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Adult wild Javan Slow Loris *Nycticebus javanicus* ‘bridging’ through the forest in Tasik Malaya, Java. Photo by Andrew Walmsley - The Little Fireface Project.

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EDITORIAL: HONOURING OUR ELDERS IN THE YEAR OF THE FIRE MONKEY

The monkey is commonly regarded as a lively, likable, witty and highly sociable animal – and featured thus in folklores, traditional performing arts, and various media. Based on the Chinese calendar, 2016 is a year of the Fire Monkey.

Asia's non-human primates need a good year. Many primate populations in Asia are not in good shape and threats continue to escalate, making a new conservation status assessment necessary last year. Thus, a workshop was organized by the IUCN SSC Primate Specialist Group at Singapore Zoo on 23-27 November 2015. The updated status reviews will appear on the IUCN Red List later this year.

In this issue we also take time to remember two towering figures of Asian primatology lost in 2015: Ardith Eudey and Chuck Southwick.

Charles "Chuck" Southwick died in July at 86. A zoologist with a doctorate from the University of Wisconsin, he clocked up an incredible 50 consecutive years of field research in South and Southeast Asia, often accompanied by his wife Heather. He shed light on primate populations and ecology that would otherwise have remained mysterious, not neglecting commensal populations. This yielded a rich body of literature; for those of us who studied macaques in the 1990s he had a hand in much of the region's prior work. Some had the privilege of conducting fieldwork or scientific collaboration with him; his broad knowledge of macaque ecology inspired many students, many of whom he guided in their studies; he was often praised as a generous mentor. In Indonesia Chuck worked on Crested Macaques with his former students Ann Kohlhaas (in North Sulawesi) and Barry Rosenbaum (in Bacan Island, Moluccas). Jatna Supriatna, his collaborator from Indonesia, gained much from Chuck's visits whether doing fieldwork or co-authoring papers or reports to donors. Besides his great legacy as a primate ecologist, Chuck contributed to the fields of agriculture, human health and human ecology, with a bold synthesis in his 1996 textbook, *Global Ecology in Human Perspective* (Oxford University Press, 416 pp.).

Ardith Eudey died in December at 80. Beginning as an anthropologist and then a tertiary teacher on primate behaviour, she did fieldwork on Thai macaques in the tough isolated conditions characteristic of the early 1970s. She became an advocate of primate welfare as well as conservation, exposing the large-scale trafficking of macaques for laboratories, and with Shirley McGreal co-founded the International Primate Protection League in 1973 to campaign on this. She took particular responsibility for the work of the IUCN Primate Specialist Group in Asia, and from 1991 to 2003 Ardith edited the forerunner to this journal, Asian Primates Newsletter, a relic of the postal era that served to unite the community. In recent years she had campaigned against mass macaque culls and trafficking in Malaysia.

So as we celebrate the Year of the Fire Monkey we keep in mind that Asian primatology, and Asian primate populations, are in better shape than they might have been thanks to the dedication of Chuck and Ardith.

John Fellowes, Jatna Supriatna, Christian Roos and Ramesh Boonratana

Charles Southwick honoured at a special symposium during the 39th meeting of the American Society of Primatologists in San Diego in 2009 “Primate Populations: The Ends of the Spectrum. A Tribute to Charles Southwick: Celebrating 50+ Years of Primate Field Research.” Photo credit: Noel Rowe.

Ardith Eudey at the IUCN Red Listing Workshop for Asian Primates in Singapore, November 2015. Photo credit: Le Khac Quyet.

DIET OF NILGIRI LANGUR *Semnopithecus johnii* INHABITING TROPICAL MONTANE SHOLA IN THE NILGIRI HILLS, SOUTH INDIA

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ABSTRACT

We studied food habits of a group of 11 Nilgiri Langurs *Semnopithecus johnii* (Fischer) in the Nilgiri Hills of the Nilgiri Biosphere Reserve in south India. The study group occupied a patch of stunted montane forest surrounded by grassland, a habitat type known in south India as *shola*. Among 20 species prominent in the diet between June and December were (1) native plant species that are found principally in shola at elevations above 1,300 m (34% of feeding time), (2) pine needles, which are low-quality food items (11%), and (3) non-native plants (15%). Human activity is fragmenting shola and decimating the Nilgiri Langur habitat and food supply. Conserving the Nilgiri Langur will require protecting the shola forests of the Nilgiri Biosphere Reserve.

Keywords: conservation, diet, habitat fragmentation, low quality food, Western Ghats.

INTRODUCTION

Anthropogenic activities which lead to forest fragmentation can cause variations in the abundance and distribution of food resources, affecting the diet of a species (Johns, 1983). Animals have been found to increase their dependence on low-quality food items and fall-back food items in fragmented habitats, as shown in Collared Lemur *Eulemur collaris* (É. Geoffroy) (Donati et al., 2011) and Diademed Sifaka *Propithecus diadema* Bennett (Irwin, 2008), Tonkean Macaque *Macaca tonkeana* (Meyer) and Moustached Guenon *Cercopithecus cephus* (Linnaeus) (Tutin, 1999; Riley, 2007). Low-quality food items contain a lower amount of carbohydrates and hence provide less energy for an individual than high-quality food items (Donati et al., 2011).

Similarly, due to the absence of certain important trees in higher altitudes, populations of a species living in higher altitudes may have to depend on low-quality and fallback food items, as shown in the Yunnan Snub-nosed Monkey *Rhinopithecus bieti* Milne-Edwards (Grueter et al., 2012).

The Nilgiri Langur *Semnopithecus johnii* (Fischer) is a folivorous arboreal primate which primarily inhabits tropical evergreen forests of the Western Ghats at an altitude above 500 m (Sunderraj, 2001; Sunderraj & Johnsingh, 2001). The Nilgiri Langur is classified as Vulnerable by IUCN (Singh et al., 2008) and is listed on CITES Appendix II and Schedule I Part I of Indian Wildlife (Protection) Act, 1972 (Molur et al., 2003). The population trend of the Nilgiri Langur shows a decline (Singh et al., 2008) and large-scale habitat destruction for plantation/agriculture and poaching have affected the species (Ramachandran & Joseph, 2001). The density of the Nilgiri Langur is highest in evergreen forests between 700 and 1,500 m, but the species occurs above 1,500 m in shola, a term referring to patches of stunted montane tropical evergreen forest amid grasslands (Thomas & Palmer, 2007), which occur in the Nilgiri Hill ranges in the Western Ghats of southern India (Johnsingh & Manjrekar, 2013).

Evergreen and semi-evergreen forests in the Western Ghats are classified as low-elevation (0-800 m), medium-elevation (800-1450 m) and high-elevation forests (1,450 m and above) (source: http://www.forest.kerala.gov.in; Pascal et al., 2004). Most trees found in the medium-elevation evergreen forests (*Cullenia-Mesua-Palaquium* type) are not present in the high-altitude montane shola regions of the Nilgiris (*Litsea-Syzygium-Microtropis* type) (Pascal, 1988). Hence, we expected the Nilgiri Langur in the Nilgiri Hills to depend on a different diet than the Nilgiri Langurs in medium-elevation evergreen forests of the Western Ghats.

We also expected the Nilgiri Langur to feed on low-quality food items as fallback foods, since forests are highly fragmented in the Nilgiri Hills. Extensive commercial plantations, easy motor vehicle access and large hydroelectric impoundment in the area are the major causes for the destruction of the shola (Davidar, 1978; Rice, 1984). Hence, in the present study we compare the diet of the Nilgiri Langur from shola in the Nilgiri Hills with that in medium-elevation evergreen forests elsewhere in the Western Ghats.

METHODS

The study adhered to the ethical guidelines of the University of Mysore, and an official permit was obtained from the Chief Wildlife Warden of the Tamil Nadu State for conducting this research.

Study area

The study was conducted in Naduvattam (11°28’ N, 76°32’E) in the Nilgiri Hills district of Tamil Nadu, India. The elevation of the study site is 1,849 m. The average annual rainfall is 2,130 mm and mean annual temperature is 15.7°C (source: www.climatedata.org). The vegetation mainly consists of shola-grassland mosaic system, tea plantations and tree plantations. The present study group inhabited a shola fragment near Naduvattam Village. The size of the fragment was 5 ha. The home range of the group was 3.5 ha. The group had one adult male, seven adult females and three juveniles. The group was sympatric with a Bonnet Macaque *Macaca radiata* (É. Geoffroy Saint-Hilaire) group in the study area.

We used previous studies from other regions (medium-elevation evergreen forest) for comparison of food items with our study. These previous studies were conducted in Kakachi at ~1,000 m altitude (Oates et al., 1980), Silent Valley at ~900 m altitude (Ramachandran & Joseph, 2001), Pachcha Palmalai shola at ~ 1,200 m altitude (Sushma, 2004) and Nelliyampathy at ~1,000 m altitude (Ramachandran & Suganthashaktivel, 2010). All these study areas, except Pachcha Palmalai, were contiguous forest areas. The Pachcha Palmalai shola was surrounded by tea estates on one side and contiguous forest on the other side (Sushma, 2004).

Study period and observation methods

The study was conducted between June and December 2010 and hence we do not have full data to compare the diet between seasons. We habituated the monkeys for two months before starting observations. We observed the langurs from a distance of about 10 m from the trees on which they were present. We did not collect any data when it was misty or when visibility was low. We collected data on major activities including feeding, resting, locomotion, self-directed and social behaviour using focal animal sampling, though for the present study, we analysed only the feeding data. We continuously followed an individual langur for 5 minutes to collect the focal data. We separated the data on feeding on different food items from the above data. We collected samples (leaf, flower, fruit) from the respective trees and had them identified at the Botanical Survey of India, Coimbatore. The total amount of time spent on focal animal sampling was 110 h (n=1,320), distributed evenly across the study period. The data was collected between 08:00 h and 16:00 h.

Information on plants was obtained from the Biotik portal (www.biotik.org) and India Biodiversity Portal (www.indiabiodiversity.org), with nomenclature checked against www.theplantlist.org.

RESULTS

Nilgiri Langurs were found to feed on 34 plant species in the present study. Of these, 20 species contributed more than 1% of observations (Table 1). About 40% of the observed diet was contributed by five major species, viz. *Turpinia cochinchinensis* (Lour.) Merr. (9.6%), *Ternstroemia gymnanthera* (Wight & Arn.) Sprague (8.8%), *Magnolia nilagirica* (Zenker) Figlar (8.9%), *Rhodomyrtus tomentosa* (Aiton) Hassk. (6.3%) and *Pinus* sp. (11.4%). The langurs spent more time consuming leaves (77%) than flowers (9.3%), fruits (8.9%), petioles (3.7%) or bark (0.8%). They spent more time feeding on broad-leafed trees (73%) than on shrubs (15%), conifers (11%) or ferns (0.6%).

