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Introduction
International Elephant Foundation IEF funded a project to conduct 10 Human Elephant Coexistence street plays, two days teacher-training workshops and 2 school education programmes in Erode Forest Division, Tamil Nadu. Zoo Outreach Organization conducted several teacher-training workshops in India (Tamil Nadu, Kerala, West Bengal), Bangladesh, Nepal, Bhutan, Indonesia and Thailand. This had an escalating effect in which participants of the training have created momentum in their institution or organization or on their own and as the educators they trained, educated more students.

The Erode district, Tamil Nadu forms the meeting point of Western Ghats and Eastern Ghats separated by Bhavani River, which include the Sathyamangalam Wildlife Sanctuary and Tiger Reserve. The human-elephant conflict has intensified in this district as the number of crop raids has witnessed a sharp rise. The human settlement bordering the Western Ghats foothills seeing severe human elephant conflict due to expanding human population that results to industrial and agriculture growth fragmenting elephant habitat in this area. More human elephant conflicts are recorded over the years and it has been increasing year by year. There was no permanent or all-encompassing solution to HEC due to its complexity and variety but that our approach would be through an age-old and imperfect method, coexistence.

Creating awareness to increase the tolerance of the people towards the animal is very important for both human and elephants well being. So it is the need of the hour to conduct awareness programmes for the community who live in the conflict areas through different ways of teaching how to take responsibility for themselves, learn ways to avoid confrontation and promote self-protection by following some simple do’s and don’ts. So we decided to conduct 10 street plays, a teacher training workshop and two school education programmes to achieve our project.

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"Karakattam" one of the folklore arts in this region

SWORD - Adhiyamaan Kalaikuzhu, Krishnagiri

1Education Officer and 2Scientist, Zoo Outreach Organization, Coimbatore. Email: 1marimuthu@zooreach.org; 2badaniel@zooreach.org
Street plays are informal folklore theatre, an effective medium of education and impact to the public about the message we convey to them. The advantage is it makes long lasting effect on audiences. Mostly social activists have used it in India and other countries for centuries. So Zoo Outreach Organization wanted to try this communicative medium for sensitizing people on Human Elephant Coexistence. Really we are new to this field.

Street play production & rehearsal
Adhiyamaan Kalaikuzhu runs by the SWORD NGO, Krishnagiri was selected to perform the play. They have very much focused in to social issues, but not in wildlife. So we felt it is necessary to have a production camp to train them. Accordingly the camp was held for three days. We hired a trainer from Chennai to assist with us to write a script on HECx and also include other folklore arts in this drama to make it enjoyable for the audience. First the script was done and rehearsed. The script covers song on HEcx, elephant facts, tips for the people who can do or not do in the HEC areas, the importance of growing alternative crops which elephant doesn't like and also including other folklore arts thappattam (beating drums), kolattam (stick dance) and karakattam (water pot dance) for enriching the play.

Selection of the villages
The next important aspect of the drama was selecting appropriate villages for the drama performance. With the assistance of Sathyamangalam Environmental and Wildlife Association, we visited several villages in Bhavani Sagar, Sathyamangalam and T.N. Palayam forest ranges of Sathyamangalam Tiger Reserve and Wildlife Sanctuary and selected ten villages, which experiences more human elephant conflicts. They are: 1. Kodepalayam 2. Karithottampalayam 3. Ramapayalaur 4. Pudhupeerkadavu 5. Periyakallipatti 6. Malliyampatti 7. Puliyangkombai 8. Kembanaickenpalayam 9. Vinobha Nagar and 10. Bagawathi Nagar. Either local people’s representatives or village forest committee presidents were met to further selecting the venue and other logistics. All of them were very supportive and extended their possible help during the visit and also performance.
Street play performance
The street plays were held from 8-12 August 2015. Two plays were performed in each day in the evening. It is due to most of the villagers are daily laborers and return after the work only in the evening. More than 500 villagers watched the street play in each village. At the end of each show we gave a hand out which contains information on do’s and don’ts in HEC areas. The villagers were evaluated randomly about the street play performance and mostly commented that they understood the concept of the drama and the importance of human elephant coexistence.

Teacher training workshop
Objectives:

The objectives of the workshop are:

- To train the teachers, create awareness to students and community the facts about Asian Elephant thereby made them appreciate the species.
- To train or educate them living in or near elephant habitat of Erode district to improve their attitudes towards wild elephants so as to avoid confrontation and conflict whenever possible.
- To adapt exciting, innovative educational tools which would be effective in bringing about attitudinal
and behavioural change among them.
• To train 35-40 teachers, 100 students through two-school awareness programmes to use these tools in order to bring about understanding the cultural and ecological importance and conservation problems of Asian Elephant.
• To train target groups to use information for education of all kinds more effectively, by disbursing it in a variety of more attractive, effective and meaningful styles through active learning techniques.
• To create a momentum which would continue and build upon it long after the workshops.

Prior to the workshop the following activities were done:

Reviews and Revision of Education Materials
First of all, the Elephant Teaching Guide and Ele-kit packet items were reviewed completely and revised with updated information.

Pre-visits
Three pre-visits were made to meet the local coordinator, Sathyamangalam Environment and Wildlife Association SEWA, Erode, National Green Corps Coordinator, District Eco-club coordinator and Chief Education Officer to chart out the venue, selection of the teachers from HEC area schools and other logistics. During the trip, we finalized the school teacher’s list, which covers most the human elephant conflict areas and decided to have the training at Gobichettipalayam due to easy accessibility of teachers.

Developing and Printing of Education Materials
The updated and revised elephant teaching guide and ele-kit packet items were developed and printed in local language. The education kit contains a variety of active learning modules or techniques to reach a wide range of ages and educational and social levels, including illiterate or non-English speaking persons.
Teacher training workshop
A two-day’s HECx teacher-training workshop was held at Bharathi Vidhyalaya Matric Higher Secondary School, Gobichettipalayam of Erode district on 25-26 August. Thirty-five teachers participated. During the workshop they were taught about assessment tools, elephant facts, mini dramas pertaining to elephant conservation and human elephant conflict and solutions, former and current elephant range countries, illustrated history of Asian elephants, elephants in our culture, do’s and don’ts in elephant areas, general information about forests in India and Tamil Nadu, Project Elephant and Elephant Reserves, how to plan an education programme with a demonstration etc. At the end of the second day they were awarded with participation certificate and 50 ele-kit packets which will be used to practice their training immediately at their school with the students or others. During the workshop the participants committed to do awareness programmes using the training techniques and the materials distributed in the workshop.

Our sincere thanks to International Elephant Foundation IEF for the funding and we would also express our sincere thanks to the following persons for their coordination and support, without their help it would not have been possible. Mr. V.S.S. Jalaluddeen and his team, SWORD-Adhiyamaan Kalaikuzhu, Krishnagiri; Mr. T. Sakthivel, Sathyamangalam Environmental and Wildlife Association SEWA; Mr. Shanmugam, Sathyamangalam; Chief Education Officer, Erode; Mrs. T. Geetha, District Eco-club Coordinator, Erode; Mr. L. Vijayendran, National Green Corps Coordinator, Gobi Educational District; Mr. P.R. Velumani, Correspondent, Bharathi Vidhyalaya Matriculation Higher Secondary School, Gobichettipalayam; all the teachers, all the local body heads and forest committee presidents.

Teacher with finger puppets

One of teacher groups busy in making properties for mini drama
Introduction
Greater Adjutant is a globally Threatened species, whose IUCN status is Endangered and population is in decreasing trend (IUCN, 2013). Till few decades back, this colonial nesting bird was distributed widely in South and South East Asian countries, but recent breeding populations are only recorded in India and Cambodia (BirdLife International, 2014). In India, this bird is mainly recorded in the Brahmaputra Valley of Assam (Singha and Rahmani, 2006) and in Koshi Valley of Bihar (Mishra and Mandal, 2009). The current population of this bird is estimated about 800 to 1200 mature individuals with majority of the populations are localized in Assam (BirdLife International, 2014). The bird is facing a massive population decline and now considered as an “Edge species” by Zoological Society of London and listed one of ten birds’ species that are on the verge of the extinction (Walter Jetz et al, 2014).

Assam is considered as a global stronghold for this bird and about 650-800 individuals are distributed in a few nesting colonies along the Brahmaputra Valley of Assam. Kamrup District harbours about 500 individuals (Barman 2009, 2012) and could be considered as the area to take urgent conservation actions to secure the future of this bird. The author has been involved in community based conservation and research activities in Kamrup District of Assam since 2009 (Barman and Sarma 2014a, Barman, 2014b). We have been doing yearly population estimation of this species in this district and also in the State of Assam following proper population estimation procedures. In one breeding colony of Dadara and Pacharia village of Kamrup District of Assam, we recorded about 450 numbers of individuals in the month of November 2013 and this could be considered as the highest number of this bird in any of its breeding colony recorded elsewhere. Local villagers informed us that they started sighting nest of this bird in their private campus. Many villagers used to cut the nesting trees either to earn livelihood options or just to avoid the bird in their campus to get rid of their foul smell in the nesting area due to left over organic food, bird droppings or dead bird chicks. We have been doing conservation work in this nesting colony since 2009 using various community conservation tools. The community now protects this bird of their own and nest numbers has significantly increased in last few years.

We came across large number of nest fall fledglings and chicks in this nesting colony especially in the month of December to April. These nest fall birds eventually die due to lack of any rescue and rehabilitation activities. Singha et al (2006) mentioned that about 15% of chicks of this bird die due to nest fall in every breeding season. Though it may be natural phenomena of nest fall for this bird, but being as an endangered, rescue and subsequent rehabilitation might be a strong conservation activity to bring the population up for this bird. This was actually tried once in another nesting colony in Assam (Singha et al, 2006) and subsequently discontinued due to unknown reason. Rescue and rehabilitation of nest fall chicks is also mentioned as...
We got a rescue call on 17th September, 2013 from the local villagers that an injured, weak nest fall chick was perching in a undergrowth scrubs under a nest and was there for two days. We reached the spot immediately. It was about four or five months old juvenile bird. We estimated the age of the chick based on the size of the bird and the feathers in the neck area. We restrained the bird physically with a net and performed the preliminary observations. Though the bird had no external injuries, it was found to be dehydrated.

**Treatment and care**

After initial examination, the bird was injected with dexamethasone @0.41mg/kg body weight following Harrison (1986). There was evidence of pain on its affected limb so symptomatic treatment was given with a dose of antibiotic enrofloxacin long acting and analgesic meloxicam @ 0.2mg/kg intramuscularly and after that these medicines were continued as oral suspension for next three days along with multivitamin and mineral mixtures following Burns et al (1988). The bird was transported to Assam State Zoo for further treatment and care. Kamrup Police Administration supported us by providing a rescue vehicle to transport this bird to Assam State Zoo, which is about 30 km away from the site of rescue.

**Housing:** At Assam State Zoo, the bird was kept in a small iron enclosure (2’x5’x6’) with chain-link mesh at the Zoo hospital with special care to avoid human imprinting.

