*. *Mammalian Species* 513: 1–4.

Hutton, A.F. (1949). Notes on Indian Pangolin (*Manis crassicaudata*). *Journal of the Bombay Natural History Society* 48: 805–806.

Lim, N.T.L. & P.K.L. Ng (2008). Home range, activity cycle and natal den usage of a female Sunda Pangolin *Manis javanica* (Mammalia: Pholidota) in Singapore. *Endang Species Research* 4: 233–240.

Molur, S., C. Srinivasulu, B. Srinivasulu, S. Walker, P. O. Namir & L. Ravikumar (2005). *Status of South Asian Non-volant Small Mammals, Conservation Assessment Management Plan Workshop Report.* Zoo Outreach Organization/ CBSG-South Asia, Coimbatore, India, 618pp.

Prater, H.S. (2005). *The book of Indian Animals.* 3rd Edn., 12th Reprint, Bombay Natural History Society, Mumbai, Oxford University Press, New Delhi, pp. 301–303.

Roberts, T.J. & J. Vielliard (1971). Commentaires sur le grand pangolin indien *Manis crassicaudata*. *Mammalia* 35: 610–613.

Samiadi, G., D. Darnaedi & A.J. Arief (2008). Sunda Pangolin *Manis javanica* in Indonesia: Status and Problems, Proceedings of the workshop on Trade and Conservation of Pangolins native to South and Southeast Asia, 30th June to 2nd July 2008, Singapore Zoo, 12–17pp.

Schlitter, D.A. (1993). *Order Pholidota*. In: Wilson, D.E. & D.M. Reeder (eds.). Mammal Species of The World: A Taxonomic and Geographic Reference. Smithsonian Institution Press, Washington D.C., 1206pp.

Vijayan, M., C. Yeong & D. Ling (2008). Captive Management of Malayan Pangolin *Manis javanica* in the Night Safari. Proceedings of the workshop on Trade and Conservation of Pangolins native to South and Southeast Asia, 30th June to 2nd July 2008, Singapore Zoo, 119–131pp.

Wu, S.B., N.F. Liu, G.Z. Ma, Z.R. Xu & H. Chen (2003). Habitat selection by Chinese Pangolin (*Manis pentadactyla*) in winter in Dawuling Natural Reserve. *Mammalia* 67: 493–501.

Madras Tree Shrew *Anathana ellioti* (Waterhouse) (Scandentia: Tupaiidae) in Kambalakonda Wildlife Sanctuary, Andhra Pradesh, India

M. Giridhar[1] and C. Srinivasulu[2*]

The endemic and rare Madras Tree Shrew *Anathana ellioti* (Waterhouse 1850) (also referred to as the South Indian Tree Shrew), is a small mammal belonging to the order Scandentia. Its range is spread over in both in the dry and moist deciduous forests of peninsular India, south of the Ganges in Andhra Pradesh, Karnataka, Kerala, Jharkhand, Madhya Pradesh, Maharashtra, Orissa and Tamil Nadu (Prater 1971, Menon 2003, Molur et al. 2005). In Andhra Pradesh, this species is known from forested tracts in the Godavari River basin of Adilabad and Warangal districts; from the Nallamala Hills and also a single sighting record from outside Hyderabad (Molur et al. 2005). This species has been hitherto not reported from the northern Eastern Ghats of Andhra Pradesh, India. Through this note we report the sighting of the Madras Tree Shrew (Photo 1) in Kambalakonda Wildlife Sanctuary (17.77 N, 83.34 E), Vishakapatnam district, Andhra Pradesh. The tree shrew has been regularly sighted since early 2010 onwards and once an individual has been observed frolicking with the three-striped squirrel (Photo 2).

Photo 1. Madras Tree Shrew in Kambalakonda Wildlife Sanctuary, Andhra Pradesh, India

Photo 2. Interaction of Madras Tree Shrew and Three-striped Squirrel in Kambalakonda Wildlife Sanctuary, Andhra Pradesh, India

References

Menon, V. (2003). *A Field guide to Indian Mammals*. Dorling Kindersley (India) Pvt. Limited, New Delhi, 200pp.