Of the 20 major food-plant species consumed by Nilgiri Langurs in the study, seven are endemic to the Western Ghats, four are non-native species and five are found only above 1,300 m asl. They spent 23% (n=531 mins) of the feeding time on endemic species, and 15% (n=347 mins) on non-native

Table 1. Plant species consumed by the Nilgiri Langur in the Nilgiri Hills, with percentage of observations for each, in the present study.

Family	Species	Plant part used	% of feeding time spent on each species
Pinaceae	*Pinus* sp.#	Leaves	11.4
Staphyleaceae	*Turpinia cochinchinensis* (Lour.) Merr.#	Leaves	9.6
Magnoliaceae	Magnolia nilagirica (Zenker) Figlar*#	Leaves, Flowers	8.9
Theaceae	*Ternstroemia gymnanthera* (Wight & Arn.) Sprague	Leaves, Flower, Bark	8.8
Myrtaceae	*Rhodomyrtus tomentosa* (Aiton) Hassk.	Leaves, Fruits	6.3
Sabiaceae	*Meliosma pinnata* (Roxb.) Maxim.	Leaves	5.6
Solanaceae	*Datura innoxia* Mill. **	Leaves	5.4
Rutaceae	*Melicope lunu-ankenda* (Gaertn.) T.G. Hartley	Leaves	4.4
Araliaceae	*Schefflera capitata* (Wight & Arn.) Harms*	Leaves, Petiole	4.2
Solanaceae	*Cestrum aurantiacum* Lindl. **	Leaves	4.1
Ulmaceae	*Celtis philippensis* Blanco	Leaves	3.4
Solanaceae	*Solanum erianthum* D. Don **	Leaves, Fruits	3.2
Lauraceae	*Litsea floribunda* Gamble*	Petiole, Leaves, Fruit	2.5
Sabiaceae	*Meliosma simplicifolia* (Roxb.) Walp.	Leaves, Fruit	2.5
Rosaceae	*Photinia serratifolia* (Desf.) Kalkman	Leaves, Flower	2.4
Lauraceae	*Litsea wightiana* (Nees) Hook. f.*#	Leaves, petiole	2.2
Oleaceae	*Jasminum mesnyi* Hance **	Leaves	1.9
Elaeocarpaceae	*Elaeocarpus munroii* Mast.*	Leaves	1.7
Elaeocarpaceae	*Elaeocarpus variabilis* Smarzty*	Leaves	1.6
Myrtaceae	*Syzygium densiflorum* Wall. ex Wight & Arn.*#	Leaves	1.5
	Other species (<1% in diet)		8.4

* Endemic species
** Non-native species
# Species found only over 1,300 m

species. They spent 34% (n=785 mins) of feeding time on trees that are found only above 1,300 m asl (both endemic and non-endemic species are included in this category).

Amongst the species used by the Nilgiri Langur in mid-elevation forests at other sites, only *Gomphandra coriacea* Wight, *Syzygium cumini* (L.) Skeels, *Litsea floribunda* Gamble, *Litsea wightiana* (Nees) Hook. f., *Meliosma pinnata* (Roxb.) Maxim., *Antidesma montanum* Blume and *Persea macrantha* (Nees) Kosterm. are found over 1,600 m asl (source: Biotik portal [www.biotik.org] and India Biodiversity Portal [www.indiabiodiversity.org]) in the Western Ghats (Table 2). Of these, only the two *Litsea* species (4.7% of feeding combined observations, n=109 mins), *M. pinnata* (5.6%, n=129 mins) and *S. cumini* (1.5%, n=35 mins) were found to be common and consumed by Nilgiri Langurs in the Nilgiri Hills. The other species were absent in the study area.

DISCUSSION

Knowledge of dietary adaptations of a species inhabiting fragmented high altitude forests is important for conservation and management of the species. In the present study we found that the diet of the Nilgiri Langur in high-altitude fragmented

Table 2. Plant species fed in percentage by the Nilgiri Langur in other studies below 1,300 m mean sea level, listed in descending order of their prominence in the diet. Nomenclature corrected according to www.theplantlist.org

Species	Family	Kakachi[1] (1,000 m)	Silent Valley[2] (900 m)	Pachcha Palmalai shola[3] (1,200 m)	Nelliyampathy[4] (1,000 m)	Average of all sites
Cullenia exarillata A. Robyns*	Bombacaceae	3.3	13.4	9.22	14.41	10.08
Gomphandra coriacea Wight**	Icacinaceae	21.4	1.2	2.08	0	6.17
Palaquium ellipticum (Dalzell) Baill.	Sapotaceae	0	7	3.09	8.47	4.64
Drypetes venusta (Wight) Pax & K.Hoffm.*	Euphorbiaceae	0	2.4	11.24	3.81	4.36
Myristica dactyloides Gaertn. **	Myristicaceae	10.8	5.2	0	0	4
Drypetes oblongifolia (Bedd.) Airy Shaw*	Euphorbiaceae	12	0	0	0	3.1
Syzygium laetum (Buch.-Ham.) Gandhi	Myrtaceae	0	4.8	0	3.39	2.05
Calophyllum polyanthum Wall. ex Planch. & Triana	Clusiaceae	0	2	0	5.51	1.88
Litsea wightiana (Nees) Hook.f. *	Lauraceae	1.1	0	0	5.93	1.76
Meliosma pinnata (Roxb.) Maxim.	Sabiaceae	0	0	6.82	0	1.76
Antidesma montanum Blume	Euphorbiaceae	5.0	1	0	0	1.5
Persea macrantha (Nees) Kosterm.	Lauraceae	1.6	0	1.33	2.12	1.46
Epiprinus mallotiformis (Müll.Arg.) Croizat*	Euphorbiaceae	1.2	0	4.36	0	1.39
Mesua ferrea L.	Clusiaceae	0	2.4	2.15	0.85	1.35
Bischofia javanica Blume	Euphorbiaceae	0	3.8	1.33	0	1.28
Dimocarpus longan Lour.	Sapindaceae	0	1.6	1.70	1.69	1.25
Ficus beddomei King*	Moraceae	0	2.4	0	2.12	1.13
Ficus exasperata Vahl	Moraceae	0	0	4.48	0	1.12
Mallotus tetracoccus (Roxb.) Kurz	Euphorbiaceae	0	0	3.6	0.85	1.11

Species	Family	Kakachi[1] (1,000 m)	Silent Valley[2] (900 m)	Pachcha Palmalai shola[3] (1,200 m)	Nelliyampathy[4] (1,000 m)	Average of all sites
Tetrastigma sulcatum (P. Lawson) Gamble	Vitaceae	4	0	0	0	1.10
Oreocnide integrifolia (Gaudich.) Miq.	Urticaceae	0	0	4.3	0	1.08
Gomphandra tetrandra (Wall.) Sleumer	Icacinaceae	0	0	0	4.24	1.06
Myristica beddomei King**	Myristicaceae	0	0	0	4.24	1.06
Diospyros sylvatica Roxb.**	Ebenaceae	0	0	4.1	0	1.03
Holigarna nigra Bourd.*	Anacardiaceae	1.1	0	0	2.54	1.01
Canarium strictum Roxb.	Burseraceae	0	1	2.15	0.85	1
Diospyros ovalifolia Wight**	Ebenaceae	0	0	4	0	1
Gordonia obtusa Wall. ex Wight*	Theaceae	0	0	4	0	1
Ficus nervosa B.Heyne ex Roth	Moraceae	0	1.60	1.33	0.85	0.95
Macaranga peltata (Roxb.) Müll.Arg.	Euphorbiaceae	0	0	1.2	2.54	0.94
Cinnamomum malabatrum (Burm.f.) J.Presl*	Lauraceae	0	2	0	1.69	0.92
Piper sp.	Piperaceae	0	0	1.9	0	0.89
Mesua thwaitesii Planch. & Triana*	Clusiaceae	0	0	0	3.39	0.85
Elaeocarpus tuberculatus Roxb.	Elaeocarpaceae	0	2.2	0	0.85	0.76
Ormosia travancorica Bedd.*	Fabaceae	2.9	0	0	0	0.73
Garcinia morella (Gaertn.) Desr.	Clusiaceae	0	2.8	0	0	0.7
Litsea oleoides Hook.f.*	Lauraceae	1.1	0	1.26	0.42	0.7
Callicarpa tomentosa (L.) L.**	Verbenaceae	0	0	2.4	0	0.65
Coffea arabica L.	Rubiaceae	0	0	0	2.54	0.64
Tectona grandis L.f.	Lamiaceae	0	0	0	2.54	0.64

Species	Family	Kakachi[1] (1,000 m)	Silent Valley[2] (900 m)	Pachcha Palmalai shola[3] (1,200 m)	Nelliyampathy[4] (1,000 m)	Average of all sites
Vernonia arborea Buch.-Ham.	Asteraceae	0	0	2.15	0	0.64
Mangifera indica L.	Anacardiaceae	0	1.2	0	1.27	0.62
Loranthus sp.	Loranthaceae	0	0	2.4	0	0.60
Viburnum punctatum Buch.-Ham. ex D. Don	Caprifoliaceae	0	0	2.34	0	0.59
Litsea floribunda Gamble*	Lauraceae	0	2.2	0	0	0.55
Artocarpus heterophyllus Lam.	Moraceae	0	0	0	2.12	0.53
Elaeocarpus serratus L.	Elaeocarpaceae	0	0	0	2.12	0.53
Garcinia gummi-gutta (L.) Roxb.**	Clusiaceae	0	0	0	2.12	0.53
Olea dioica Roxb.	Oleaceae	0	1.6	0	0.42	0.51
Cinnamomum verum J.Presl**	Lauraceae	2.	0	0	0	0.5
Macaranga indica Wight	Euphorbiaceae	0	2	0	0	0.5
Syzygium cumini (L.) Skeels	Myrtaceae	0	2	0	0	0.5
Agrostistachys indica Dalzell	Euphorbiaceae	1.9	0	0	0	0.48
Cinnamomum sulphuratum Nees*	Lauraceae	1.9	0	0	0	0.48
Xanthophyllum flavescens Roxb.	Polygalaceae	0	1.8	0	0	0.45
Melia azedarach L.	Meliaceae	0	0	1.77	0	0.44
Prunus ceylanica (Wight) Miq.	Rosaceae	1.2	0	0	0	0.4
Syzygium mundagam (Bourd.) Chithra	Myrtaceae	0	1.6	0	0	0.4
Symplocos cochinchinensis (Lour.) S. Moore	Symplocaceae	0	1.6	0	0	0.4
Turpinia malabarica Gamble	Staphyleaceae	0	1.6	0	0	0.4
Aglaia bourdillonii Gamble*	Meliaceae	1.5	0	0	0	0.38