**Table 1:** Initial clinical examination records of the rescued bird

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Temperature (cloacal)</td>
<td>106° F</td>
</tr>
<tr>
<td>Heart beat</td>
<td>124 / minute</td>
</tr>
<tr>
<td>Respiration</td>
<td>40 / minute</td>
</tr>
<tr>
<td>Weight</td>
<td>4.72 kg</td>
</tr>
</tbody>
</table>

**Table 2:** Routine blood test was carried out and results were as follows: (Test 1 & 2)

<table>
<thead>
<tr>
<th>Blood components</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBC</td>
<td>27 x10³/mm³</td>
</tr>
<tr>
<td>Lymphocytes</td>
<td>34%</td>
</tr>
<tr>
<td>Monocytes</td>
<td>3.7%</td>
</tr>
<tr>
<td>Granulocytes</td>
<td>62.3%</td>
</tr>
<tr>
<td>RBC</td>
<td>1.27 x10⁹/mm³</td>
</tr>
<tr>
<td>MCV</td>
<td>150.6 fl</td>
</tr>
<tr>
<td>Hct</td>
<td>19.1%</td>
</tr>
<tr>
<td>MCH</td>
<td>136.2 pg/dl</td>
</tr>
<tr>
<td>MCHC</td>
<td>90.5 g/dl</td>
</tr>
<tr>
<td>RDW</td>
<td>7.8%</td>
</tr>
<tr>
<td>Hb</td>
<td>17.3 g/dl</td>
</tr>
<tr>
<td>THR</td>
<td>24 x10³/mm³</td>
</tr>
</tbody>
</table>
Food
Greater Adjutant is a carnivorous bird. In the wild it feed on live vertebrates, fishes, frogs, snakes, snails, and carrion. During its care at Assam State Zoo, the bird was given small live fish of *Channa* sp. of 150 gm and small pieces of chicken (50 gm) in the morning and afternoon hours. Initially the bird was fed with human assistance with offering the food with a long steel fork. Gradually the bird started to feed by its own. The fishes were provided in a small tray with water. Weight of the bird was taken every week to know the food intake and proper growth. Feed supplements were given occasionally. The physiological parameters and hematological values recorded are presented in Table 1, 2 and 3.

Release and site selection
After about two months of treatment and care the bird seems to be fit enough for release. The weight of the bird was 8 Kg on 20 November, 2013 and had gained about 4 kg since it was rescued. It regularly spread its wings inside the cage. So, we decided to give a try for its release and give a chance to the bird to fly. Ideally the bird could have been placed in a bigger enclosure with enough space for flight practice, but such facility was not available at Assam State Zoo. We decided to release the bird in Boragaon garbage dumping site near Guwahati city where adult Greater Adjutants are regularly seen throughout the whole day. Baragaon garbage dump is about 5 km aerially from the rescue site and most of the Greater Adjutant of Kamrup District and its surroundings do forage here regularly throughout the year. So, we decided to release in this site. On 20 November, 2013 we took the bird in a wooden crate and transported to Boragaon garbage dump. We put a standard bird ring in both the legs of the bird for future monitoring. We released at about 7.30 am at the garbage dump. Once we opened the crate door, the bird came out of its own and took few steps. It spread its wings and flew away. It flew for one minute and joined a group of adult Greater Adjutant in a nearby wetland. The bird immediately started to forage with the group and remained with them for 32 minutes. After that, the bird flew with the other birds and disappeared from our sight and vanished in the other side of the wetland. We continuously monitored the group for one week at the release site and we could sight the bird only twice in one week time. The bird looked healthy and found foraging with other birds.

We decided to tag the release of this bird with a conservation message. So, we decided to involve school students and named the bird as “Arshiya” after a very enthusiastic young school student Ms Arshiya.

### Table 3. Blood counts of the bird

<table>
<thead>
<tr>
<th>Blood components</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBC</td>
<td>166.54 m/mm³</td>
</tr>
<tr>
<td>Lymphocytes</td>
<td>34%</td>
</tr>
<tr>
<td>Monocytes</td>
<td>3.7%</td>
</tr>
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<tr>
<td>RDW</td>
<td>7.8%</td>
</tr>
<tr>
<td>Hb</td>
<td>17.3 g/dl</td>
</tr>
</tbody>
</table>
Mahanta, a student of Sarala Birla Gyanjyoti School located near its breeding colony. This was to encourage school student to participate and help conservation programmes in the future. The bird 'Arshiya' was released by the young school student Arshiya and she seems to be very happy after she experienced the successful release of this bird. She promised to take this message back to her friends at School and to participate in conservation efforts in future.

Acknowledgements
We sincerely thank and acknowledge the timely help and support from Dr. M.L. Smith and Dr. Panchomi Shama Veterinarians, Assam State Zoo, Mr. Chandan Bora, Divisional Forest Officer of Assam State Zoo cum Botanical Garden and its staff for successful treatment of this bird. We sincerely thank BNHS for their support and guidance in the Greater Adjutant Conservation programme. We sincerely thank Assam Police Department for their help in transporting the rescued bird from rescued site to Assam State Zoo and to the release site. We thank and acknowledge Conservation Leadership Programme (CLP) and Mohammad bin Zayed (MBZ) Species Conservation for their support in Greater Adjutant conservation programme in Assam.

References


Abstract
The Adiantum capillus - veneris L., so far reported in Gorakhpur - Eastern Uttar Pradesh and Palni hills, Sambavvarvadakarai, Tenkasi taluk, Tirunelveli District of Western Ghats. First time reported in Yercaud hills of Eastern Ghats.

Introduction
The genus Adiantum is a large and diverse genus of ferns. Previously the genus was regarded under the family Polypodiaceae, later it was classified under the homosporous fern family Adiantaceae. The genus name, Adiantum, is from the Greek word Adiantos, meaning "unwetted" as the leaves of this plant repel water even though the herb grows in a wet environment. About 150 species of Adiantum are found to be world (Tryon et al., 1990). About 25 species and two varieties of Adiantum have been reported from India (Dixit, 1984).

Previously it was known in Palni hills of Southern Western Ghats of Tamil Nadu (Manickam, 1986), Gorakhpur in the Eastern Uttar Pradesh (Rajkumar et al., 2012) and Sambavvarvadakarai, Tenkasi taluk, Tirunelveli District of Tamil Nadu (Maridass 2013). During field work in 2011-2013 at Yercaud Hills of Eastern Ghats of Tamil Nadu, was observed by Adiantum capillus-veneris L. in growing on moist rocky slopes. It is infrequently found as chasmaendolithophytic (rock crevices) with on cool areas of limestone in hills or hill slopes of Yercaud region. This species was first time recorded in Yercaud Hills of Eastern Ghats.

Adiantum capillus-veneris is a perennial herb with creeping rhizomes. It reproduces sexually by spores and asexually by rhizomatous growth or the transportation of clumps of vegetative material downstream.

A.capillus - veneris can form large colonies (Hornbeck et al., 2003).

Systematic treatment

Perennial herb, evergreen, rhizomatous, fibrous-rooted, canopy ± closed with ascending, spreading, and drooping to pendent leaves, < 50 cm tall; shoots glabrous; young fiddleheads ca. 4 mm diameter; rhizomes vertical and creeping, axis 12–40+ × 2–4 mm, light brown, densely scaly, bearing hairy adventitious roots and persistent petiole bases, the scales awl-shaped flared at base, 1.5–3 × 0.2–0.5 mm, light to golden brown and ± transparent, entire or sometimes slightly toothed on 1 side, netted-veined, the veins conspicuous and opaque brown.

Leaves (fronds): helically alternate, odd-2 (–3)-pinnately compound to 1-pinnate above midpoint, 60-500 mm long, petiolate; petiole (stipe) channeled, 20–230 mm long, 0.6–1.5 mm wide at base, glossy dark reddish brown to almost black, bearing scales like on rhizome, the scales dense at base becoming widely spaced above, not flared, decreasing in length upward; blade lanceolate in outline, 50–320 × 20–120 mm, with 6-23 primary divisions, the divisions alternate and widely spaced, below midpoint 1-divided or 2 divided; rachis wirelike, glossy brown to dark reddish brown or almost black, slightly flexuous at base becoming more so toward tip; secondary axes diverging from main axis 30–60°, straight to slightly zigzagged; petiolules 0.3–4.5 mm long (lateral leaflets) to 8 mm long

Fig. 1

Distribution of Adiantum capillus-veneris L. (Adiantaceae) in India
Parthipan, M. and A. Rajendran*

*E-mail: arajendran222@yahoo.com (Corresponding author)
(terminal leaflets); blades of ultimate leaflets (pinnules) fan-shaped, subrhombic, or wedge-shaped and often markedly asymmetric, 4–22 × 4–20 mm, 0–7-lobed, thin, dull light green, broadly tapered at base, minutely dentate on margins except where folded under to form false indusium, the sinuses between lobes 0.6–10 mm deep, dichotomously veined, the veins free at tips, grading from same dark color as petiolule at base to greenish approaching margin, with each vein terminating in a short tooth; false indusia typically 2–7(--9) per leaflet (± corresponding to number of lobes), 0.8–1.3 × 1–4.5 mm.

**Sori:** absent.

**Sporangia:** ± 0.2 mm wide, brown, forming sub marginally on lower surface of leaflet under false indusium.

**Spores:** Yellowish brown. January–December (fertile sporangia always present).

**Distribution:** In India Eastern Uttar Pradesh, Palni hills, Sambavarvadakarai, Tenkasi taluk, Tirunelveli District of Tamil Nadu and Yercaud hills (Servarayan hills and Kiliyur waterfall) Eastern Ghats of Tamil Nadu (Fig. 2).

**Specimen examined:** Yercaud hills, (Servarayan hills and Kiliyur waterfall) Eastern Ghats of the Tamil Nadu. Parthipan, M., and Rajendran, A. 350 (BH).

**Traditional Uses:** Adiantum species are well-known for their significant medicinal efficacies and are being traditionally used in the treatment of various ailments for a long period (Husson et al., 1986; Ambasta, 1986). The dried whole plant is used as an antipyretic and diuretic, and also in the treatment of bronchitis in folklore medicine in China (Namba, 1980). *Adiantum capillus-veneris* L., is reputed to have numerous applications in traditional medicine in the treatment of leprosy, animal bites, thyroid dysfunction and musculoskeletal disorder (A. Vijayalakshmi and Y. Kiran Kumar, 2013).

**Acknowledgement**
We extend our sincere thanks to Professor and Head, Dept. of Botany, Bharathiar University, Coimbatore for providing necessary facilities.

**References**


Abstract

Impatiens pseudo-acaulis Bhaskar is an endemic scapigerous perennial balsam was collected from Silent Valley National Park which is the first distribution record of this taxon to the angiosperm flora of Kerala. Taxonomic descriptions, phenology, distribution and ecology along with colour photograph are provided.

Introduction

Balsams often called as Jewel weeds, are handsome plants bearing curious and variably coloured flowers coming under the family Balsaminaceae consists of two genera, the monotypic genus Hydrocera and Impatiens. The genus Impatiens has over more than 1000 species (Grey-Wilson, 1980) which are mostly distributed in five distinct diversity hotspots, viz., Tropical Africa, Madagascar, Southern India and Sri Lanka, Eastern Himalaya and Southeast Asia (Grey-Wilson, 1980; Mabberly, 2008). In India, the genus is mainly concentrated in two biodiversity hotspots viz., Himalaya and Western Ghats with 210 species (Bhaskar, 2012), among them 80 species are so far reported from Kerala part of Western Ghats (Sasidharan, 2013). While conducting the floristic inventories, the authors could collect an interesting specimen of Impatiens from Silent Valley National Park, Palakkad District, Kerala. On critical examination with types and literature (Bhaskar, 2012) the plant was identified as Impatiens pseudo-acaulis Bhaskar an endemic taxon which is described and colour photographs are provided for easy identification.