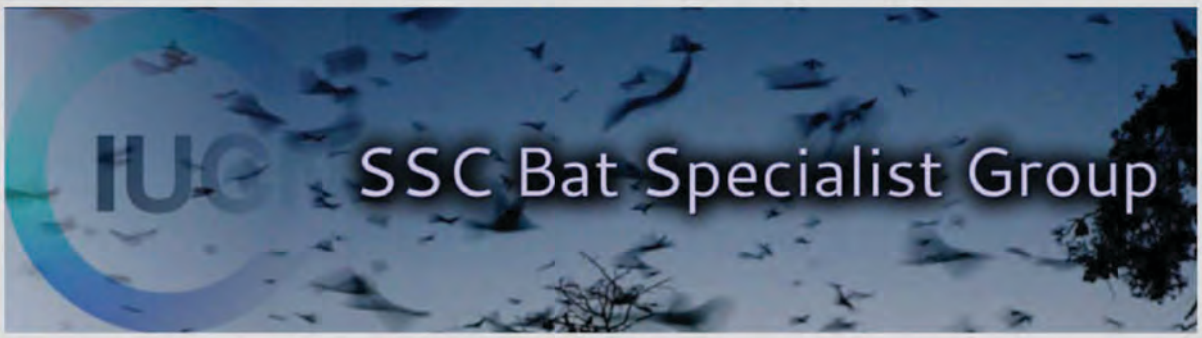
Molur, S., C. Srinivasulu, B. Srinivasulu, S. Walker, P.O. Nameer & L. Ravikumar (2005). *Status of South Asian Non-volant Small Mammals: Conservation Assessment and Management Plan (CAMP) Workshop Report*. Zoo Outreach Organization/CBSG-South Asia, Coimbatore, India, 618pp.

Prater, S.H. (1971). *The Book of Indian Animals*. BNHS-Oxford, Mumbai, 324pp+xxiv.

[1]Biodiversity Research and Conservation Society, Swarnadhamanagar, Old Bowenpally, Secunderabad.
[2]Department of Zoology, Osmania University, Hyderabad,
***hyd2masawa@gmail.com**

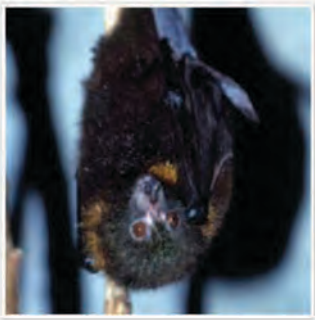
IUCN SSC Bat Specialist Group http://www.iucnbsg.org/

HOME ABOUT BSG MEMBERS REGIONAL GROUPS WORKSHOPS & NEWS PUBLICATIONS LINKS CONTACT



Home

The official website for the Bat Specialist Group of the IUCN Species Survival Commission



The Bat Specialist Group (BSG) is one of a number of specialist groups formed within the Species Survival Commission (SSC) of IUCN-The World Conservation Union (IUCN). We are a collaborative multidisciplinary network of bat biologists and conservationists providing support and promoting bat conservation activities throughout the world.

Bats make up one fifth of all terrestrial mammals (1,116 species). They are among the most endangered of the world's creatures, primarily because much of their habitat has been eliminated by human development or because they are persecuted. Because bats are important seed dispersers and pollinators for many native plants, and key insect predators globally, their loss has serious consequences for the ecosystems to which they belong.

Latest News

Hunting of flying foxes and perception of disease risk in Indonesian Borneo- New Publications. Click on Workshops & News to Read more.
posted 15 Aug 2011
Help save the BBC Wildlife Fund ! Potential funding for bats! http://www.savebbcwildlifefund.net/
posted 9 Aug 2011

Year of the bat

To celebrate the environmental impact of bats and encourage more international cooperation on bat conservation, the Convention on the Conservation of Migratory Species of Wild Animals (CMS) and EUROBATS have designated 2011 European Year of the Bat and 2012 International Year of the Bat. The Year of the Bat aims to raise awareness of these often misunderstood animals and their diverse biodiversity benefits.