Species	**Family**	**Kakachi[1] (1,000 m)**	**Silent Valley[2] (900 m)**	**Pachcha Palmalai shola[3] (1,200 m)**	**Nelliyampathy[4] (1,000 m)**	**Average of all sites**
Mallotus paniculatus (Lam.) Müll.Arg.	Euphorbiaceae	1.5	0	0	0	0.38
Calophyllum walkeri Wight	Calophyllaceae	1.3	0	0	0	0.33
Clerodendrum infortunatum L.	Lamiaceae	1.3	0	0	0	0.33
Grewia tiliifolia Vahl	Malvaceae	0	0	0	1.27	0.32
Holigarna grahamii (Wight) Kurz*	Anacardiaceae	0	0	0	1.27	0.32
Apodytes dimidiata E.Mey. ex Arn.	Icacinaceae	0	1.2	0	0	0.3
Vepris bilocularis Engl.	Rutaceae	1.2	0	0	0	0.3
Toddalia asiatica (L.) Lam.	Rutaceae	0	0	1.14	0	0.29
Cyathea spinulosa Wall. ex Hook.	Cyatheaceae	1.1	0	0	0	0.28
Ficus hispida L.f.	Moraceae	0	0	1.07	0	0.27
Ficus microcarpa L.f.	Moraceae	0	1	0	0	0.25
Mallotus philippensis (Lam.) Müll.Arg.	Euphorbiaceae	0	0	1.01	0	0.25
Ochlandra sp.*	Poaceae	0	1	0	0	0.25
Other species (<1% in diet)		19.6	20.8	10.08	12.3	15.7

* Endemic to Western Ghats

** Endemic to South India and Sri Lanka

[1] Oates et al. (1980)

[2] Ramachandran and Joseph (2001)

[3] Sushma (2004)

[4] Ramachandran and Suganthashaktivel (2010)

[5] As *D. elata*

areas constituted mainly of broad-leafed trees and conifers. Also, the Nilgiri Langurs fed on several non-native species.

Altitude is a strong predictor of the diet of the colobines (Tsuji et al., 2013). Colobines inhabiting alpine temperate forests fed more on lichens than on fruits and flowers than those living at lower altitudes (Ruhiyat, 1983; Kirkpatrick & Grueter, 2010), due to shortage of their preferred foods (fruit and foliage) in high-altitude habitats (Tsuji et al., 2013). In the Nilgiri Hills, the Nilgiri Langurs depend on many plants that are present only above 1,300 m altitude. Many favoured tree species that are found in medium-elevation forests are absent in high-altitude forests, and hence, do not figure in the diet of Nilgiri Langurs.

The Nilgiri Langurs were not found to feed on non-native species to a large extent (>1% of the diet) in medium-elevation evergreen forests of the Western Ghats. However, in the Nilgiri Hills, they were found to feed on non-native food species. The decreased availability of native species due to fragmentation may have led them to feed on non-native species even where these are suboptimal foods. In particular, *Datura* spp. have high levels of toxicity due to presence of tropane alkaloids and the langurs might need to spend a higher amount of time resting to digest these (Preissel & Preissel, 2002). Similarly, pine needles are not generally a preferred food among primates. Japanese Macaques *Macaca fuscata* (Blyth) avoided conifer leaves, which had high tannin content (Hanya et al., 2011). However, Barbary Macaques *Macaca sylvanus* (Linnaeus) included conifer leaves in their diet even though the tannin content was higher than the leaves consumed by the Japanese Macaques. Barbary Macaques consumed conifer needles only when there was a dietary stress in a lean winter season (Taub, 1977), and is possible that the high consumption of conifer needles in the present study might likewise be an indication of dietary stress.

The major habitat of the Nilgiri Langurs in the Nilgiri Hills is small fragments of shola. The absence of mid-elevation evergreen trees restricts the dietary breadth, and destruction of remaining shola will further narrow this. Collection of firewood, human disturbance and poaching are major threats in the remaining small fragments. Hence, a large-scale effort has to be put into conservation and management of the remaining shola fragments in the Nilgiri Hills.

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REFERENCES

Davidar, E.R.C. 1978. Distribution and status of the Nilgiri Tahr (*Hemitragus hylocrius*) 1975-78. *Journal of Bombay Natural History Society* **75**: 815-844.

Donati, G., Kesch, K., Ndremifidy, K., Schmidt, S.L., Ramanamanjato, J.-B., Borgognini-Tarli, S.M. and Ganzhorn, J.U. 2011. Better few than hungry: Flexible feeding ecology of collared lemurs *Eulemur collaris* in littoral forest fragments. *PLoS One* **6**: e19807.

Grueter, C.C., Li, D., Ren, B., Xiang, Z. and Li, M. 2012. Food abundance is the main determinant of high-altitude range use in snub-nosed monkeys. *International Journal of Zoology* 2012: 739419. doi:10.1155/2012/739419.

Hanya, G., Ménard, N., Qarro, M., Tattou, M.I., Fuse, M., Vallet, D., Yamada, A., Go, M., Takafumi, H., Tsujino, R., Agetsuma, N. and Wada, K. 2011. Dietary adaptations of temperate primates: comparisons of Japanese and Barbary macaques. *Primates* **52**: 187-198.

Irwin, M.T. 2008. Feeding ecology of *Propithecus diadema* in forest fragments and continuous forest. *International Journal of Primatology* **29**: 95-115.

IUCN. 2015. The IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>. Downloaded on 13 April 2015.

Johns, A.D. 1983. *Ecological Effects of Selective Logging in a West Malaysian Rain-forest.* PhD dissertation, University of Cambridge, UK.

Johnsingh, A. and Manjrekar, N. 2013. *Mammals of South Asia.* Universities Press, Hyderabad, India.

Kirkpatrick, R.C. and Grueter, C.C. 2010. Snub-nosed monkeys: multilevel societies across varied environment. *Evolutionary Anthropology* **19**: 98–113.

Molur, S., Brandon-Jones, D., Dittus, W., Eudey, A., Kumar, A., Singh, M., Feeroz, M.M., Chalise, M., Priya, P. and Walker, S. 2003. *Status of South Asian Primates: Conservation Assessment and Manage-*

ment Plan (CAMP). Zoo Outreach Organization/ CBSG-South Asia, Coimbatore, India.

Oates, J.F., Waterman, P.G. and Choo, G.M. 1980. Food selection by the south Indian leaf-monkey, Presbytis johnii in relation to leaf chemistry. *Oecologia* **45**: 45-56.

Pascal, J.P. 1988. Wet Evergreen Forests of the *Western Ghats of India.* French Institute of Pondicherry, Pondicherry.

Pascal, J.P., Ramesh, B.R. and Franceschi, D.D. 2004. Wet evergreen forest types of the southern Western Ghats, India. *Tropical Ecology* **45**: 281-292.

Preissel, U and Preissel, H.G. 2002. *Brugmansia and Datura: Angel's Trumpets and Thorn Apples*. Firefly Books, Buffalo, New York, USA.

Ramachandran, K.K. and Joseph, G.K. 2001. Feeding ecology of Nilgiri Langur (*Trachypithecus johnii*) in Silent Valley National Park, Kerala, India. *Indian Forester* **127**: 1155-1164.

Ramachandran, K.K and Suganthasakthivel, R. 2010. *Ecology and Behaviour of the Arboreal Mammals of the Nelliyampathy Forests*. KFRI research report No. 382, KFRI, Peechi, India.

Rice, C. 1984. *Behavior and Ecology of Nilgiri Tahr* (*Hemitragus hylocrius*). PhD dissertation, Texas A & M University, USA.

Riley, E.P. 2007. Flexibility in diet and activity patterns of Macaca tonkeana in response to anthropogenic habitat alteration. *International Journal of Primatology* **28**: 107-133.

Ruhiyat, Y. 1983. Socio-ecological study of *Presbytis aygula* in west Java. *Primates* **24**: 344-359.

Singh, M., Kumar, A. & Molur, S. 2008. *Trachypithecus johnii*. The IUCN Red List of Threatened Species 2008: e.T44694A10927987. http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T44694A10927987.en. Downloaded on 29 October 2015.

Sunderraj, S.W. 2001. Ecology and conservation of Nilgiri langur (*Trachypithecus johnii*). *Envis Bulletin: Wildlife and Protected Areas* **1**: 49-59.

Sunderraj, S.W. and Johnsingh, A. 2001. Impact of biotic disturbances on Nilgiri langur habitat, demography and group dynamics. *Current Science* **80**: 428-436.

Sushma, H. 2004. *Resource Utilization and Niche Separation in Sympatric Rain Forest Arboreal Mammals.* PhD dissertation, University of Mysore, India.

Taub, D.M. 1977. Geographic distribution and habitat diversity of the Barbary macaque *Macaca sylvanus* L. *Folia Primatologica* **27**: 108-133.

Thomas, S. and Palmer, M. 2007. The montane grasslands of the Western Ghats, India: community ecology and conservation. *Community Ecology* **8**: 67-73.

Tsuji, Y., Hanya, G. and Grueter, C.C. 2013. Feeding strategies of primates in temperate and alpine forests: comparison of Asian macaques and colobines. *Primates* **54**: 201-215.

Tutin, C.E.G. 1999. Fragmented living: behavioral ecology of primates in a forest fragment in the Lopé reserve, Gabon. *Primates* **40**: 249-265.

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CROSSING INTERNATIONAL BORDERS: THE TRADE OF SLOW LORISES *Nycticebus* spp. AS PETS IN JAPAN

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ABSTRACT

Japan's involvement in the wildlife trade is widely recognised. We investigated the extent and legitimacy of trade of slow lorises, *Nycticebus* spp., as pets in Japan. We collected data from online videos, pet shops, and selected informants between May and July 2014 in Japan, and supplemented these with data from CITES Trade Database and confiscation records. We recorded 114 slow lorises in 93 Japanese online videos, and across 20 pet shops we recorded the sale of 74 individuals of six threatened species, including 12 Critically Endangered *N. javanicus* and two hybrids, each costing USD 3,290-8,650, with animals displayed with falsified CITES permits. From 1985 to 2013, CITES data specify that Japan imported more slow lorises than any other country (n=633), and 400 individuals were confiscated entering Japan, between 2000 and 2013. Penalties imposed on law breakers are weak and our investigations highlight inadequacies in Japan's enforcement of national law and CITES regulation. To combat the illegal trade and demand for wildlife as pets, we emphasise the need for: stronger penalties, improved legislative regulation, provision of educational materials and training programs to border control staff and the public. Finally, we strongly urge the continued monitoring of the slow loris trade in Japan.