Impatiens pseudo-acaulis


Fig 1. Impatiens Pseudo-acaulis from Silent Valley National Park, India

Epiphytic, scapigerous, perennial herbs, 20-26 cm tall. Leaves 1-3, radical, petiolate; petiole 5-8 cm long, glabrous, pink; lamina 2.5-5 × 1.8-3 cm, ovate or oblong to orbicular, glabrous, green or greenish brown, obtuse at apex, rounded or sub cordate at base, shallowly toothed; nerves 6, opposite. Inflorescence scapose, peduncle 20-26 cm long, slender, terete, glabrous, pink, 6-8 flowered; pedicels 1-2.5 cm long, slender, glabrous, pale pink; bract 4-4.5 mm long, ovate, convex, glabrous, dark pink. Flowers 3.8 × 3 mm long, pale pink, distal; standard 6-7 × 7-9 mm, broadly obovate, glabrous, pale purple; lateral sepal 2-2.5 × 1-1.5 mm, ovate lanceolate, obtuse, glabrous, pale pink; wings 3 lored, 17-20 × 10-11 mm; basal 7-9 × 2 mm; middle 11 × 4-4.5 mm; distal 11-16 × 2.5-3 mm; lip 5-6 × 3-3.5 mm, cymbiform, obtuse, glabrous, white; spur 2.6-4.2 cm long, cylindrical, slightly curved, glabrous, white. Column 3-3.5 × 2-2.5 mm, connate; anther 1 mm long, yellow; stalk 2-2.5 mm long.

Pistil 2-2.5 × 1-1.5 mm, broadly ellipsoid, acute, pale green, pale pink streaked at tip. Capsules 1-1.5 cm, ovate-oblong, glabrous; seeds brown, covered with short and stout hairs all over the surface.

Specimen examined: 288536 (Kerala Forest Research Institute, Peechi, Thrissur (KFRI)), 02.10.2013, ±2000 m, Sispara, Silent Valley, Palakkad district, Kerala, India, V.S. Hareesh & V.B. Sreekumar.

Phenology: August-November.

Distribution: Endemic to North-East monsoon zone of South in Nilgiris near Naduvattam, Kudahs, Mukurthi of Tamil Nadu. In Silent Valley the distribution of
*I. pseudo-acaulis* is restricted to evergreen patches in Sispara.

**Ecology and habitat:** Silent Valley National Park is situated in the Mannarkkad forest Division of Palakkad district, Kerala extending over 8952 hectares at south-western corners of the Nilgiris. The vegetation is characterized by tropical evergreen, shola and high altitude grasslands. It harbours a large number of rare, endangered and endemic species of flora and fauna. Sispara is at the south-east region of the valley and is the floristically one of the important region in which seventeen new taxon were reported from the region itself. *I. pseudo-acaulis* grows in the wet rocky areas with an altitudinal gradient range between 1950-2050 m.

**Notes:** This species so far known only from the evergreen forests in North-East monsoon zone of South in Nilgiris near Naduvattam, Kundahs, Mukurthi of Tamil Nadu (Bhaskar, 2012). The present collection from Sispara forests of Silent Valley National Park, Palakkad district is the extended distributional record for this taxon to the angiosperm flora of Kerala.

**Acknowledgement**
The authors are thankful to the Director, Kerala Forest Research Institute, Peechi for encouragement and facilities and Kerala Forest Department for the permission to conduct scientific works in Kerala part of Western Ghats.

**References**


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The theme for the 5th AZEC conference is “Conserving the Natural Environment and Biodiversity in Asia”. Concern about the accelerating loss of species and habitats has brought on an appreciation for biological diversity. This conference focuses on Biodiversity and will be a place for related organization such as the Zoo, aquarium, arboretum, science museum, museum, national park, wildlife rescue center, NGOs, NPOs, nature conservation agency. This conference provides a opportunity to share ideas and discuss common interests of educators.

For more information contact:
The 5th Asian Zoo Educators’ Conference, E-mail 2015azec@seoul.go.kr
‘Living with Villagers’ for Bat Conservation at Triyuga Municipality, Udayapur, Nepal
Sanjan Thapa

Introduction
"Living with Villagers for Bat Conservation", an innovative volunteer project was started at Madi, Sankhuwasabha District of Eastern Nepal during 2012-13. The second part of the project was continued from August 3-25, 2015 at Triyuga Municipality, Udayapur District in South Eastern Nepal. The targeted audiences were lower secondary level students covering 9 schools as well as the students of Agriculture Junior Technical Assistance (J.T.A.) Training Centre. Documentary shows were screened and posters were supplied to them on bat conservation.

Background
Nepalese people have negative attitude towards bats in most parts of the country. In some places, they have the misconception and misbelieve of bats as ghost, witches as they are seen flying at the night. People are afraid of bats as they conceive bats bite, prick their eyes or urinate on their body. At western part of Nepal, people blame bats for damaging the horns of cattle and goats. In Chitwan, bats are blamed for damaging Rhino horn. Some nomads, tribes such as Chepangs kill bats for subsistence. The killing of bats for bush meat is their tradition. The condition has been deteriorated further now, bat meat consumption is not limited to Chepangs only but also other castes have started to eat in a belief that it cures diseases such as cancer. Local bat trade has been flourished in Saktikhor, Chitwan District (Dahal et al. 2011). All over the country bats are killed to feed the cattle to cure Babeiosis (Acharya et al. 2010).

Government has neglected the bat conservation. They have neither concerned for formulation of conservation plans and policies nor allocated budget for its conservation. The role of bat conservation is up to the effort of Non-Government Organizations and individuals. Funding for the conservation of these species is generously supported by International agencies.

A few bat conservation projects have been carried out including surveys in different parts of Nepal, most of them in remote areas. These projects run for a short period of about two months in each project area. The effectiveness of the projects is sustained only during project period, and the project aim could not be achieved completely because of the project’s short duration. Moreover, the available fund is very limited or very little for the conservation of species like bats. With these realities in mind, a long-lasting, effective, self-sustaining project “Living with villagers for bat conservation” was planned.

This is absolutely my personal initiative attached with Small Mammals Conservation and Research Foundation. Besides, it is a volunteer project, without any financial support from other sources. This project has five years tenure and the plan will be substantial visits to be made to villages and suburban areas and interacting with the villagers. It has three objectives; educating the schoolchildren, raising awareness through the outreach materials and surveying the species diversity. First two objectives are expected to inform about bats, their role in ecosystem services and change the misconception about them. Subsequently, it will benefit in long-term conservation of bats in Nepal.

In 2012-2013, the project was initiated from a remote part of Eastern Nepal at Madi, Madi- Rambeni Village Development Committee, Sankhuwasabha District. Awareness campaign was conducted in 3

Small Mammals Conservation and Research Foundation, Balkhu, Kathmandu, Nepal.
schools through bat art drawing, supply of posters, leaflets and greeting cards, talk on bat and their ecological importance, bat documentary show, distributing book "Bats of Nepal, A Field Guide" to school library and display of bat education materials

Table 1: Bat Conservation awareness in School/Institution in Triyuga Municipality

<table>
<thead>
<tr>
<th>School/Institution Name</th>
<th>Place</th>
<th>GPS Location (x)</th>
<th>GPS Location (y)</th>
<th>No. of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brilliant Academy</td>
<td>Chuhade, Triyuga Municipality (T.M.) ward # 13</td>
<td>E86.63061111111111</td>
<td>N26.8247499999999</td>
<td>40</td>
</tr>
<tr>
<td>Janajyoti Higher Secondary School</td>
<td>Chuhade, T.M. ward # 13</td>
<td>E86.6247499999999</td>
<td>N26.8259722222222</td>
<td>80</td>
</tr>
<tr>
<td>Shree Truiyuga English Secondary School</td>
<td>Chuhade, T.M. ward # 13</td>
<td>E86.628138888888888</td>
<td>N26.8247222222222</td>
<td>40</td>
</tr>
<tr>
<td>Maha Rauta Rani Public English School</td>
<td>Rajabas, T.M. ward # 16</td>
<td>E86.6646111111111</td>
<td>N26.81683333333333</td>
<td>30</td>
</tr>
<tr>
<td>Sishu Bidhyapith</td>
<td>Bhulke, T.M. ward # 7</td>
<td>E86.6955277777777</td>
<td>N26.76983333333333</td>
<td>40</td>
</tr>
<tr>
<td>Crimson Academy</td>
<td>Salghari, Bagaha, T.M. ward # 8</td>
<td>E86.67136111111111</td>
<td>N26.78538888888889</td>
<td>15</td>
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<tr>
<td>Standard Vision Academy</td>
<td>Motigada, T.M. ward # 7</td>
<td>E86.6687</td>
<td>N26.77766666666666</td>
<td>40</td>
</tr>
<tr>
<td>Kakani Model School</td>
<td>Rajabas, T.M. ward # 16</td>
<td>E86.66119444444445</td>
<td>N26.81777777777777</td>
<td>40</td>
</tr>
<tr>
<td>Bahuri Das Memorial (B.D.M.) English Boarding School</td>
<td>Motigada, T.M. ward # 7</td>
<td>E86.68544444444444</td>
<td>N26.78052777777777</td>
<td>30</td>
</tr>
<tr>
<td>Sunakhari JTA (Agriculture Junior Technical Assistance) Training Center, WOREC Nepal, Udayapur</td>
<td>Rajabas, T.M. ward # 16</td>
<td>E86.65827777777777</td>
<td>N26.81836111111111</td>
<td>50</td>
</tr>
</tbody>
</table>

Project area

Triyuga Municipality is one of the three municipalities in Udayapur District. It covers an area of 20,978 ha divided into 17 wards. The municipality includes the Headquarter of the district, Gaighat. It covers Inner Tarai (flood plains formed by the Triyuga River as a main channel and other several tributaries of it). The climate is characterized by tropical monsoon type with annual maximum temperature 41°C and annual minimum temperature 16°C. It receives an annual average rainfall of 2152mm. Sal (Shorea robusta) predominates the vegetation of the area. Other
major tree species are Saj (*Terminalia elliptica*), Karam (*Adina cordifolia*) etc. There are 47 Community Forests in the municipality, which covers an area of 17367ha. Paddy, wheat, maize, millet, barley, pulses, lentils, and mustard are the major crops cultivated in 3428ha agricultural land. The forest and agricultural landscape is the watershed of Triyuga River (DDC Udayapur 2008).

**Objective**

The anticipated aim of this project is to initiate bat conservation awareness in and around Gaighat. Specific objective of the current project is to educate the school children about role of bats play in the ecosystem such as pollination, seed dispersal and pest control.

**Methods**

**Documentary show**

Documentary on “Secret World of Bats” provided by Bat Conservation International was exhibited. The 45 minutes documentary provided insight into bats facts and their socio- ecological role like in pollination, seed dispersal and pest control, tourism etc. throughout different parts of the globe.

Equipment granted by IDEA WILD; 3M MPro 160 pocket projectors with all accessories and Lenovo G 505 were deployed for the documentary show. The participants (school children and J.T.A.) were asked to convey the conservation message learnt to their family, friends and relatives.

**Distribution of Posters**

Two hundred posters focused on evidence based bat conservation message were supplied to schoolchildren. They were asked to take it to home and show them to their family, friends and relatives. Twenty posters were displayed at schools too.