The Bat Specialist Group is proud to be a partner in the Year of the Bat initiative, and we will be working to highlight the conservation plight of fruit bats across the globe with many exciting new conservation and education awareness initiatives in 2011-2012. Please visit the Year of the Bat website to read more!

New Posts: 06/28/2011 : Click on the link to Publications to view a newly posted PDF of the Action Plan for the Conservation of Bats of Bolivia (2010) by Luis Aguirre *et al.*

IUCN

IUCN Home
IUCN Species Survival Commission
IUCN Red List

IUCN SSC Bat Specialist Group

SMALL MAMMAL NETWORKS

Chiroptera Conservation and Information Network of South Asia (CCINSA)

CCINSA is a network of South Asian Chiroptera specialists, educators and enthusiasts. The network aims to enhance communication, cooperation and collaboration among chiroptera specialists of this region and thereby create a chiroptera conservation "community" for better biodiversity conservation.

Chair: Sripathi Kandula
Convenor and Administrator: Sally Walker
Red List and Technical Advisor: Sanjay Molur

Rodentia, Insectivora, and Scandentia Conservation & Information Network of South Asia (RISCINSA)

RISCINSA network of South Asia was suggested by interested biodiversity conservation specialists and the purpose of this network, then is to link together rodent field researchers and their field knowledge throughout South Asia (Afghanistan, Bangladesh, Bhutan, India, Nepal, Maldives, Pakistan and Sri Lanka) so the pooling of information can lead to conservation action.

Scientific Chair: Sujit Chakraborty
Convenor and Administrator: Sally Walker
Red List and Technical Advisor: Sanjay Molur

SMALL MAMMAL NETWORKS
2011-2012 Donors and Partners

Chester Zoo, North of England Zoological Society Chester Zoo Conservation Fund has been supporting ZOO/CCINSA office, BAT NET newsletter and field techniquest training for the last decade. **www.chesterzoo.org**

Knowsley Safari park
www.knowsleysafariexperience.co.uk/

Columbus Zoo and Aquarium
http://www.colszoo.org/

IUCN SSC Bat Specialist Group
CCINSA represents the IUCN SSC Bat Specialist Group in South Asia. BSG utilises the CCINSA Network to locate specialists in different subject areas, to organise training as well as conservation assessment workshops and other activities to assist the CSG in their mission.
Contact : Chair Paul Racey:
p.racey@abdn.ac.uk
See Website:
www.iucnbsg.org/

Small Mammal Mail

SMM is a web-based bi-annual Newsletter celebrating the most useful yet most neglected Mammals for both CCINSA & RISCINSA -- Chiroptera, Rodent, Insectivore, & Scandens Conservation and Information Networks of South Asia.

Editor: Sally Walker; Technical Advisors: Sanjay Molur, B.A. Daniel, R. Marimuthu; and Publication Assistants: Latha Ravikumar, Ravichandran, Pravin Kumar.

CCINSA and RISCINSA are an activity of Zoo Outreach Organization (ZOO) and Wildlife Information Liaison Development (WILD) in association with CBSG, South Asia and RSG, South Asia.

Note: ZOO's PRINT Magazine, Journal of Threatened Taxa, Newsletters and a variety of reports can be found on our websites: www.zooreach.org and www.zoosprint.org.

Small Mammal Mail, C/o Zoo Outreach Organization
96 Kumudham Nagar, Villankurichi Road, Coimbatore 641035 TN INDIA
Phone: 91 422 2665298, 2665450; Fax 2665472; Email: zooreach@zooreach.org
Websites: www.zooreach.org, www.threatenedtaxa.org, www.zoosprint.org;
www.pterocount.org; www.southasiantaxa.org., www.southasianprimatenetwork.org