Keywords: Asia, exotic pets, illegal wildlife trade, legislation, primates

INTRODUCTION

Numerous internationally protected and rare species are threatened by global wildlife trade (Warchol, 2004; Bush et al., 2014). Species are traded through various markets, established international routes, and more recently via the Internet, where trading systems are notoriously difficult to regulate (Broad et al., 2003; Blundell & Mascia, 2005; Alacs & Georges, 2008). Southeast Asia, a mega-biodiverse region, has been identified as a 'wildlife trade hotspot' predominantly supplying demand from the United States, the European Union and Japan (Nijman, 2010; Rosen & Smith, 2010; Baker et al., 2013). Japan is notably involved in the legal and illegal importation, use and consumption of wildlife, including vascular and medicinal plants (Iwatsuki, 2008; Ishihara et al., 2010), bear gallbladders (Mano & Ishii, 2008), timber wood for products such as chopsticks (Barden et al., 2000; Tian & Yin, 2006), whale meat (Danaher, 1997), and animals for the exotic pet trade (Walker et al., 2004; Ishihara et al., 2010). These activities regularly include species listed on the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (Takahashi, 2009; Ishihara et al., 2010) and they continue to elicit international criticism regarding law enforcement, wildlife management and protection (Hirata, 2005; Takahashi, 2009).

Of the forms of wildlife trade, the commercial pet trade prevails as a driving force behind the loss of biodiversity (Shepherd et al., 2004; Fernandes-Ferreira et al., 2012) and involves thousands, sometimes millions, of individual reptiles, amphibians, birds and mammals (Gilardi, 2006; Linder et al., 2013). More than half of the world's primate taxa are listed as threatened with extinction on the IUCN Red List (IUCN, 2014), yet despite all primate species being listed under CITES Appendix I (banning all commercial trade), or Appendix II (regulating trade to avoid detriment to species survival in the wild) (CITES, 2014), their trade is by no means declining (Nijman et al., 2011).

A commonly protected and threatened group of primates available in the pet trade are slow lorises, *Nycticebus* spp., a small, nocturnal, arboreal-living primate taxon endemic to South, "East" (Southern Yunnan), and Southeast Asia (Shepherd, 2010; Nekaris & Bearder, 2011). Frequently traded for use in traditional medicines (Starr et al., 2010) and the photo prop trade (Osterberg & Nekaris, 2015), their prevalence and demand as pets, particularly in non-range countries, has been fuelled by their popularity on Internet videos, of which a large number originate from Japan (Nekaris et al., 2013a). Since 2007, *Nycticebus* spp. have been listed on CITES Appendix I but individuals are still regularly smuggled. Between 2007 and 2013, a total of 99 live individuals, likely destined for the pet trade in Eastern Europe, Russia, the Middle East, China, and Japan, were officially confiscated (Nekaris et al., 2013a; TRAFFIC, 2013). Of these 99 individuals, 73 were destined for or seized in Japan (TRAFFIC, 2013) and this report remains one of the few to quantify slow loris trade in Japan (see Black, 2007; McGreal, 2007a, 2007b; Sakamoto, 2007).

We set out to examine the nature of and extent to which slow lorises are legitimately or illegally traded as pets in Japan, with the aim of providing an insight and analysis as to the magnitude of their exploitation. We also used online videos, which offer a unique opportunity to analyse aspects of the pet trade (Nekaris et al., 2013a), from Web 2.0 sites where videos are uploaded and can be viewed worldwide for gaining further insight into the demand of pet slow lorises in Japan. More specifically, we examine the following questions. How common is the slow loris pet trade in Japan and what species are kept as pets? What form does this trade most often take (pet shops, Internet) and what evidence is there that it is legal? How can slow lorises serve as an example for illegal wildlife trade in Japan?

METHODS

We conducted research for a two-month period in Japan and the UK between May and July 2014, and used databases available from the UK from January to July 2014. We investigated both online and in-store pet shops.

Online videos

To locate online videos of pet slow lorises in Japan, we used purposive sampling (Bernard, 2006) to consult three popular Web 2.0 sites: the Japanese version of YouTube, Niconico, and MSN. We entered the search terms 'pet slow loris' and 'slow loris' into each Web 2.0 site with English and with Japanese characters (Katakana) and only selected those videos with their upload location as Japan. To avoid duplication, only the first available video from each individual user was utilised. Individuals were deemed pet slow lorises if they were observed in a typical pet environment (i.e. in a human household, on household furniture, in a cage etc.) or if a term relating to pet was used in the description. We excluded any individual observed in alternative situations (i.e. sanctuary, zoo, private exhibit). For each video we recorded: number of slow lorises, species of slow loris and its age group.

In-store and online pet shop investigations

Using a purposive sampling method (Bernard, 2006; Newing et al., 2011), we investigated five in-store pet shops in Tokyo, and 18 online pet shops across Japan, which were advertising the sale of slow lorises. We collected information on: species, age group (recorded as infant, juvenile or adult, following Rode-Margono et al., 2014), sex, availability of CITES permit (and its information, i.e. trade date), source (i.e. captive bred), and sale price. We followed the taxonomy of Nekaris (2014) recognising eight Slow Loris species, one of which is Critically Endangered (*N. javanicus* É. Geoffroy, 1812), and also included the putative new taxon *N. coucang hilleri* (Nekaris & Jaffe, 2007). When identifying individuals, we used the identification key by Nekaris et al. (2015) and an associated photo ID collection that includes known hybrids from captivity. In some parts of their range, where one allopatric species meets another, hybrid species of slow loris are possible but no research is currently available. Consequently, those animals that had all the features of known hybrids from captive facilities are considered here as hybrids. Informal interviews (Bernard, 2006; Newing et al., 2011) were additionally conducted with all five in-store pet shop dealers, hereafter known as informants, regarding slow loris demand and source.

CITES trade data

For an overview of the international trade of *Nycticebus* spp. into Japan, we obtained data from the United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) CITES Trade Database. This database holds records of imports, exports and re-exports of CITES-listed species for member countries. Japan officially became a Party to CITES in 1980; import data are not available until 1985, therefore we collected data between 1985 and 2013 (inclusive), the latter being the last year of obtainable data. As the UNEP-WCMC CITES Trade Database only recognises three species of slow loris: *N. bengalensis* (Lacépède, 1800), *N. coucang* (comprising *N. coucang* [Boddaert, 1785], *N. javanicus, N. menagensis* [Trouessart, 1893]), and *N. pygmaeus* (Bonhote, 1907), frequency of distinct species could not be determined. We downloaded data on the imports of all *Nycticebus* spp. into Japan for analysis focusing upon live trade (instead of trade in animal parts or specimens [i.e. skulls, bodies, hair etc.]), importer-reported quantities instead of exporter-reported quantities (as this reflects the numbers in the country of import), exporter and purpose.

Confiscation records and illegal activity

To gain insight into the illegal trade of *Nycticebus* spp. in Japan, we obtained data from three separate sources. Confiscation data of slow lorises between 2000 and 2013 (the latter being the latest year of available data) were acquired from Japan's Ministry of Economy, Trade and Industry (METI) database consisting of seizure records from Japanese airport and marine border controls, while records regarding prosecutions and seizures from international border controls were collected from TRAFFIC, the wildlife trade monitoring network's bulletin (TRAFFIC, 2013). Though records and computerised databases provide valuable information (Flowerdew, 2005), inaccuracy and missing values are known disadvantages of secondary data (Silver et al., 2013). While TRAFFIC records provide listings of species-specific names, this is rare in the METI database and slow lorises are commonly recorded as *Nycticebus* spp. or 'monkey' due to identification problems and inadequate species knowledge at confiscation. To avoid data limitation we cross-checked information from each source to prevent duplication and confirmed two listings of slow lorises as 'monkey' in METI records. For each confiscation incident bound for or found in Japan, we recorded available information on species, age group, exporting country, the number of slow lorises traded, and purpose. In the METI records, the only details available between 2000 and 2002 were the number of slow lorises confiscated and frequency of seizures. We therefore separated this analysis into: the total number of individuals confiscated between 2000 and 2013 (i.e. Fig. 2), and those confiscated between 2003 and 2013 where we could determine the exporting country. Furthermore, to review the extent of the illegal activity since the transfer of *Nycticebus* spp. to CITES Appendix I in 2007, we also examined information from TRAFFIC (2013), Japan Wildlife Conservation Society (JWCS), reports, and media articles regarding the arrests of slow loris pet dealers and owners.

RESULTS

Online videos

We observed 114 individuals in 93 online videos with the earliest uploaded in May 2007, and the latest in July 2014. Of these, *N. bengalensis*, *N. coucang*, and *N. pygmaeus* made up 89.5% of individuals observed (Table 1). Seven individual *N. javanicus* and three hybrids also appeared in the videos. We observed individuals across all age groups: 63.2% adults, 22.8% juveniles, and 14% infants.

In-store and online pet shop investigations

We discovered 74 slow lorises of six threatened species, including 12 Critically Endangered *N. javanicus*, for sale, in 20 pet shops; two in-store pet shops and 18 online pet shops (Table 1). The two in-store pet shops were displaying a total of 18 individuals priced between ~USD 4,330 and USD 8,650 per individual. The majority of these 18 individuals were adults (83%), with 17% juveniles and no infants. All 18 individuals were displayed with CITES permits stating those specific slow lorises had been imported prior to 13 September 2007 (Fig. 1), however the presence of these documents with juvenile slow lorises clearly shows they are false. No import permit contained information on their origin. We witnessed the actual purchase of one adult *N. javanicus* individual for ~USD 4,330.

All five informants expressed the desirability of *Nycticebus* spp. as pets in Japan, describing them as 'rare', 'popular' and 'valuable'. Two informants revealed that although slow lorises were typically acquired from private breeders, it was possible to obtain wild individuals. One informant implied that two individuals currently for sale were wild-caught; one (hybrid species identified by the authors) from Thailand, and another (*N. coucang hilleri*) from Sumatra. Another emphasised the popularity of pet slow lorises explaining he had sold one *N. pygmaeus* in December 2013 for ~USD 6,920, and the shop was currently awaiting two new juveniles due to arrive at the end of 2014.

Online pet shop investigations revealed the sale of 56 individuals priced between ~USD 3,290 and ~USD 8,220 per individual. Of these, only 33 were said to be captive bred, 12 were recorded as having been imported before June 2007, despite one being a juvenile, and 11 had either no visible CITES permit or no mention of one on the website.

Of all 74 individuals, the most common species for sale was *N. pygmaeus* (39.2%). Individuals from all three age groups were observed: 60.7% adults, 23.2% juveniles, and 16.1% infants. With a considerable number of juvenile and infant slow lorises for sale, it is

Table 1. Frequencies and percentages of *Nycticebus* spp. and hybrids.