**Results**

Bat conservation awareness programme was conducted in 9 schools and Agriculture Junior Technical Assistance (J.T.A.) Training Centre (institution) during August 3-25, 2015 (Table 1). School children of lower secondary level were the targeted group. However, Agriculture Junior Technical Assistance (J.T.A.) and students of higher secondary level also participated.
Acknowledgements
I would like to express esteemed acknowledgements to IDEA WILD and Ann Marie Gage for the equipment support. I am grateful to Mr. Ashim Khadka for shipping the granted equipment to Nepal from USA, Bat Conservation International for providing documentary "Secret World of Bats" and Small Mammals Conservation and Research Foundation for posters. I would like to thank Mr. Bibas Danuwar for his assistance during the field work. I owe gratitude to all local school administration for permission and appreciation to conduct the conservation awareness programme and school children for their active participation in the conservation awareness programme.

I am indebted to Emeritus Prof. Dr. Paul A. Racey; Ms. Caroline Ware, Natural History Museum, London, UK, Ms. Sally Walker, Dr. B.A. Daniel, R. Marimuthu, Zoo Outreach Organization, India; Dr. Debbie Bartlett, University of Greenwich, UK; Dr. Maheshwar Dhakal, Department of National Parks and Wildlife Conservation, Kathmandu, Nepal; Prof. Karan Shah, Himalayan Nature, Kathmandu, Nepal; Dr. Hem Sagar Baral, Zoological Society of London, Kathmandu, Nepal and Dr. Shant Raj Jnawali, WWF Nepal, Kathmandu, Nepal for their kind and continuous support.

References


Status and conservation of montane herpetofauna of Southern Eastern Ghats, India
S.R. Ganesh¹ and M. Arumugam²

Abstract
We examined the conservation status levels of amphibians and reptiles inhabiting the Southern Eastern Ghats hill range, peninsular India. We surveyed the herpetofauna in the montane zones (> 900 m asl) of four hill ranges namely Jawadi, Shevaroys, Kolli and Sirumalai. For each species recorded by us in the field, we allocate an appropriate form of rarity among the eight forms defined in literature based on distribution, habitat use and population size. Based on our results, we highlight the potential of Southern Eastern Ghats to harbor a characteristic herpetofauna which warrants better research and conservation.

Introduction
The amphibians and reptiles inhabiting the Eastern Ghats hill range in peninsular India remain poorly understood (Aengals et al., 2011; Dinesh et al., 2009). The Southern Eastern Ghats (10.14°-12.81°N 77.93°-79.04°E; < 1620 m asl; after Jayakumar et al., 2008), the region of interest for the present work currently lacks any protected area, but is reported to harbor several range-restricted or otherwise potentially threatened species of herpetofauna (Daniels & Ishwar, 1994; Daniels & Kumar, 1998; Kumar & Daniels 1999; Vanak et al., 2001). In a pioneering work Daniels & Ishwar (1994) studied the rarity and threat status of amphibians and reptiles by (briefly) surveying select localities in the Southern Eastern Ghats and allocating the recorded species into several threat categories (Rabinowitz et al., 1986) based on their data.

Later, Murthy & Aengals (2008) provided an updated checklist of Eastern Ghats reptiles and commented upon the recent additions of taxa to this region. Subsequently works on both amphibians (Dinesh et al., 2009; Biju et al., 2014 read with Oliver et al., 2015) and reptiles (Aengals et al., 2011; Somaweera et al., 2015) reveal further additions to the Southern Eastern Ghats herpetofauna. Therefore, the current data on this region’s herpetological diversity stands starkly different from the scenario known earlier (Daniels & Ishwar, 1994).

However, since the two decades old work of Daniels & Ishwar (1994), subsequent attempt to reassess the threat status of the herpetofauna of this region are still wanting. In this work, we present information on the forms of rarity (after Rabinowitz et al., 1986) and furnish information on distribution, habitat use and population size based mainly on our survey data, apart from literature where found necessary.

Materials and Methods
We present our compilations based on our fieldwork in the Southern Eastern Ghats during 2011-15. We surveyed the montane zones (> 900 m asl) of four select massifs namely Jawadi (=Tirupattur) hills (12.26-12.51°N 78.60-78.76°E; 1200 m asl) in Vellore district; Shevaroy hills (11.72-11.93°N 78.12-78.36°E; 1620 m asl) in Salem district; Kolli hills (11.19-11.46°N 78.28-78.47°E; 1400 m asl) in Namakkal district and Sirumalai hills (10.12-10.28°N 77.92-78.11°E; 1400 m asl) in Dindigul district, all situated in Tamil Nadu state (see Jayakumar et al., 2008) and generated herpetological species list. These four massifs were selected to amass the greatest possible spectrum of herpetological diversity of the region, particularly the montane wet-zone endemics. Hence, for this study, our surveys were restricted to these four massifs and excluded other partly or fully conjoined hills and other smaller hill ranges situated within this region. We then compiled the threat status categories as defined by Rabinowitz et al. (1986) (after Daniels & Ishwar, 1994) for all the species of herpetofauna we recorded.

We categorized the variables given in Rabinowitz et al. (1986) as follows–i. Distribution range: wide (occurring in the plains as well as hills); narrow (absent in the plains, but present in all or most of the hill ranges); very narrow (absent in the plains, present only in a few hill ranges); ii. Habitat specificity: no (present in dry as well as wet zones, in many habitats both natural and anthropogenic); mild (absent in dry zone, present only in wet zone, but in both natural and anthropogenic habitats); yes (absent in dry zone, present only in the wet zone, that too in natural forests alone); iii. Population / rarity: abundant (> 250 sightings); common (101-250 sightings); occasional (51-100 sightings); rare (< 50 sightings).

We used our field data and literature (Aengals et al., 2011; Biju, 2001; Das, 2002; Daniel, 2002; Daniels, 2005; Whitaker & Captain, 2008) data for one variable–the distribution range; but only our field data for the other two variables– habitat use and population size. Hence, for a given species, much of the resulting categorisation may not hold true at all cases, but is rather case-specific, pertaining to the Southern Eastern Ghats’ montane herpetofauna.

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Table 1. Classification of species into various forms of rarity (after Rabinowitz et al., 1986).

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Species</th>
<th>Distribution range</th>
<th>Habitat specificity</th>
<th>Population / rarity</th>
<th>Rabinowitz et al. scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Duttaphrynus melanostictus</em></td>
<td>Wide</td>
<td>No</td>
<td>Common</td>
<td>Form 1</td>
</tr>
<tr>
<td>2</td>
<td><em>Fejervarya</em> sp.</td>
<td>Wide</td>
<td>No</td>
<td>Abundant</td>
<td>Form 1</td>
</tr>
<tr>
<td>3</td>
<td><em>Fejervarya</em> cf. nilagirica</td>
<td>Very Narrow</td>
<td>Yes</td>
<td>Rare</td>
<td>Form 8</td>
</tr>
<tr>
<td>4</td>
<td><em>Sphaerotheca</em> cf. <em>dobsonii</em></td>
<td>Narrow</td>
<td>Mild</td>
<td>Rare</td>
<td>Form 8</td>
</tr>
<tr>
<td>5</td>
<td><em>Sphaerotheca</em> sp.</td>
<td>Very Narrow</td>
<td>Mild</td>
<td>Rare</td>
<td>Form 8</td>
</tr>
<tr>
<td>6</td>
<td><em>Indosylvirana</em> sreeni</td>
<td>Very Narrow</td>
<td>Yes</td>
<td>Occasional</td>
<td>Form 6</td>
</tr>
<tr>
<td>7</td>
<td><em>Indirana</em> sp.</td>
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<td>Mild</td>
<td>Rare</td>
<td>Form 8</td>
</tr>
<tr>
<td>8</td>
<td><em>Microhyla</em> cf. <em>sholigari</em></td>
<td>Very Narrow</td>
<td>Mild</td>
<td>Occasional</td>
<td>Form 6</td>
</tr>
<tr>
<td>9</td>
<td><em>Pseudophilautus</em> cf. <em>wynaadensis</em></td>
<td>Very Narrow</td>
<td>Mild</td>
<td>Occasional</td>
<td>Form 6</td>
</tr>
<tr>
<td>10</td>
<td><em>Raorchestes</em> cf. <em>leucolatus</em></td>
<td>Very Narrow</td>
<td>Yes</td>
<td>Rare</td>
<td>Form 6</td>
</tr>
<tr>
<td>11</td>
<td><em>Draco dussumierii</em></td>
<td>Narrow</td>
<td>Mild</td>
<td>Occasional</td>
<td>Form 6</td>
</tr>
<tr>
<td>12</td>
<td><em>Calotes calotes</em></td>
<td>Narrow</td>
<td>Mild</td>
<td>Occasional</td>
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</tr>
<tr>
<td>13</td>
<td><em>Calotes rouxii</em></td>
<td>Narrow</td>
<td>Mild</td>
<td>Occasional</td>
<td>Form 6</td>
</tr>
<tr>
<td>14</td>
<td><em>Calotes versicolor</em></td>
<td>Wide</td>
<td>No</td>
<td>Occasional</td>
<td>Form 1</td>
</tr>
<tr>
<td>15</td>
<td><em>Psammophilus</em> blanfordianus</td>
<td>Wide</td>
<td>Yes</td>
<td>Occasional</td>
<td>Form 2</td>
</tr>
<tr>
<td>16</td>
<td><em>Psammophilus</em> dorsalis</td>
<td>Narrow</td>
<td>Yes</td>
<td>Occasional</td>
<td>Form 6</td>
</tr>
<tr>
<td>17</td>
<td><em>Cnemaspis</em> cf. <em>gracilis</em></td>
<td>Very Narrow</td>
<td>Mild</td>
<td>Abundant</td>
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<tr>
<td>18</td>
<td><em>Cnemaspis</em> mysoriensis</td>
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<td>Mild</td>
<td>Abundant</td>
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<td>19</td>
<td><em>Cnemaspis</em> sp.</td>
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<td>Mild</td>
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<td>20</td>
<td><em>Cnemaspis</em> yercaudensis</td>
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<td>Common</td>
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<tr>
<td>21</td>
<td><em>Calodactylodes</em> aureus</td>
<td>Narrow</td>
<td>Yes</td>
<td>Abundant</td>
<td>Form 6</td>
</tr>
<tr>
<td>22</td>
<td><em>Cyrtojustinus</em> sp.</td>
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<td>Mild</td>
<td>Occasional</td>
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<td>23</td>
<td><em>Cyrtojustinus</em> cf. <em>collegalensis</em></td>
<td>Narrow</td>
<td>Mild</td>
<td>Rare</td>
<td>Form 7</td>
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<tr>
<td>24</td>
<td><em>Hemidactylus</em> cf. <em>acanthophilis</em></td>
<td>Very Narrow</td>
<td>Yes</td>
<td>Occasional</td>
<td>Form 8</td>
</tr>
<tr>
<td>25</td>
<td><em>Hemidactylus</em> cf. <em>brookii</em></td>
<td>Wide</td>
<td>No</td>
<td>Occasional</td>
<td>Form 3</td>
</tr>
<tr>
<td>26</td>
<td><em>Hemidactylus</em> frenatus</td>
<td>Wide</td>
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<td>Common</td>
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<tr>
<td>27</td>
<td><em>Hemidactylus</em> graniticus</td>
<td>Narrow</td>
<td>Mild</td>
<td>Occasional</td>
<td>Form 6</td>
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<tr>
<td>28</td>
<td><em>Hemipodactylus</em> aurantiacus</td>
<td>Narrow</td>
<td>No</td>
<td>Occasional</td>
<td>Form 5</td>
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<tr>
<td>29</td>
<td><em>Eutropis</em> alipallensis</td>
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<td>Mild</td>
<td>Abundant</td>
<td>Form 6</td>
</tr>
<tr>
<td>30</td>
<td><em>Eutropis</em> beddomei</td>
<td>Narrow</td>
<td>Yes</td>
<td>Occasional</td>
<td>Form 6</td>
</tr>
<tr>
<td>31</td>
<td><em>Eutropis</em> carinata</td>
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<td>No</td>
<td>Occasional</td>
<td>Form 1</td>
</tr>
<tr>
<td>32</td>
<td><em>Eutropis</em> macularia</td>
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<td>No</td>
<td>Occasional</td>
<td>Form 1</td>
</tr>
<tr>
<td>33</td>
<td><em>Lygosoma</em> punctatum</td>
<td>Wide</td>
<td>No</td>
<td>Rare</td>
<td>Form 3</td>
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<tr>
<td>34</td>
<td><em>Lygosoma</em> cf. <em>pruthi</em></td>
<td>Narrow</td>
<td>Mild</td>
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<tr>
<td>35</td>
<td><em>Kaestlea</em> sp.</td>
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<td>Yes</td>
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<td>Form 8</td>
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<tr>
<td>36</td>
<td><em>Ophisops</em> minor <em>nictans</em></td>
<td>Narrow</td>
<td>Yes</td>
<td>Rare</td>
<td>Form 8</td>
</tr>
</tbody>
</table>