	In-store and online pet shops				Online videos	
Species (subspecies)	In-store pet shops (2)	Online pet shops (18)	Total pet shops (20)	Total percentage (%)	Frequency	Percentage (%)
N. bancanus	0	0	0	0	0	0
N. borneanus	0	0	0	0	0	0
N. bengalensis	1	12	13	17.6	28	24.6
N. coucang						
(N. c. hilleri)	4 (1)	8 (3)	12 (4)	16.2 (5.4)	41 (1)	36 (0.9)
N. javanicus	5	7	12	16.2	7	6.1
N. kayan	0	0	0	0	1	0.9
N. menagensis	0	2	2	2.7	0	0
N. pygmaeus	6	23	29	39.2	33	28.9
Hybrid	1	1	2	2.7	3	2.6
Total frequency	18	56	74	100	114	100

Note: (1) recorded in two in-store pet shops in Tokyo and 18 online pet shops across Japan; and (2) observed in 93 Japanese online videos from three Web 2.0 sites, during investigations between 8 May and 1 July 2014.

130－007682 号

登録を受けた国際希少野生動植物種の個体

種名 スローロリス属

区分 生体・卵 はく製・標本 その他（ ）

登録時（平成25年12月日）における主な特徴

体長 28.1cm
体重 885.0g
雌雄の別 雌
年齢 XXXXXXXX

規制適用日（平成19年9月13日）より前に取得された個体

備考

00415-0011

平成25年12月5日交付

Fig. 1. Photograph of CITES permit stating that the specific slow loris was imported into Japan prior to 13 September 2007 as recorded during the in-store pet shop investigations in Tokyo, Japan between 8 May and 1 July 2014. The slow loris in question was too young to have been imported at this time, showing the falsification of the document. Photograph source: principal investigator.

important to highlight that any slow lorises bred from adults that had been illegally acquired are also illegal.

CITES trade data

CITES records indicate that between 1985 and 2013 there were 633 imports of live *Nycticebus* spp. into Japan, with Malaysia the most frequent exporter, followed by China and Singapore. The only other exporting country was Thailand. All imports were for commercial purposes and the last import was recorded in 1999.

Confiscation records and illegal activity

Between 2000 and 2013, 42 incidences involving 400 individuals listed as *Nycticebus* spp. on METI records were confiscated at Japanese borders (Fig. 2). When analysing the data with available information on exporting country (between 2003 and 2013), 309 individuals listed as *Nycticebus* spp. in 28 incidences were confiscated at Japanese borders between 2003 and 2013 (Table 2). If individuals listed as 'monkey' are included in the data (a total of two listings, both in 2007), a total of 30 incidences involving 350 individuals occurred between 2003 and 2013. Regardless of whether individuals listed as 'monkey' are incorporated into these results, Thailand and Indonesia were the most significant exporting countries between 2003 and 2013 (Table 2).

Examination of reports from TRAFFIC (2013) and JWCS revealed that between late 2006 and 2008 seven further attempts were made to smuggle 42 individuals illegally from Thailand into Japan. Furthermore, information from reports and media articles revealed that between 2008 and 2014, nine separate arrests of slow loris dealers or pet owners were made, involving 26 slow lorises. Three of these arrests were due to illegal sales, and the further six were due to failure to produce a valid CITES permit.

DISCUSSION

Based on our investigations the incidence of sale of slow lorises as pets in Japan was high and covered six threatened species, most notably 12 Critically Endangered *N. javanicus*. While some individuals may legitimately derive from legal sources, evidence of falsified CITES permits and 400 confiscated individuals at Japanese borders between 2000 and 2013 highlight the extent of the illegal activity. Trade links between slow loris range countries and Japan are strong and provide appropriate opportunities to accommodate their increasing demand as pets. Although Japanese national laws are in place in accordance with international regulation to deter this commercial trade, enforcement of CITES regulation is weak, penalties are lenient, and Japan has trouble safeguarding these threatened species.

CITES data reveal that Japan's imports of live slow lorises are the highest amongst any CITES Party (Svensson & Friant, 2014), with the last recorded import occurring in 1999. Between 1985 and 1999, the national legislation in China, Singapore and Thailand did not fully protect or prohibit slow lorises from being traded and therefore the export of these individuals to Japan were legal at the time (Nekaris & Starr, 2015). Malaysia officially protected slow lorises under the Protection of Wild Life Act 1972, however the Minister is able to grant special permits to those with a valid application when satisfying certain conditions. There are two possible explanations for the recorded exports from Malaysia: either they were granted by special permit, or CITES permits were misused. As Malaysia is widely recognised as a major exporter of live animals and is frequently found to be illegally trading internationally protected wildlife (Nijman, 2010; Rosen & Smith, 2010), the latter is a legitimate possibility but has not been confirmed.

According to the five informants, slow loris species are typically sourced from private captive breeders, however their reproductive success rates in captivity are particularly low, with most slow loris species listed as rare or non-breeders in accredited zoos (Fuller et al., 2013; Nekaris et al., 2013a). We cannot discount that some individuals observed during our study were truly legally captive bred. However, data from the European studbooks reports that since 1990 the highest number of births per annum of captive Pygmy Slow Loris *N. pygmaeus* across 26 European Association of Zoos and Aquaria (EAZA) institutions is 19 individuals, with a population size at the end of the study period of 90 (Elvidge, 2013). In our study we discovered 29 Pygmy Slow Lorises for sale in pet shops and 33 in videos in two months of investigation, which points strongly towards the infeasibility of them all having been captive bred. Slow lorises are particularly susceptible to stress in non-natural environments and have the highest infant mortality rates of all prosimian primates in accredited zoos (Debyser, 1995; Fuller et al., 2014). It is unlikely that their care would be met to a high enough standard in pet shops to produce viable reproductive individuals and ensure infant survival (Streicher, 2004a; Fuller et al., 2014). Slow lorises also have a specific copulation method whereby the female must suspend from a branch upside down in order for mating to occur, which further reduces their breeding

Table 2. Frequencies of *Nycticebus* spp. seizures and numbers involved.

	Nycticebus spp. listing only		*Nycticebus* spp. including 'monkey' listings	
Exporting Country	Frequency of seizures	Number of individuals	Frequency of seizures	Number of individuals
China	1	7	1	7
Indonesia	7	74	8	85
Philippines	1	1	1	1
Singapore	2	8	2	8
Thailand	17	219	18	249
Total	28	309	30	350

Note: with and without those listed as 'monkey', and the exporting countries from confiscation records from Japanese airports and marine border controls between 2003 (the first year of data detailing exporting country) and 2013 (the last year of available data for analysis). Data obtained from Ministry of Economy, Trade and Industry (METI).

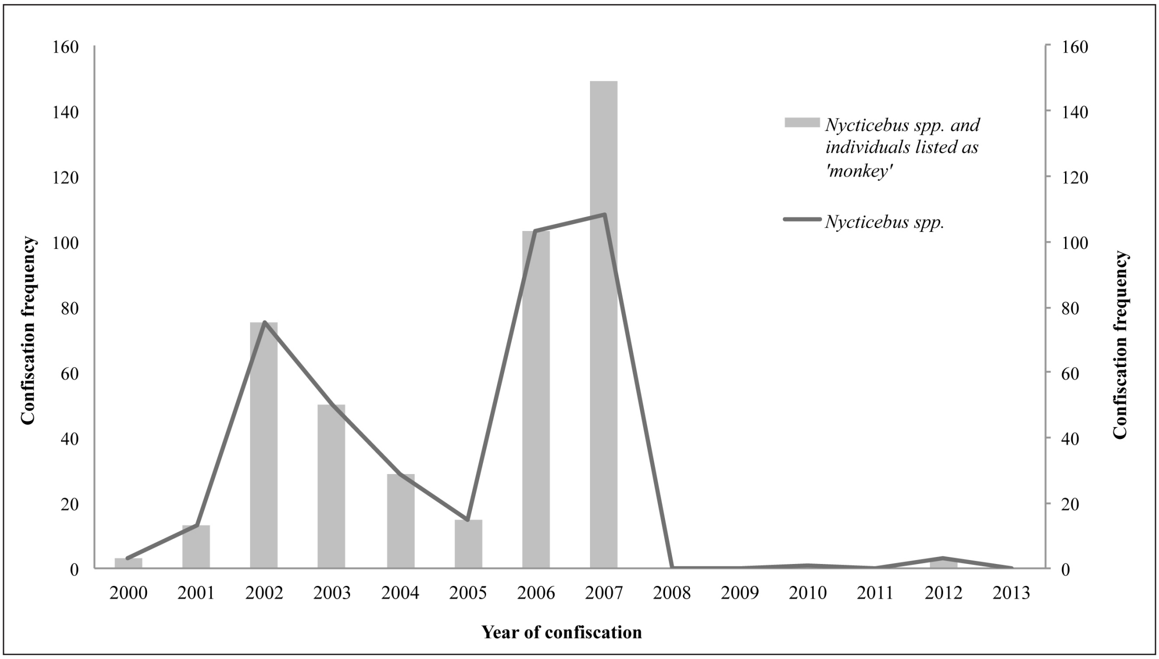

Fig. 2. Number of *Nycticebus* spp., with and without those listed as 'monkey', from confiscation records from Japanese airports and marine border controls between 2000 and 2013 (the last year of available data). Data obtained from Ministry of Economy, Trade and Industry (METI).

ability in non-natural environments (Fitch-Snyder et al., 2001; Dixson, 2012). These factors raise doubt that inadequate facilities, lacking in specialised knowledge, could have produced the 74 slow lorises discovered for sale in pet shops and the further 114 seen in the videos.

Sakamoto (2007) found 29 slow lorises for sale in four in-store pet shops in Tokyo, Japan during a short investigation. While the majority of pet shop dealers denoted private breeding as their source, the quantity and age range for sale strongly suggested wild collection, particularly from Java, Sumatra and China (Sakamoto, 2007). While some of the individuals discovered for sale in our investigations may have legitimately derived from breeding facilities, it is likely that these pet shops are used as a 'front' to launder illegally caught individuals from their natural habitats. The cost of captive breeding outweighs the time and expenditure of wild harvesting and wild individuals collect much higher profits from buyers (Brooks et al., 2010; Abbott & Van Kooten, 2011). Consequently, extracting animals from their natural habitats and concealing their acquisition is a common activity repeatedly observed in the global illegal wildlife trade (Nijman & Shepherd, 2009; Lyons & Natusch, 2011).

The concealment of illicit trade under that which looks to be legal is often made possible through the transfer of goods by long-distance public transport, hiding products and animals amongst legal goods, corrupt border control agents, and the use of false trade permits (Li & Wang, 1999; Warchol, 2004; Van Song, 2008). Like many other countries, Japan's involvement in such activities has been intimated. Ishihara et al. (2010) revealed the ease with which Japanese traders can participate in illegal activities over the Internet while Dalebout et al. (2002) told of the concealment of illegal trade of CITES Appendix I listed Minke Whale *Balaenoptera acutorostrata* (Lacépède, 1804) from Japan's oceans through scientific permits. Furthermore, Wyatt (2009) detailed how the illegal trade of raptors from Russia to Japan is made possible through organised crime networks facilitating smuggling under the facade of legal exports. During our investigations informants indicated the possibility of acquiring wild individuals, and records confirmed the illegal smuggling of slow lorises. Continued discrepancies with regards to CITES permits were also highlighted and we recorded 30 slow lorises that were said to have been imported prior to their trade ban in 2007, while 11 had no permit at all.

Trade links between Japan and Southeast Asia are known to be strong, particularly from Thailand and Indonesia (Ishihara et al., 2010; Baker et al., 2013). Since Indonesia's inception as a Party in 1979, only two cases of legal exportation of live *Nycticebus* spp. have been recorded, to Hungary and to the USA (CITES Trade Database, 2014). As Japan has never legally imported live *Nycticebus* spp. from Indonesia, Hungary or the USA, the 12 *N. javanicus* (an Indonesian endemic) discovered for sale in our study (Table 1) must be illegal and their CITES permits stating that they had been imported prior to 2007 must have been falsified. Evidence of attempted smuggling of species from Indonesia was also frequent, totalling more than 70 individuals (Table 2). This is a particularly pertinent issue as *N. javanicus* is the only species of slow loris listed as Critically Endangered on the IUCN Red List, as a result of habitat degradation and their consistent and severe exploitation for the pet trade (Nekaris et al., 2013b). While the pet trade is recognised as a primary threat to all slow loris species (Shepherd et al., 2004; Nekaris et al., 2013a), it is causing such a significant population decline to *N. javanicus* that traders in Java are now unable to find individuals to smuggle and are resorting to overexploiting alternative slow loris species (Nijman & Nekaris, 2014).

Slow lorises have adequate regulation supporting their protection that in theory should prevent any detriment to wild populations. National legislation across their distribution range now protects slow loris species from hunting, trading and possession, and their CITES listing provides the framework for Parties to develop and enforce their own domestic laws to end all commercial trade (Streicher, 2004b; Schneider, 2012). In 1980 Japan joined CITES as a Party, yet it continues to list reservations (Mofson, 1994; Takahashi, 2009), and it was not until 1992 that Japan implemented The Law for the Conservation of Endangered Species of Wild Fauna and Flora (LCES) in line with CITES regulation (Knight, 2007). This legislation has moreover been criticised for its limited commitment to CITES, including a lack of communication regarding wildlife trade matters and weak control on imports (Reeve, 2002). However, the import and distribution of slow lorises is also prohibited by Japanese national legislation: the Customs Act, the Foreign Exchange and Foreign Trade Act, the Endangered Species Act and the Invasive Diseases Act, and perpetrators are in violation of these laws. While this legislation exists and seems robust, it requires increased regulation and enforcement to deal with the diversified modes of trade, particularly the Internet (Ishihara et al., 2010) where slow lorises are predominantly being sold.

Under current Japanese legislation, penalties imposed upon those involved in illegal trade or non-compliance with CITES regulation are weak. Fines of less than ~USD 2,600 are given for falsified permits and less than ~USD 40,000 is set for wildlife smuggling along with an occasional short prison sentence; moreover court cases are regularly dismissed (Sakamoto, 2007, 2009). When considering these penalties compared with the rate and price at which slow lorises are sold in Japan, offenders are not likely to be deterred from continuing their activities. Across the slow loris distribution range there is a lack of resources and manpower supporting legislation, which has resulted in an absence of fear among poachers, hunters and traders with regard to penalties and prosecution (Shepherd, 2010; Nijman & Nekaris, 2014). Japanese enforcement agencies need to increase support and funding so officials can better monitor the legitimacy of wildlife sales and provision of permits, and regularly investigate pet shops. It is imperative that law enforcement officials undergo training regarding trade issues, are provided with resource materials, and are fully equipped to identify wildlife to the correct genus and species level (Pantel, 2008; Zhang et al., 2008). This will help ensure population viability and species-specific breeding if individuals confiscated from the trade are later transferred to a zoo or sanctuary where reproduction could occur (Frankham et al., 2010). Furthermore, if government agencies are seen to take strong action against illicit trade, even those heavily involved are more likely to be influenced by such punitive measures and reduce their involvement to avoid punishment (Natusch & Lyons, 2012).

Despite official figures from METI indicating a sharp increase in smuggling the year prior to and during the 2007 CITES trade ban (Fig. 2), there seems to be a reduction in illegal trade, which the government considers a success (Ministry of Environment staff, pers. comm.). Nevertheless, according to Rivalan et al. (2007) this occurrence of an upsurge in harvesting prior to and during the legislative alterations and up-listing of species is a legitimate concern when instigating trade bans. They are likely to be responsible for adding market value through perceived rarity to traders and consumers stimulating overexploitation before any declines in the trade are detected, and even then illegal activities are likely to remain prominent (Rivalan et al., 2007; Sollund, 2011). Courchamp et al. (2006) found that a quarter of species were subject to a significant increase in illegal trade during and after their altered CITES protection. Species with CITES status were also significantly more expensive than those without. According to wildlife traders this was attributable to confirmation of their rarity by conservation organisations (Courchamp et al., 2006) and highlights the need for improved enforcement efforts to help deter any potential upsurge.

Irrespective of the harvesting purpose, this phenomenon can have dire consequences for species (Courchamp et al., 2006; Gault et al., 2008). Within two years of up-listing rhinos, their horn price on Korean markets increased by 400% and corresponded to an increase in rhino poaching and illegal trade (Rivalan et al., 2007). Similarly, after the new description of the Roti Island Snake-necked Turtle *Chelodina mccordi* (Rhodin, 1994), its perceived rarity was confirmed and its sale price and trade increased tenfold (Shepherd & Ibarrondo, 2005). Perceived rarity has also been found to significantly influence consumer choice; Gault et al. (2008) confirm the exaggerated preference for caviar derived from rare sturgeon species, and Lyons & Natusch (2013) demonstrate how Green Pythons *Morelia viridis* (Schlegel, 1872) from areas of low harvest were perceived as the least common, and therefore fetched the highest sale price. Tournant et al. (2012) similarly found that collectors of stag beetles in Japan were primarily interested in purchasing rare specimens irrespective of sale price.

Termed the Anthropogenic Allee Effect (AAE), this predisposition to value rarity increases species' and their derivatives' economic value and purchasing incentive (Courchamp et al., 2006; Gao & Clark, 2014), and poses an additional threat to slow loris populations and their future survival. Using a bioeconomic model, Hall et al. (2008) illustrate that the ultimate outcome of rarity-fuelled demand for species is extinction, as either the species becomes trapped at a low population size where it is particularly vulnerable, or intensified hunting pressure to meet demand drives extinction. According to informants slow lorises are perceived as rare and valuable species in Japan, and their popularity has not wavered since 2007. Despite individual slow lorises being sold for ~USD 1,810 in the mid-2000s, buyers are now willing to pay up to ~USD 8,650 per individual. As slow lorises are non-native to Japan, their perceived rarity and protection status on CITES could contribute to their demand and significant price increase since the 2000s. Furthermore, their presence on social media as pets has made these animals available for viewing to audiences that would otherwise have been unaware of their existence (Nekaris et al., 2013a).

At the moment data are too sparse to confirm that the change in CITES listing and perceived rarity has definitely contributed to demand for and price increase in slow lorises, and investigating this relationship should be a focus of future studies. Forthcoming investigations might also benefit from visiting private breeders to examine slow loris breeding records and sale information. With such high prices and demand in Japan, legitimate breeders, much like livestock and domestic animal breeders (McGreevy & Nicholas, 1999; Derry, 2006), would have records of the birth of slow loris offspring, parental lineage, longevity and health, as well as financial accounts regarding sales to pet shops and consumers. These details would help confirm any discrepancies between those claimed to have derived from private breeders by pet shop owners and the actual rate of slow loris reproduction through private breeding. Such information would also further substantiate our evidence of the illegal slow loris pet trade in Japan. Additionally, talking to slow loris pet owners regarding their desire to possess these species, and knowledge of their ecological, behavioural and welfare needs, would help inform future mitigation efforts and awareness-raising campaigns. Finally, unlike the online stores, our investigations into in-store pet shops were geographically restricted to Tokyo for logistical reasons. This limited the amount of information we could collect from informants concerning source and demand. We strongly recommend that future studies gather information from across the country and that investigations are conducted for a longer period of time, ideally over a few years.

Slow lorises are consistently sourced and sold as pets in the global black-market wildlife trade and Japan represents one of the major destinations. Given Japan's patterns of wildlife and natural resource use, their established trade links with Southeast Asia and current law enforcement, their involvement in the trade of *Nycticebus* spp. as pets is noteworthy. Evidence from our investigation reveals illegal trade of slow lorises for the pet trade, high rates of sale and demand, elevated market price, and perceptions of species as desirable. This information should be used to put pressure on the Japanese government to implement more stringent regulation of national law and the LCES in accordance with their international protection, as well as initiate educational resources and campaigns. Increased scrutiny of CITES permits by Japanese authorities is a necessity as are continued pet shop investigations. Only through cooperation of the international community and more rigorous protective measures will the future survival of the slow loris be ensured.

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REFERENCES

Abbott, B. and Van Kooten, G.C. 2011. Can domestication of wildlife lead to conservation? The economics of tiger farming in China. *Ecological Economics* **70**: 721-728.

Alacs, E. and Georges, A. 2008. Wildlife across our borders: a review of the illegal wildlife trade in Australia. *Australian Journal of Forensic Sciences* **40**: 147-160.

Baker, S.E., Cain, R., Van Kesteren, F., Zommers, Z.A., D'Cruze, N. and MacDonald, D.W. 2013. Rough trade: animal welfare in the global wildlife trade. *BioScience* **63**: 928-938.

Barden, A., Anak, N.A., Mulliken, T. and Song, M. 2000. *Heart of the Matter: Agarwood Use and Trade and CITES Implementation for Aquilaria malaccensis.* TRAFFIC South East Asia, Kuala Lumpur, Malaysia.

Bernard, H.R. 2006. *Research Methods in Anthropology: Qualitative and Quantitative Approaches.* AltaMira Press, Oxford, UK.

Black, R. 2007. *Too cute for comfort.* BBC News. <http://news.bbc.co.uk/1/hi/sci/tech/6731631.stm>. Downloaded on 10 May 2014.