Snakes

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Species</th>
<th>Distribution range</th>
<th>Habitat specificity</th>
<th>Population / rarity</th>
<th>Rabinowitz et al. scheme</th>
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</thead>
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<tr>
<td>37</td>
<td><em>Gerrhopilus</em> cf. <em>beddomei</em></td>
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<td>Rare</td>
<td>Form 8</td>
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<tr>
<td>38</td>
<td><em>Rhinophilus</em> goweri</td>
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<td>Rare</td>
<td>Form 8</td>
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<tr>
<td>39</td>
<td><em>Uropeltis</em> shortii</td>
<td>Very Narrow</td>
<td>Mild</td>
<td>Rare</td>
<td>Form 8</td>
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<tr>
<td>40</td>
<td><em>Uropeltis</em> cf. <em>ceylanica</em></td>
<td>Very Narrow</td>
<td>Mild</td>
<td>Rare</td>
<td>Form 8</td>
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<tr>
<td>41</td>
<td><em>Uropeltis</em> cf. <em>phipsonii</em></td>
<td>Very Narrow</td>
<td>Mild</td>
<td>Rare</td>
<td>Form 8</td>
</tr>
</tbody>
</table>
Results and Discussions

Form 1 (widespread, generalist, common): Two species of frogs (Duttaphrynus melanostictus, Fejervarya sp.) and four species of lizards (Calotes versicolor, Hemidactylus frenatus, Eutropis carinata, E. macularia) were represented in this category. These species were pan-Indian, human-commensally, commonly encountered and ubiquitous in nature (Biju 2001; Aengals et al., 2011; Daniels, 2005). It is noteworthy that no snakes were represented here (Indotyphlops braminus absent in dataset), because snakes occupy a higher trophic level (Whitaker & Captain, 2008) compared to frogs and lizards (Varanus bengalensis absent in dataset).

Form 2 (widespread, habitat-specific, common): Only one species of rock-dwelling agamid lizard (Psammophilus blanfordanus) endemic to peninsular Indian hills represent this category. The habitat-specificity in this case is not of arid or mesic conditions, but refers to the rock formations, towards which these lizards have an affinity (Das, 2002; Daniel, 2002).

Form 3 (widespread, generalist, rare): Two species of lizards (Hemidactylus cf. brookii, Lygosoma punctatum) and six species of snakes (Ptyas mucosa, Amphiesma stolatum, Xenochrophis piscator, Ahaetulla nasuta, Bungarus caeruleus, Naja naja) represent this category. The snakes falling under this category were very widespread, pan-Indian taxa that are eclectic in their habitat-preference (Das, 2002; Daniel, 2002; Whitaker & Captain, 2008), but were all essentially-rare because all snakes occupy a higher trophic level than most frogs and lizards. The two aforesaid lizards were represented by low number of sightings in our dataset because of our sampling design that paid less attention to human habitations and the elusive nature of the semi-fossorial skinks that could potentially evaded detections.
Form 4 (widespread, habitat-specific, rare): Not represented, as none of the widespread species of herpetofauna encountered in this study are habitat-specific (Aengals et al., 2011; Biju, 2000; Das, 2002; Daniel, 2002; Daniels, 2005; Dinesh et al., 2009; Whitaker & Captain, 2008).

Form 5 (rage-restricted, generalist, common): One species of lizard (Hemiphyllodactyulus aurantiacus) represent this category. This species has a restricted distribution, it occurs in all habitats (Das, 2002) and is not uncommon in at least in one of the surveyed sites.

Form 6 (rage-restricted, habitat-specific, common): Four species of frogs (Microhyla cf. sholigari, Indosylvirana sreeni, Pseudophilaetus cf. wynaadensis, Raorchestes cf. leucolatus) and twelve species of lizards (Draco dussumierii, Calotes calotes, C. rouxii, Psammophilus dorsalis, Cnemaspis cf. gracilis, Cnemaspis sp., C. mysoriensis, C. yercaudensis, Hemidactylus graniticulus, Calodactylodes aureus, Eutropis allpallensis, E. beddomei) represent this category. These species were amongst the most commonly seen taxa in their respective study-sites, although intolerant to dry zones and absent in the surrounding plains (Biju, 2001; Biju & Bossuyt, 2009; Das, 2002; Daniel, 2002; Daniels, 2005; Vijayakumar et al., 2014).

Form 7 (rage-restricted, generalist, rare): Two species of lizards (Cyrtodactylus cf. speciosus, C. speciosus) and three species of snakes (Macropisthodon plumbicolor, Boiga forsteni, Trimeresurus gramineus) represent this category. These reptiles, although occurring in many habitat types (Aengals et al., 2011; Das, 2002; Daniel, 2002; Whitaker & Captain, 2008) were never commonly recorded in any site.

Form 8 (rage-restricted, habitat-specific, rare): Most (n=23; 37%) species fell under this category. This is also the only category that has frogs, lizards and snakes represented in. Many taxa in this form are narrow-endemics that are rarely reported in studies (Biju, 2001; Das, 2002; Daniel, 2002; Whitaker & Captain, 2008; Aengals et al., 2011). As can be seen from Table 1 many species present in this form are taxonomically unresolved ones that require urgent systematic studies.

We limit comparing in detail our results with that of earlier study (Daniels & Ishwar, 1994) because of the differences in species composition, as the two studies although were from a largely overlapping same general area, still differed due to elevational variations. While our surveys deliberately excluded low-elevation belts to concentrate on the montane forms, Daniels & Ishwar (1994) worked even on the Eastern Costal Plains sites. Yet, we note in passing that similar to Daniels & Ishwar (1994), our study too reveals that Form 8 is the commonest form of rarity with many species having narrow geographic range, restricted habitat preference and low population densities. Thus, although it is true that the adjacent Western Ghats is a recognised herpetological hotspot (Aengals et al., 2011; Dinesh et al., 2009), the Southern Eastern Ghats also harbours endemics and a characteristic herpetofauna (also see Somaweera et al., 2015), at least to a lesser extent, thereby deserving further research and conservation attention.

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References


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Husbandry and Care of Birds (Chapter 32, ZOOKEEPING)
Ted Fox¹ and Adrienne Whiteley²

Introduction
Members of the class Aves are the most widespread of vertebrate animals on the planet. Birds can be found in every habitat on the continents, and some even spend the majority of their lives at sea, returning to land only to reproduce. All birds share certain characteristics: feathers; beaks; sturdy, lightweight skeletons; and egg-laying. After completing this chapter, the reader will have a basic understanding of:

- avian families
- avian physiology
- exhibit design and maintenance
- the formulation and presentation of diets
- reproduction
- the form and function of bird eggs
- major disease concerns
- management strategies, including mixed-species exhibits
- avian-specific terminology.

Taxonomy
There is some dispute regarding the number of orders that exist in the class. The classification standard for decades has been that of James Clements (2007). Recently, Sibley and Monroe (1997) published a revised taxonomy based on DNA sampling. The DNA taxonomy is gaining slow acceptance among aviculturists, although there is growing evidence in its favor. Depending on the source used, the number of orders is either 27 or 22. As the Clements standard is still more widely used, however, it is the classification described in table 32.1.

General Life Cycle and Anatomy
All birds hatch from eggs. An egg is self-contained and includes all the nutrients necessary to allow the embryo to grow to hatching. Eggs are porous and lose weight throughout incubation ("drying down"). At the end of the incubation period, the chick breaks into the air cell and begins to breathe prior to hatching. Using a specialized egg-tooth, it cracks the shell around the perimeter of the egg, usually at the widest point, on the end with the air cell. The hatch muscle provides the force for the beak to penetrate through the shell. The chick then begins stretching its body until it can push free of the surrounding egg.

Most chicks are raised by one or both parents, although a few species practice parasitism: laying their eggs in another species' nest, then leaving them to be raised by the nest-owners. The chicks of these species are typically larger than the nest's resident chicks and outcompete them. For example, cowbirds (Molothrus ater) may lay their eggs in a chipping sparrow (Spizella passerina) nest. The chipping sparrow nestlings are much smaller than the newly hatched cowbirds, and soon starve as the cowbirds reach the food brought to the nest first. Interestingly, cowbird chicks will make sparrow vocalizations to beg from their "parents". After weaning, they acquire vocalizations appropriate for cowbirds.

Other species are colonial and allow helpers at the nest. White-crested laughing thrushes (Garrulax leucocephalus) are one example of this. Closely related birds may help with nest building and chick feeding, occasionally even taking turns with incubation. Altricial chicks must be fed by their parents; precocial chicks are able to feed themselves. Altricial chicks are usually nidifugous (staying in the nest while they grow). Precocial chicks are usually nidificous, (leaving the nest soon after hatching, following the parents to find food). Altricial chicks are typically bare, or nearly so, on hatching. As the chicks grow, their feathers develop. Time in the nest varies by species. Generally, smaller birds spend less time in the nest; a cardinal (Cardinalis cardinalis) fledges 9 to 13 days after hatching. Bald eagle (Haliaeetus leucocephalus) chicks spend nearly three months in the nest, building their flight muscles while perched on the nest edge for the last few weeks before taking off.