Blundell, A.G. and Mascia, M.B. 2005. Discrepancies in reported levels of international wildlife trade. *Conservation Biology* **19**: 2020-2025.

Broad, S., Mulliken, T. and Roe, D. 2003. The nature and extent of legal and illegal trade in wildlife. **In**: *The Trade in Wildlife: Regulation for Conservation*, S. Oldfield (ed.), pp. 3-22. Earthscan Publications Ltd, London, UK.

Brooks, E.G.E., Roberton, S.I. and Bell, D.J. 2010. The conservation impact of commercial wildlife farming of porcupines in Vietnam. *Biological Conservation* **143**: 2808-2814.

Bush, E.R., Baker, S.E. and MacDonald, D.W. 2014. Global trade in exotic pets 2006-2012. *Conservation Biology* **28**: 663-676.

CITES 2014. The CITES Appendices. <http://www.cites.org>. Downloaded on 6 May 2014.

CITES Trade Database 2014. CITES Trade Database. <http://trade.cites.org>. Downloaded on 8 June 2014.

Courchamp, F., Angulo, E., Rivalan, P., Hall, R.J., Signoret, L., Bull, L. and Meinard, Y. 2006. Rarity value and species extinction: the anthropogenic allee effect. *PLoS Biology* **4**: e415 doi:10.1371/journal.pbio.0040415.

Dalebout, M.L., Lento, G.M., Cipriano, F., Funahashi, N. and Baker, C.S. 2002. How many protected minke whales are sold in Japan and Korea? A census by microsatellite DNA profiling. *Animal Conservation* **5**: 143-152.

Danaher, M. 1997. Public awareness of environmental issues in Japan. **In:** *East Asian Cultural and Historical Perspectives*, S. Tötösy de Zepetnek and J.W. Jay (eds), pp. 17-34. Research Institute for Comparative and Cross-Cultural Studies, Alberta, Canada.

Debyser, I.W.J. 1995. Prosimian juvenile mortality in zoos and primate centers. *International Journal of Primatology* **16**: 889–907.

Derry, M.E. 2006. *Horses in Society: A Story of Animal Breeding and Marketing Culture, 1800-1920.* University of Toronto Press, Buffalo, New York, USA.

Dixson, A.F. 2012. *Primate Sexuality: Comparative Studies of the Prosimians, Monkeys, Apes, and Humans.* Oxford University Press, Oxford, UK.

Elvidge, A. 2013. *Captive Breeding Programmes for Nocturnal Prosimians.* MSc Dissertation, Oxford Brookes University, UK.

Fernandes-Ferreira, H., Mendonça, S.V., Albano, C., Ferreira, F.S. and Alves, R.R.N. 2012. Hunting, use and conservation of birds in Northeast *Brazil. Biodiversity and Conservation* **21**: 221-244.

Fitch-Snyder, H., Schulze, H. and Larson, L.C. 2001. *Management of Lorises in Captivity: A Husbandry Manual for Asian Lorisines (Nycticebus and Loris spp.).* Center for Reproduction of Endangered Species, Zoological Society of San Diego, San Diego, USA.

Flowerdew, R. 2005. Finding previous work on the topic. **In:** *Methods in Human Geography: A Guide for Students Doing a Research Project*, R. Flowerdew and D. Martin (eds), pp. 48-56. Pearson Education Limited, Essex, UK.

Frankham, R., Ballou, J.D. and Briscoe, D.A. 2010. *Introduction to Conservation Genetics.* Cambridge University Press, Cambridge, UK.

Fuller, G., Kuhar, C.W., Dennis, P.M. and Lukas, K.E. 2013. A survey of husbandry practices for lorisid primates in North American Zoos and related facilities. *Zoo Biology* **32**: 88-100.

Fuller, G., Lukas, K.E., Kuhar, C. and Dennis, P.M. 2014. A retrospective review of mortality in lorises and pottos in North American zoos, 1980-2010. *Endangered Species Research* **23**: 205-217.

Gao, Y. and Clark, S.G. 2014. Elephant ivory trade in China: trends and drivers. *Biological Conservation* **180**: 23-30.

Gault, A., Meinard, Y. and Courchamp, F. 2008. Consumers' taste for rarity drives sturgeons to extinction. *Conservation Letters* **1**: 199-207.

Gilardi, J.D. 2006. Captured for conservation: will cages save wild birds? A response to Cooney and Jepson. *Oryx* **40**: 24-26.

Hall, R.J., Milner-Gulland, E.J. and Courchamp, F. 2008. Endangering the endangered: the effects of perceived rarity on species exploitation. *Conservation Letters* **1**: 75-81.

Hirata, K. 2005. Why Japan supports whaling. *Journal of International Wildlife Law and Policy* **8**: 129-149.

Ishihara, A., Kanari, K., Saito, T. and Takahashi, S. 2010. *The State of Wildlife Trade in Japan.* TRAFFIC East Asia, Tokyo, Japan.

IUCN 2014. IUCN Red List of Threatened Species Version 2014.3 <http://www.iucn.org>. Downloaded on 20 June 2014.

Iwatsuki, K. 2008. Endangered vascular plants in Japan. *Proceedings of the Japan Academy, Series B Physical and Biological Sciences* **84**: 275-286.

Knight, C. 2007. The system of wildlife management and conservation in Japan, with particular reference to the Asiatic Black Bear. *New Zealand Journal of Asian Studies* **9**: 62-79.

Li, W. and Wang, H. 1999. Wildlife trade in Yunnan province, China, at the border with Vietnam. *TRAFFIC Bulletin* **18**: 21-30.

Linder, J.M., Sawyer, S. and Brashares, J.S. 2013. Primates in trade. **In:** *Primate Ecology and Conservation: A Handbook of Techniques*, E.J. Sterling, N. Bynum and M.E. Blair (eds), pp. 323-345. Oxford University Press, Oxford, UK.

Lyons, J.A. and Natusch, D.J.D. 2011. Wildlife laundering through breeding farms: illegal harvest, population declines and a means of regulating the trade of green pythons (*Morelia viridis*) from Indonesia. *Biological Conservation* **144**: 3073-3081.

Lyons, J.A. and Natusch, D.J.D. 2013. Effects of consumer preferences for rarity on the harvest of wild populations within a species. *Ecological Economics* **93**: 278-283.

Mano, T. and Ishii, N. 2008. Bear gallbladder trade issues and a framework for bear management in Japan. *Ursus* **19**: 122-129.

McGreal, S. 2007a. Loris confiscations highlight need for protection. *International Primate Protection League News* **34**(1): 3.

McGreal, S. 2007b. Slow lorises receive international trade protections. *International Primate Protection League News* **34**(2): 15.

McGreevy, P.D. and Nicholas, F.W. 1999. Some practical solutions to welfare problems in dog breeding. *Animal Welfare* **8**: 329-341.

Mofson, P. 1994. Protecting wildlife from trade: Japan's involvement in the convention on international trade in endangered species. *The Journal of Environment and Development* **3**: 91-107.

Natusch, D.J.D. and Lyons, J.A. 2012. Exploited for pets: the harvest and trade of amphibians and reptiles from Indonesian New Guinea. *Biodiversity and Conservation* **21**: 2899-2911.

Nekaris, K.A.I. 2014. Extreme primates: ecology and evolution of Asian lorises. *Evolutionary Anthropology* **23**: 177-187.

Nekaris, K.A.I. and Bearder, S.K. 2011. The lorisiform primates of Asia and mainland Africa: diversity shrouded in darkness. **In:** *Primates in Perspective*, C.J. Campbell, A. Fuentes, K.C. MacKinnon, S.K. Bearder and R.M Stumpf (eds), pp. 34-54. Oxford University Press, Oxford, UK.

Nekaris, K.A.I. and Jaffe, S. 2007. Unexpected diversity of slow lorises (*Nycticebus* spp.) within the Javan pet trade: implications for slow loris taxonomy. *Contributions to Zoology* **76**: 187-196.

Nekaris, K.A.I. and Starr, C.R. 2015. Conservation and ecology of the neglected slow loris: priorities and prospects. *Endangered Species Research* **28**: 87-95.

Nekaris, K.A.I., Campbell, N., Coggins, T.G., Rode, E.J. and Nijman, V. 2013a. Tickled to death: analysing public perceptions of 'cute' videos of threatened species (slow lorises – *Nycticebus* spp.) on web 2.0 sites. PLoS ONE **8**: e69215 doi:10.1371/journal.pone.0069215.

Nekaris, K.A.I., Shekelle, M., Wirdateti, Rode, E.J. and Nijman, V. 2013b. *Nycticebus javanicus.* The IUCN Red List of Threatened Species 2013. e.T39761A17971158. http://dx.doi.org/10.2305/IUCN.UK.2013-2.RLTS.T39761A17971158.en. Downloaded on 23rd December 2015.

Nekaris, K.A.I., Musing, L. and Parish, T. 2015. Slow loris identification guide. *Canopy* **15**: 1-5.

Newing, H., Eagle, C., Puri, R. and Watson, C.W. 2011. Conducting Research in Conservation: *A Social Science Perspective*. Routledge, Abingdon, UK.

Nijman, V. 2010. An overview of international wildlife trade from Southeast Asia. *Biodiversity and Conservation* **19**: 1101-1114.

Nijman, V. and Shepherd, C.R. 2009. *Wildlife Trade from ASEAN to the EU: Issues with the Trade in Captive-bred Reptiles from Indonesia*. TRAFFIC Europe, Brussels, Belgium.

Nijman, V., Nekaris, K.A.I., Donati, G., Bruford, M. and Fa, J. 2011. Primate conservation: measuring and mitigating trade in primates. *Endangered Species Research* **13**: 159-161.

Nijman, V. and Nekaris, K.A.I. 2014. Traditions, taboos and trade in slow lorises in Sundanese communities in southern Java, Indonesia. *Endangered Species Research* **25**: 79-88.

Osterberg, P. and Nekaris, K.A.I. 2015. The use of animals as photo props to attract tourists in Thailand: a case study of the slow loris Nycticebus spp. *TRAFFIC Bulletin* **27**: 13-18.

Pantel, S. 2008. Efforts to scale-up enforcement to combat the illegal pangolin trade in South-East Asia. *TRAFFIC Bulletin* **22**: 13-14.

Reeve, R. 2002. *Policing International Trade in Endangered Species: The CITES Treaty and Compliance.* The Royal Institute of International Affairs and Earthscan Publications Ltd, Abingdon, United Kingdom.

Rivalan, P., Delmas, V., Angulo, E., Bull, L.S., Hall, R.J., Courchamp, F., Rosser, A.M. and Leader-Williams, N. 2007. Can bans stimulate wildlife trade? *Nature* **447**: 529-530.