Most chicks learn their vocalizations from their parents. Some, like mockingbirds (Mimus polyglottos) increase their repertoire throughout their lives. Song vigor and plumage coloration directly correlate to mate selection in many species. Female mate choice is prevalent among birds, the dominant females often choosing the best singers with the brightest colors. In species that exhibit sexual dimorphism, male birds are frequently much "showier" than females, many going to great lengths

Zookeeping
An Introduction to the Science and Technology
Edited by Mark D. Irwin, John B. Stoner, and Aaron M. Cobaugh

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162 Rosamond Gifford Zoo, Syracuse, NY 13204, USA
to impress a prospective mate, literally singing and
dancing their way into her favor. Courtship rituals
vary widely among species; some are the most
dramatic displays in the animal world. For species in
which song and plumage plays a lesser role in
courtship, the mechanism behind mate selection is
more mysterious. Much of a bird’s life is spent in
courtship, bonding, chick-rearing, and territorial
defense. What time is left over is devoted to feeding
and preening. Keeping feathers in good condition is
critical to a bird’s survival. Some birds, of course, do
find time to enjoy themselves. The astounding
aeronautical maneuvers of crows (Corvus
brachyrhynchos) on a windy day can be considered a
display of play behavior.

Guidelines for the Avian Keeper

Interaction between Keepers and Birds

It is paramount for keepers to have an understanding
of normal species behavior. Birds can be habituated
to human presence, and food is a great motivator to
accomplish this. Feeding live food or presenting food
in a way that allows birds to come close to the keeper
is extremely beneficial in allowing close observation.
It is obviously important to move slowly and carefully
when working in proximity to birds, since they are
sometimes easily alarmed. One should always know
where the birds are when moving among them, and
allow them an escape route. Birds that are
frightened out of hiding spaces or off perches may fly
blindly into enclosure barriers, risking injury or even
death.

In addition to taking care to avoid injuring a bird, it is
important to remember that some birds are very
capable of inflicting damage on a careless keeper.
Large birds, like cranes, use their beaks as weapons
and will frequently aim for a person’s face. Birds of
prey have formidable beaks and talons, with which
they are capable of inflicting serious harm.
Psittacines use their beaks to open very hard objects
like nuts, and have no difficulty with a relatively soft
object like a human finger. Large parrots like
hyacinth macaws (Anodorhynchus hyacinthinus) can
easily break the bones in a person’s hand if given the
opportunity. Even smaller birds can cause injury with
the right motivation; waterfowl may peck or hit
keepers with their wings if their nest or offspring are
approached. Even small passerines may attack by
flying at a person who ventures too close to their
nest. Keep in mind that a bird’s behavior can change
dramatically with changing circumstances (e.g.,
restraint, breeding, chick-rearing), resulting in a bird
that no longer acts in a familiar way.

Special Considerations for Wild-caught
Specimens

Wild-caught specimens must be closely monitored for
health and behavioral problems. Their food
consumption should be documented. It is important
to feed newly acquired birds as close to a natural diet
as possible. If changing over to a different diet is
necessary, it should be done gradually. Holding areas
should have adequate perching and visual barriers to
allow birds to become acclimated to their new
surroundings. It is paramount for keepers to move
calmly and quietly. Night lights should be provided
when room lights are not in use.
Many people advocate the use of softly playing music
to help keep the birds calm and to help mask
unfamiliar ambient sounds. As soon as the bird is
stable in the new environment, medical tests
(physical exam, hematology, radiographs, and cloacal...
and choanal cultures) should be performed to ascertain baseline health.

Observations: Visual and Vocal
A healthy bird will appear to be bright and alert with clean, unbroken plumage. The feathers will lie close against the body, and the bird will preen to keep the feathers in good condition. Most birds are relatively lively throughout their respective activity periods (diurnal, nocturnal, etc.).

Enclosure Design and Maintenance

Indoor Versus Outdoor Enclosures, with Climate Considerations
Birds can be exhibited in indoor enclosures with controlled light and climate, or in outdoor areas with exposure to the elements. The best choice depends on the species being exhibited and the ability to keep the birds safe and secure. Some choices are obvious: for example, one would not keep an Antarctic penguin species in an outdoor enclosure in Arizona. Bird species typically found in climate parameters similar to those in which the zoo is located may usually be kept outdoors with access to appropriate shelter. Birds capable of flight should be kept in exhibits that are netted or meshed in a suitable size to prevent escape or injury. It is possible to render a bird incapable of flight either permanently by surgical means (pinioning or tendonectomy) or temporarily by feather clipping to keep it contained in an area that is not completely enclosed. This option is most successful with birds that are typically found on the ground or in water (waterfowl, wading birds, cranes, etc.). Birds that do not fly can be restrained by walls or fences. In temperate areas, tropical birds can be displayed outdoors seasonally.

Walk-Through Aviaries
Mixed-species aviaries are very popular with the public and can be used to illustrate not only individual species, but the ways in which multiple species can interact with a similar environment. These aviaries provide a great deal of interest, both visual and auditory. Care must be taken to provide adequate space to meet the needs of all the species chosen to inhabit the enclosure. Knowledge of the behavioral parameters of each individual species is the key to selecting birds that will successfully share the area allotted to them. It is useful to have a variety of perching opportunities at multiple levels, plentiful nesting material, and multiple feeding areas. Live plants and water features will enhance the effect of the space and provide enrichment for the birds.

Containment Materials
Birds housed indoors will also need containment of some type: examples include free-standing cages, glass-fronted rooms, aviaries that employ double door entries, and exhibits with piano wire or "invisible" netting. It is sometimes possible to house diurnal birds in a lighted exhibit that zoo visitors can view from a darkened hallway, as the birds will be reluctant to enter an unlit space.
Shelters and Climate control
All birds exhibited outdoors must have some shelter from inclement weather. This may take many forms, such as a simple windbreak, a covered roof, or a nest box. Climate control in enclosed habitats is used to help create an environment that replicates the natural habitat as closely as possible. The previously mentioned Antarctic penguins kept in Arizona would need a refrigerated habitat to keep them comfortable and healthy.

Water Features
Water is an essential environmental component for most bird species. It is necessary for drinking and bathing. Some birds swim and/or find their food in water. Adding a water feature to a habitat for many birds enhances the environment and the birds' well-being, while also increasing interest for the visitor by allowing the birds to display a broader range of natural behavior. Moving water (waterfalls, misters, etc.) may attract the birds' attention, motivating them to make use of the feature. The water should be monitored for quality and cleaned frequently enough to prevent bacterial growth. Fresh, clean drinking water should be provided daily.

Substrates
A variety of substrates can be used, depending on the species and type of enclosure. A freestanding cage should allow the fecal material to drop through the cage bottom and collect on a surface that can be cleaned (cement, newspaper, wood shavings, etc.). Larger spaces may have grass, dirt, sand mulch, or other natural substances. Fecal material should not be allowed to build up, regardless of the substrate used. Some consideration must also be given to pest control. Mice and rats in particular have an amazing aptitude for finding their way into animal exhibits with their unending food supply. It is helpful to bury wire mesh under the substrate where feasible, to prevent rodents from tunneling their way in. Integrated pest management is essential to keep all pest populations under control without causing harm to the collection.

Temporary Holding, Capture, and Introduction units
It is sometimes necessary, especially in large enclosures, to use a temporary cage. Such a cage may take one of many forms, but it should have enough space to comfortably house a specimen for the period of time required. When introducing a bird to a new space or to new exhibit mates, an introduction cage can be used to allow the birds to see and hear each other without making physical contact. A temporary holding may be used to protect a nesting female and her chicks prior to fledging in a mixed-species environment. A capture unit is very useful in a large aviary, where it can be very difficult to net an individual bird that may need attention. The unit can be baited with food and rigged with a trapdoor to isolate a specimen that may need to be examined. If the capture unit is left in the environment, the birds will become desensitized to it, thus simplifying the process. The netting should have a small enough mesh to contain the smallest species in the aviary, while being large enough inside to accommodate the largest species. Plant material (natural or artificial) can be used to camouflage the unit and make it less obtrusive in the environment.

Avian Diets: Presentation and Formulation
Complete Diets
Many commercial diets are formulated by reputable companies to meet the needs of specific types of birds. These diets often come in the form of an extruded pellet available in a variety of shapes and size that allow easy consumption by the bird for which it is designed. A nutritionist or veterinarian can assist in the selection of appropriate diets for the species in the collection. Knowledge of natural diets will also be helpful in choosing an adequate diet. One should keep in mind that many birds in the wild have access to a large assortment of food choices. Feeding one single complete feed can lead to boredom and subsequent behavioral problems. In addition, birds can be quite picky about what food they will consume. Obviously, a perfectly designed diet will be of no benefit to a bird that refuses to eat it. It may be necessary to supplement the food with something more interesting (e.g., chopped fruit, diced hard-boiled egg, or insects) to entice the bird to eat it all. Some birds that may lay eggs more frequently (e.g., poultry and pigeons) have higher calcium requirements. A dish of mineral-rich grit in the enclosure will allow them to consume minerals when they are depleted.

Live Food
Numerous birds consume live food, insects in particular, every day. When possible, insects should be part of the food offered to them. Crickets, mealworms, and moth larvae are all readily available through commercial sources. Pet stores frequently stock these, albeit at fairly high prices. Some large vendors sell insects in bulk at more reasonable prices. Live crickets can be stored in bins with screened lids for extended periods of time if they are provided with air circulation, food, and water. A high-quality cricket food will increase the nutritional content of the crickets as food for the birds. Mealworms can likewise be kept in bins with food (sliced yam and pelleted poultry food work well) for a fairly long time. The insect bins should be cleaned weekly to prevent the buildup of waste. It is possible to store live mealworms and moth larvae in the refrigerator for weeks without feeding them (they will not eat when cooled in this way). When removed from refrigeration and warmed, these insects will become active again. The advantage of refrigeration is longer storage without metamorphosis to the next life stage (to beetles for the mealworms and to moths for the moth larvae). Live food makes an excellent enrichment for many bird species. Insects are also fed exclusively by some species to their hatchlings, and thus are crucial to the survival of these young.
Frozen Food
Special consideration must be given to proper thawing techniques for frozen food items. In almost all cases, frozen foods should be brought to room temperature before they are fed to birds. Ideally, frozen food should begin thawing in a refrigerator. Once it is thawed, it can be brought to room temperature for a short period of time in an enclosed container prior to feeding. Refrigerated thawing reduces the risk of bacteria growing in the food item. Previously frozen food should be fed to birds as soon as possible after reaching room temperature, or should be kept in a refrigerator for no more than two to three days.

Supplements
Many nutrients in food break down during storage. It is sometimes necessary to add supplements to it to maintain its nutritional quality. For example, fish loses some of its essential vitamins during storage in a freezer. Specially formulated vitamins for piscivores can help replace these lost nutrients. Certain bird species, like flamingos and scarlet ibis, need carotenoids in their diet to maintain their plumage coloration. These carotenoids can be given as a supplement if the birds’ diet does not contain sufficient amounts.

Browse
Supplying browse to birds may serve a variety of purposes: enrichment, food, camouflage, or nesting material. Psittacines will benefit from a steady supply of branches to tear apart, satisfying their urge for destruction. The provision of fruiting branches (e.g., hawthorn [Crataegus spp.] or autumn olive [Elaeagnus umbellata]) will be greatly appreciated by fruit-eating birds, as it will give them the opportunity to forage for their food. Twigs and branches of varying sizes can be scattered about the enclosure to allow the birds to select nesting material. Any plant species added to an aviary should first be checked against a reliable plant list to determine its level of toxicity.

Species Management
Single Versus Mixed
Unquestionably it is simpler to care for a single species within a given exhibit than to manage multiple species. Some species, such as large birds of prey, are generally incompatible with other bird species and should therefore be housed by themselves. However, many bird species can be held in mixed-species exhibits with other birds, or even with reptiles or mammals. Although such exhibits present a greater management challenge, they also offer greater opportunity for educating the visitor and create a richer and more natural environment for the animals being displayed. Single-species exhibits focus all the attention on the individual bird species and their requirements. In the absence of competition for space and resources, the single species housed can have their biological needs more easily met. Mixed-species displays must have resources (food, space, nesting opportunities) available that meet a wide variety of needs, so that all the species can function without undue stress or aggression. Once again, knowledge of the biological requirements and natural behavior of all the species being considered is critical in making wise decisions about which species will be compatible with each other. Communication with other zoo professionals is invaluable in avoiding poor selections that may have disastrous consequences. For example, small primate species may make a lovely display with a rainforest passerine, but if the bird is not given nesting areas that the primates can’t reach, its eggs or young chicks may become a tasty monkey treat. Discussions with colleagues can help avoid fatal errors.

Special considerations for single specimens
Most bird species are social creatures, but circumstances may dictate that a particular bird should be housed individually. This could happen for a host of reasons. One likely example would be a parrot that is donated to the zoo after having been a family pet. Psittacines that have been raised in isolation are often difficult to introduce to other parrots, as they are generally imprinted on their human family. These birds may have to be housed alone. In such a situation, enrichment is extremely important. Birds that are bored and socially segregated may become psychologically impaired and act with increased aggression towards their keepers. Feather-plucking, stereotypical movements, and screaming are just some behaviors that may be seen in a parrot that is not adequately stimulated.

Capture, Restraint, and Handling
Medical attention, transport, and beak or nail trims are just a few reasons why a bird may need to be captured, restrained, and physically manipulated. Capturing a bird improperly can cause injury to the bird or the keeper. A bird’s lightweight bones are easily fractured, and blood feathers can be broken or air sacs ruptured by careless handling. It is essential to restrain a captured bird securely without placing undue pressure on it to avoid such injuries. Restraint attempts may cause many species to aggressively defend themselves from the perceived attack. Potential captives may peck, bite, scratch, kick, or talon the person attempting to control them.

A skilled keeper may be able to hand-catch a bird. This is easiest with a bird that is habituated to approaching people (hand-feeding is one way to accomplish this), or one that has been maneuvered into a confined space. Trap units like those described above can also be used to confine a bird for capture. Nets are indispensable tools that extend the keeper’s reach and help to reduce injury; they are available in many types and sizes, and it is important to match the net type to the job. Small, lightweight mesh nets for small passerines and large woven nylon nets for waterfowl are two examples. Some nets are made with extendable handles, which may be useful for capturing birds in large aviaries.
If possible, it can help to extinguish lights just before making contact with the bird. Generally a bird will remain motionless when it is suddenly subjected to darkness. Obviously one must know exactly where the bird is located, and must be able to reach it in the dark. Once the bird is captured, it is important to keep its wings folded against its body to keep it from flapping and potentially injuring itself or the handler. Some birds, like penguins or swans, can deliver painful blows with their wings. Particular attention should be paid to keeping the legs of long-legged birds from hitting against each other and causing damage to the skin or underlying tendons. This is done by keeping a finger or hand between the two legs. Some birds may stay calmer when being held if their eyes are covered by a hand, towel, or hood.

A handler often must restrain a bird’s head to keep it from biting. The most common way to do this is to hold the bird by the back of the head with one hand, keeping one’s thumb and middle finger on each side of the bird’s mandible and one’s index finger over the top of the bird’s head and controlling its movement, while taking care that the throat is not constricted and allowing access for a physical exam. Birds, like all animals, may overheat if held too long, especially if they are struggling.

**Introductions**

When introducing birds to a new environment or conspecifics, one should try to anticipate their negative reactions. It may be necessary to add visual barriers, extra enrichment, or hiding spaces while they become acclimated. An anxious bird may fly headlong into a glass window, resulting in injury or death; it thus may be necessary to cover the glass on a glass-fronted exhibit with paper or soap until the bird becomes aware of the barrier. Introduction cages can be used to enable new birds to assess one another before making any physical contact.

**Stress**

Birds are subject to many types of social, environmental, or medical stress, which can lead to illness or death. A keeper must guard a bird against severe stress by observing it every day. A stressed bird may show poor appetite; listless behavior; dull, broken, or piloerect feathers ("fluffed" appearance); open-mouthed breathing; or pacing. It is paramount to ascertain the cause of the stress and alleviate it as soon as possible. If reducing the stressor is not effective, medical intervention may be necessary. Birds are masters of camouflaging illness, so by the time symptoms are observed, there may not be much time for a cure.

**Beak and Nail maintenance, Feather Clipping, and Pinioning**

Captive birds sometimes need help in keeping their beaks and nails in good condition. A varied environment is the best way to help a bird keep itself in an optimal state. Perches of varying thickness and texture will allow a bird to naturally maintain its beak and nails. Occasionally the beak and nails may need to be trimmed if they are growing abnormally. Overgrown portions can often be clipped with human or dog nail trimmers; one should be careful not to cut too close to the blood supply. Thick beaks or nails can be ground by a high-speed rotary grinder, such as a Dremel® tool. This electric tool works quickly, and can be stressful for the bird; it may take more than one session to restore a beak to its natural condition. Knowledge of the natural shape and length of the beak and nails will guide a keeper in knowing how much trimming is necessary. In some circumstances it may be desirable to render a full-winged bird flightless. Birds housed in outdoor exhibits that are not fully enclosed can have their wings clipped to prevent them from flying off. This is done by clipping the primary feathers on either the left or the right wing (not both) just under the tip of the wing coverts. The lack of primaries on only one side will prevent the bird from gaining lift and keep it off balance so that it cannot take off. The cut is usually made with strong scissors at a 90-degree angle to the feather shaft. This solution is only temporary, as new feathers will grow in each year as a normal part of molting and must be clipped again as soon as the blood supply of the new feathers dries up. New or developing feathers (called blood or pin feathers) should never be trimmed, as the resulting blood loss can compromise the bird’s health. If a blood feather is cut inadvertently, it can be pulled out with a pair of pliers or forceps to prevent excessive bleeding. Pinioning is a method of permanently rendering a bird flightless as a hatchling, by removing the end of its wing at the wrist joint when it is three to five days old. Done properly, this amputation is quick and relatively painless with little blood loss. The young bird heals quickly and will not need to be caught and have its wings trimmed annually. Pinioning is most commonly used on waterfowl, cranes, flamingos, and other birds that are often housed in open outdoor exhibits.

**Crating and Transport**

Birds can be trained to enter a crate on their own volition, or they can be captured and placed in a transport crate. A transport crate should have a perch or a nonslip substrate, depending on the needs of the species. IATA regulations specify the types of containers required for air transport of birds. Food and water should be included in the crate for long-distance travel. It is wise to cover the doors and windows with an opaque material that will allow air flow to decrease stress to the bird. Padding can also be added, especially on the ceiling, for birds that are likely to jump up and injure their heads (cranes, ratites, pigeons, and pheasants, for example).

**Avian Reproduction**

**Common Breeding Strategies**

Bird breeding strategies vary widely from species to species. Some species practice seasonal or long-term monogamy, in which two birds in a pair reproduce only with each other, or polygamy, in
which one bird has multiple partners. Monogamous birds, like rock pigeons (Columba livia) and Humboldt penguins (Spheniscus humboldti), generally share incubation and chick-rearing. In polygamous species, the female often rears the chicks on her own. Megapodes (brush and scrub turkeys) have a unique breeding strategy: the males construct large nest mounds in which the females lay their eggs. The heat produced by the decomposition of the vegetation in the mounds incubates the eggs. The male monitors and adjusts the nest and the chicks hatch in a superprecocial state, able to survive without parental care. Ostriches (Struthio camelus) gather in groups and all the hens lay eggs in one nest, where they are incubated by the dominant male and female in the group.

**Seasonality and Photo periods**
Most birds are seasonal breeders. They lay eggs and hatch and rear their young when light and food are abundant. Increased day length is often the trigger for the start of reproduction; it can be replicated in an indoor zoo exhibit by increasing the amount of time during which artificial lights are on, or by providing the birds access to increasing ambient sunlight. Emperor penguins (Aptenodytes forsteri) are obvious exceptions to this, as the males incubate the eggs during the darkest, coldest times of the year in Antarctica. However, this seasonal timing allows the young penguins to make their way to the ocean when conditions are more favorable for them. It is important to understand which breeding strategy is favored by the birds being considered for a zoo’s collection, if it is a goal to ensure that the breeding requirements will be met.

**Nest sites and Nesting material**
Bird nest types range from the simple "scrape" on hard-packed soil made by an ostrich to an elaborate platform constructed of sticks and grasses which can be reused from year to year to support a family of osprey (Pandion haliaetus). Many birds use nests made of grass woven together to support the eggs. Others may lay their eggs in tree hollows. Barn swallows (Hirundo rustica) build their nests out of mud and plant fibers which they attach to vertical surfaces just under ceilings. Captive birds may use an artificial nest if provided with one of the appropriate type, size, and shape. Making nesting material available, again of the proper type and size, may allow the birds to construct a suitable nest. Researching the type of nest used in a natural setting will guide the selection of materials to offer.

**Eggs**
All birds lay eggs. An egg comprises an ovum and yolk sac, albumin, an allantois, amniotic fluid, chalazae cords which hold the yolk in place, a blood supply, an air space, and a shell. The yolk provides nourishment for the developing embryo and is eventually pulled into the chick through the umbilicus. The outer shell contains pores through which respiration takes place.

**Incubation: Artificial and Natural**
Whenever feasible, natural incubation is preferable to artificial. Incubation and hatching is a complicated process that requires detailed knowledge for replication in an artificial setting. Birds instinctually know how tightly to brood, when to turn their eggs, and how to vocalize to the chicks while they are hatching. They create the ideal temperature for embryos to develop within the eggs. A newly hatched chick imprints on its parents and begins learning the behaviors appropriate for its species soon after leaving the egg. There may be circumstances which lead a keeper to select an artificial means of incubation, such as a desire to imprint a bird on humans, a nest that has been abandoned after eggs have been laid in it, or a high risk of predation. If it is necessary to artificially incubate and hatch bird eggs, one can choose from a number of incubators. Standard models work well for poultry or waterfowl eggs with a moderate amount of monitoring. Specialized models with more precise temperature and humidity controls and adjustable rollers that can be set to the desired turning time are also available, and are well worth acquiring if eggs from rare, endangered, or delicate species need to be hatched artificially. Artificial incubation will require more staff time, expertise, and resources for monitoring the equipment and the eggs, and for successfully raising the chicks.

**Parent-Rearing Versus Hand-Rearing**
Parent-reared chicks will naturally acquire the species-specific knowledge that is essential for normal behavior. Hand-reared chicks always become imprinted on humans to some degree. In some birds this may not prevent them from interacting with conspecifics. However, hand-rearing may impede the chick from connecting with others of its own species, reducing the possibility of it socializing or breeding when it reaches maturity. For birds that are planned to be used exclusively in outreach or education programs, hand-rearing may reduce stress and abnormal behavior by acclimating the bird to its keepers from the beginning.

**Veterinary Care**
Common Medical Concerns
Birds are susceptible to a number of diseases to which they may quickly succumb if the symptoms are not recognized and treated quickly. Certain diseases affect species that are naturally found in cold or very dry climates when they are housed in temperate regions. Fungal infections or insect-borne diseases like malaria (Plasmodium spp.) are not common in cold or dry habitats, so species from those habitats may have no immunity to them. Snowy owls (Nyctea scandiaca) are particularly susceptible to malaria. Humboldt penguins may readily contract malaria as well as aspergillosis, a fungal infection that is extremely difficult to treat successfully. West Nile virus has become a concern in North American zoos, especially those housing swans, corvids, raptors, and penguins, which seem to experience very high
mortality when exposed to this recently introduced virus. Mycobacterium avium (sometimes known as avian tuberculosis) gives cause for concern when diagnosed in a zoo bird. However, it is being better managed as its prevalence decreases and more is known about its transmission. Parasitic infections may also be a problem in birds. Roundworms, tapeworms, coccidia, giardia, Cryptosporidium, mites, lice, and ticks are commonly detected in birds.

**Identification of Illness**

Each of the medical conditions mentioned above has symptoms that can be detected by a knowledgeable keeper. Once specific symptoms are observed or even suspected, medical assistance should be sought as soon as possible before the disease is out of control.

**Preventive Medicine**

Many medical problems can be prevented or controlled with a proactive approach. Vaccines are available to build immunity to West Nile virus, prophylactic medicines to guard against malaria can be given during mosquito season, and regular deworming will help control parasites. It is very important to develop a comprehensive preventive medicine program, and every zoo should have one in place.

**Management of Infirm Birds**

Aggressive treatment may be necessary when a bird has been diagnosed with an illness. The sick bird may require supportive care, which might include a secluded treatment area, quiet surroundings, and most importantly a constant source of heat. Birds have difficulty thermoregulating when fighting disease, so a warm environment may prevent deterioration or even death.

**Zoonotic Concerns**

Some avian diseases are transmissible to humans and can cause illness or death. Strains of avian influenza periodically transfer to human populations, often from infected poultry, resulting in flu-like symptoms, which may be severe. Bacterial infections like salmonellosis and psittacosis can also be contracted if contact is made with an infected bird or its secretions or feces. Good hygiene and sanitation is the best way to ensure that disease transmission is unlikely to occur.

**Conservation**

The International Union for the Conservation of Nature (IUCN) recognizes 10,027 bird species. Of these, 190 species are listed as critically endangered, 372 as endangered, and 678 as vulnerable, for a total of 1240 (12%) species at risk out of the total population (IUCN 2011). The greatest threats facing birds are global climate change, habitat loss, and ecosystem degradation and exploitation by human populations. Zoos assist in conservation in many different ways: an excellent example is the California Condor Recovery Program. In cooperation with the US Fish and Wildlife Service, California condors have been brought back from near-extinction. In 1985 the last few remaining wild California condors were brought into captivity at the San Diego Wild Animal Park and the Los Angeles Zoo. These condors have a very low reproductive rate, usually producing only one chick every other year. But through the use of foster parents and artificial incubation, their reproductive rate was dramatically increased. By 1992 some of the captive birds were being reintroduced to the wild. The total population of California condors now stands at about 350 birds, with nearly all of these living back in the wild (Zoological Society of San Diego 2011). Other zoos and agencies have joined the effort, ensuring that the California condor species has a much greater chance of surviving into the future. Providing optimal care for bird collections and educating the visiting public can aid in the global conservation effort by increasing awareness and maintaining genetic diversity.

**Summary**

Birds are everywhere, and they have adapted to thrive in a wide variety of habitats. They vary greatly across species, ranging from the bee hummingbird (Mellisuga helenae), which weighs less than two grams, to the ostrich, which can weigh up to 160 kilograms. Birds come in numerous sizes, shapes, and colors, but they all have a few traits in common: all have feathers, lay eggs, are endothermic, and have wings (although not all birds fly). The care and management of exotic birds requires patience, dedication, and an understanding of what birds need to thrive. Keepers must be willing to seek information from any available source, such as mentors, colleagues, books, or journals, to build their proficiency in avian husbandry. There is still much to be learned about comprehensive management practices. The desire to observe birds and disseminate what they have learned can lead keepers to contribute to the body of avian knowledge and improve standards for zoo bird collections.

**References**


Snake Survey and Awareness Programme
Sundarvan, Ahmedabad, Gujarat conducts different awareness programmes to spread message on biodiversity and nature conservation among different walk of people. It is popularly known for reptile rescue and awareness programme.

As per the request from Lafarge Indian Pvt. Ltd to Sundarvan to carry out a reptile survey and awareness programme for Sonadih Cement Plant, Bilaspur district, Chhattisgarh the same was conducted from 8-14, August. Twenty-two snakes: Indian Rat Snake *Ptyas mucosa* (6); Striped Keelback *Amphiesma stolatum* (11); Checkered Keelback *Xenochrophis piscator* (2); Common Wolf Snake *Lycodon aulicus* (1); Indian Rock Python *Python molurus* (1); Spectacled cobra *Naja naja* (1) and a monitor lizard *Varanus bengalensis* were rescued from residential and industry area during this period. A total of nine snake awareness programmes were conducted to Ladies Club members (1); School children (4); Employees (2); Medical staff (1) and Security personnel (1) and 815 people were reached. Topics such as introduction to the world of snakes, their diversity, venomous, non-venomous, commonly seen snakes, major symptoms of venomous snakebite, snakebite, first aid, treatment, precautions to avoid bite, myths and facts, ecological services and conservation issues were covered in the session. Along with above topics, guidelines for the snakebite management by the World Health Organization were also discussed with medical staff. Five set of posters each on venomous and non-venomous snakes developed by Sundarvan was given to them to display in prominent places. The same kind of activity was conducted for Lafarge during 2012 and 2014 also. The snake awareness programme was well received. Submitted by: S. Sivakumar, Park Manager, Sundarvan. Email: s.sivakumar@ceeindia.org

Biodiversity – Awareness, Welfare and Conservation Exhibition at Tirunelveli, TN
On 20 June 2015, Mr. Rajendra Balaji, Minister inaugurated the annual government exhibition at municipal ground in Tirunelveli in the presence of district collector Mr. Karunakaran, other government officials and people representatives.

Various Government departments, non-government organisations and others set up stalls in this exhibition. Environment Department also setup a stall. In this they displayed photographs of flora and fauna, paper clippings of environmental news, nests of weaver bird, cereal feeder for sparrows, bird nesting foxes, water purifiers, alternatives for plastics, recycled materials, rainwater harvesting, cloth and paper bag which made by cottage industries were kept for exhibition to create an awareness on environmental conservation.

Mrs. Rani Kirubairaj – Retd. Botany Assistant and State Government Environment Award recipient of 2010 exhibited reports of animal welfare, conservation and awareness programmes conducted in various schools, scrap note books, annual report of National Green Corps and Newspaper clippings. Zoo Outreach Organisation’s education kits such as tiger, education reports, snake awareness programme for security personnel
elephant etiquette, monkey manners, frog, vulture, bear, bat, live more simply, pollinators etc. were displayed at the stall and explained by Govt. College botany lecturer Mr. Murugan and students Mr. Guru Sankar and Mr. Thambu Narayanan. School Teachers, Correspondents enquired about the education materials and were inspired to conduct awareness programmes at their school premise in near future. The collector awarded schools that performed best in environmental activities with cash prize Rs. 10,000. Submitted by: Mrs. Rani Kirubairaj, Retd. Teacher, Tirunelveli. Email: ranijoel12@gmail.com

Eco-exhibition at Sri Jeyendra Vidyalaya Matric. School, Sengottai, TN

The School is shadowed by the mountain ranges of the Western Ghats and also recently it received Rs. 10,000/ performance award from the Collector, being one among the best schools of National Green Corps. Further, Ms. Velvilzhi, won Best NGC Coordinator award and Ms. Geetanjali Eco-club, Asst. Coordinator, assists her.

Systematically they observe all environmental days and also the school campus is plastic free. They wanted to exhibit their environmental activities so that all parents, nearby school students may be benefitted. Dr. Vijayalakshmi, Dist. NGC coordinator inaugurated the eco exhibition in the presence of Mrs. Rani Kirubairaj, Retd teacher, Correspondent, Principal and Asst. Principal Ms. Deepa. The guests planted saplings at the school campus. She told the students that they must be aware the ecological role of wild animals in pollination, seed dispersal, pest control and others.

Students from class I to XII displayed the exhibits and explained them nicely to the visitors. They exhibited small grains, different kinds of cereals, medicinal herbs, purifying hard water for irrigation purposes, recycle of wastes, SAY ‘No’ to PLASTICS – Plastics bags into flowers and plastic pet bottles into flower vases. They also displayed alternatives for plastics such as paper cups, boxes, cloth bags, plates made from betel nut tree barks, jute Bags and insisted the visitors to use these materials in day to day life.

Regarding wildlife they displayed the exhibits on afforestation, forest conservation, ecosystem, food web, food chain, a collection of bird nests, squirrels nests, grain feeders and rainwater harvesting. Zoo Outreach Organisation’s education materials were also displayed. At the school the students maintain herbal garden, floral garden and vermicomposting pit for making organic manure. Students took an oath to conserve biodiversity, natural food grains, following Gandhi’s principle of simple life; protect water bodies from pollution and forest from forest fires and poaching. Mr. Thangamoorthy, President, Lions Club Kadaya Nallur distributed 20 tree saplings to 15 schools with the promise that if they raising them well will be awarded in the future. Submitted by: Mrs. Rani Ram Mohan, Principal & Mr. Ram Mohan, Correspondent. Email: ranirammohan@gmail.com
ZOO’s PRINT Publication Guidelines

We welcome articles from the conservation community of all SAARC countries, including Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka and other tropical countries if relevant to SAARC countries’ problems and potential.

**Type** — Articles of semi-scientific or technical nature. News, notes, announcements of interest to conservation community and personal opinion pieces.

**Feature articles** — articles of a conjectural nature — opinions, theoretical, subjective.

**Case reports**: case studies or notes, short factual reports and descriptions.

**News and announcements** — short items of news or announcements of interest to zoo and wildlife community.

**Cartoons, puzzles, crossword and stories**

**Subject matter**: Captive breeding, (wild) animal husbandry and management, wildlife management, field notes, conservation biology, population dynamics, population genetics, conservation education and interpretation, wild animal welfare, conservation of flora, natural history and history of zoos. Articles on rare breeds of domestic animals are also considered.

**Source**: Zoos, breeding facilities, holding facilities, rescue centres, research institutes, wildlife departments, wildlife protected areas, bioparks, conservation centres, botanic gardens, museums, universities, etc. Individuals interested in conservation with information and opinions to share can submit articles ZOOS’ PRINT magazine.

**Manuscript requirements**

Articles should be typed into a Word format and emailed to zooreach@zooreach.org. Avoid indents, all caps or any other fancy typesetting. You may send photos, illustrations, tables.

Articles which should contain citations should follow this guideline: a bibliography organized alphabetically and containing all details referred in the following style: surname, initial(s), year, title of the article, name of journal, volume, number, pages.

**Editorial details**

Articles will be edited without consultation unless previously requested by the authors in writing. Authors should inform editors if the article has been published or submitted elsewhere for publication.

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ZOOS’ PRINT magazine is informal and newsy as opposed to a scientific publication. ZOOS’ PRINT magazine sometimes includes semi-scientific and technical articles which are reviewed only for factual errors, not peer-reviewed.

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