Rode-Margono, E.J., Nijman, V., Wirdateti and Nekaris, K.A.I. 2014. Ethology of the critically endangered Javan slow loris Nycticebus *javanicus* É. Geoffroy Saint-Hilaire in West Java. *Asian Primates Journal* **4**: 27-41.

Rosen, G.E. and Smith, K.F. 2010. Summarizing the evidence on the international trade in illegal wildlife. *EcoHealth* **7**: 24-32.

Sakamoto, M. 2007. *Slow Lorises Fly So Fast into Japan.* Japan Wildlife Conservation Society, Tokyo, Japan.

Sakamoto, M. 2009. *Exotic Pets and Japan.* Japan Wildlife Conservation Society, Tokyo, Japan.

Schneider, J.L. 2012. *Sold into Extinction: The Global Trade in Endangered Species.* Praeger, California, USA.

Shepherd, C.R. 2010. Illegal primate trade in Indonesia exemplified by surveys carried out over a decade in North Sumatra. *Endangered Species Research* **11**: 201-205.

Shepherd, C.R. and Ibarrondo, B. 2005. *The Trade of the Roti Island Snake-necked Turtle Chelodina mccordi.* TRAFFIC Southeast Asia, Petaling Jaya, Selangor, Malaysia.

Shepherd, C.R., Sukumaran, J. and Wich, S.A. 2004. *Open Season: An Analysis of the Pet Trade in Medan, Sumatra, 1997-2001.* TRAFFIC South East Asia, Petaling Jaya, Selangor, Malaysia.

Silver, L., Stevens, R.E., Wrenn, B. and Loudon, D.L. 2013. *The Essentials of Marketing Research.* Routledge, Abingdon, United Kingdom.

Sollund, R. 2011. Expressions of speciesism: the effects of keeping companion animals on animal abuse, animal trafficking and species decline. *Crime, Law and Social Change* **55**: 437-451.

Starr, C., Nekaris, K.A.I., Streicher, U. and Leung, L. 2010. Traditional use of slow lorises *Nycticebus bengalensis* and *N. pygmaeus* in Cambodia: an impediment to their conservation. *Endangered Species Research* **12**: 17-23.

Streicher, U. 2004a. Confiscated primates-health aspects and long-term placement options. **In:** *Conservation of Primates in Vietnam*, T. Nadler, U. Streicher and H.T Long (eds), pp. 154-60. Frankfurt Zoological Society, Frankfurt.

Streicher, U. 2004b. *Aspects of Ecology and Conservation of the Pygmy Loris* (Nycticebus pygmaeus) *in Vietnam*. PhD dissertation, Ludwig-Maximilians Universität, Munich, Germany.

Svensson, M.S. and Friant, S.C. 2014. Threats from trading and hunting of pottos and angwantibos in Africa resemble those faced by slow lorises in *Asia. Endangered Species Research* **23**: 107-114.

Takahashi, M.A. 2009. Overview of the structure and the challenges of Japanese wildlife law and policy. *Biological Conservation* **142**: 1958-1964.

Tian, M. and Yin, Z. 2006. Study on the export of disposable wooden chopsticks from China to Japan in great quantities. *Journal of Beijing Forestry University* **S2**.

Tournant, P., Joseph, L., Goka, K. and Courchamp, F. 2012. The rarity and overexploitation paradox: stag beetle collections in Japan. *Biodiversity and Conservation* **21**: 1425-1440.

TRAFFIC 2013. *TRAFFIC BULLETIN: Seizures and Prosecutions 16 (3).* TRAFFIC, Cambridge, UK.

Van Song, N. 2008. Wildlife trading in Vietnam: situation, causes, and solutions. *The Journal of Environment and Development* **17**: 145-165.

Walker, R.C.J., Rix, C.E. and Woods-Ballard, A.J. 2004. The export of the endangered Madagascar spider tortoise (*Pyxis arachnoides*) to support the exotic pet trade. *Herpetological Bulletin* **90**: 2-9.

Warchol, G.L. 2004. The transnational illegal wildlife trade. *Criminal Justice Studies* **17**: 57-73.

Wyatt, T. 2009. Exploring the organization of Russia Far East's illegal wildlife trade: two case studies of the illegal fur and illegal falcon trades. *Global Crime* **10**: 144-154.

Zhang, L., Hua, N. and Sun, S. 2008. Wildlife trade, consumption and conservation awareness in southwest China. *Biodiversity and Conservation* **17**: 1493-1516.

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FEEDING ECOLOGY OF THE NORTHERN PLAINS SACRED LANGUR *Semnopithecus entellus* (DUFRESNE) IN JESSORE, BANGLADESH: DIETARY COMPOSITION, SEASONAL AND AGE-SEX DIFFERENCES

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ABSTRACT

Feeding behaviour of the Northern Plains Sacred Langur *Semnopithecus entellus* (Dufresne) was studied from September 2012 to August 2013 in Jessore, Bangladesh. The study was based on direct observation from dawn to dusk and data was collected using focal animal sampling. The results showed that while they were largely folivorous, fruits and other items where actively sought out when available. We identified 54 plant species in the diet (33 trees, 8 shrubs and 13 herbs). Of the time spent feeding, the greatest amount was spent on leaves (57.5%) followed by fruits (20.7%), buds (8.5%), flowers (3.9%) and bark (0.5%). Langurs also consumed provisioned food (8.7%), and non-plant food items including soil, water and fungi (1%). The number of different plant species consumed varied seasonally, being higher in winter (49 spp.) and summer (48 spp.) than in the rainy season (37 spp.). Time spent feeding on natural foods significantly differed between adult males and adult females while no difference between sub-adult males and females was detected. The amount of time allocated to feeding was the highest in the early morning and the lowest at mid-day, regardless of season. Time spent feeding did not significantly fluctuate seasonally.

Keywords: age-class and sex, feeding behaviour, folivorous, Northern Plains Sacred Langur

INTRODUCTION

Primates select what they eat from what is available in their environment at any given time, in order to maximize their daily intake of required energy and nutrients to thrive and survive (e.g. Freeland & Janzen, 1974; Leighton, 1993; Barton & Whiten, 1994; Stevenson, 2003; Jildmann et al., 2008; Jaman et al., 2010; Tsuji et al., 2013). The study of food and feeding behaviour is therefore vital for understanding the basic biology of a species, its ecological adaptation and vulnerability to extinction. It is important to understand whether primates living in marginal habitats can find appropriate resources to survive. Looking at fluctuations in food availability may not always be directly measurable, but by comparing the number of food items ingested across seasons and between groups helps to understand to what extent they are successful. Such information provides baseline data for the management and conservation of a species (Minhas et al., 2010).

Primates are sometimes categorized according to their main diet in spite of seasonal variation in their annual diet (Hill, 1997). In general, the proportion of different food items (leaves, fruit, buds, insects etc.)

in the diet has been found to correlate well with the number of different foods available (Symington, 1987; Strier, 1991; Peres, 1994; Dela, 2007; Nijman, 2012; Tsuji et al., 2013). Macaques and langurs that live in seasonal habitats tend to either concentrate on specific food items available year round or maintain a diet that varies according to season, when different food items are available (e.g. Hill, 1997; Tsuji et al., 2013). It is rare to see extreme dietary specialization among such species, and most utilize a wide range of food resources as they become available (Hill, 1997). For example, largely folivorous Humboldt's Woolly Monkey *Lagothrix lagotricha* (Humboldt) living in seasonal environments feed on fruit when available (Di Fiore, 2004). Similarly, the diet of Purple-faced Langur *Semnopithecus vetulus* (Erxleben) in Sri Lanka varies due to seasonal food availability, and they feed on a wider range of fruits and vegetable crops than previously thought, when available (Dela, 2007; Nijman, 2012).

Food consumption also differs according to age-sex class and depends on such factors as body size, energetic or nutritional requirements, and physical strength. These differences in feeding behaviour have been studied in many wild primate species including Northern Pig-tailed Macaque *Macaca leonina* (Blyth), Sunda Pig-tailed Macaque *Macaca nemestrina* (Linnaeus), and Japanese Macaque *Macaca fuscata* (Blyth) where variation in time and substrate use during feeding has also been found (e.g. Feeroz, 2000; Agetsuma, 2001; Kamilar & Pokempner, 2008; Jaman & Huffman, 2011).

In natural settings, primates tend to have greater access to non-monopolizable food resources and exhibit feeding strategies based more on individual food requirements. In contrast, studies on provisioned Japanese macaques have found that high ranking adults acquire most of their energy from easily accessible provisioned food, whereas low ranking immatures acquire more of their energy from natural plants (Soumah & Yokota, 1991; Jaman & Huffman, 2011), spending more time feeding on plant foods than adults do (Hanya, 2003; Jaman & Huffman, 2011).

The Northern Plains Sacred Langur *Semnopithecus entellus* (Dufresne) is the most widely distributed of the six species currently recognized in the Hanuman Langur group, i.e. Chamba Sacred Langur *S. ajax* (Pocock), *S. entellus*, Terai Sacred Langur *S. hector* (Pocock), Malabar Sacred Langur *S. hypoleucos* Blyth, Tufted Sacred Langur *S. priam* Blyth, Central Himalayan Sacred Langur *S. schistaeus* Hodgson, in the Indian subcontinent (Roos et al., 2014). *S. entellus* inhabits an area spanning over 1900 km across India from east to west between major rivers, the Tapti River (Gujarat State), the Narmada and Krishna Rivers, all the way north to the Himalayan foothills (Mittermeier et al., 2013; Roos et al., 2014; Ashalakshimi et al., 2015).

Only a few studies have been conducted on *S. entellus* in Bangladesh. This population is reported to have possibly originated from a single pair introduced by Hindu pilgrims on the bank of the River Jalangi in early times and now is concentrated in only a few districts, particularly in Jessore, in extremely human dominated landscapes (Brandon-Jones, 2004; Mitra & Molur, 2008). Ahsan & Khan (2006) reported that *S. entellus* in Keshabpur consumed food from over 60 natural and cultivated plants, of which 48 species were identified. Data collected on their feeding ecology included plant parts consumed, but no indication was made of seasonal or age-sex differences. Another study by Khatun et al. (2013) looked at human-langur conflicts in Keshabpur, focusing mainly on the local people's perceptions of crop damage caused by the species. They found 27 different crop species cultivated in these villages, among which the langurs mostly damaged fruits, during the fruiting and harvesting season.

As witnessed in many part of the developing world, the rapid increase in human settlements and expansion of agricultural lands in Bangladesh is contributing to a steady decrease in biodiversity, putting the survival of many species at risk (Mukul, 2007; Khatun et. al., 2013). Understanding a species' feeding ecology is an essential component of assessing its ability to survive and is important for management and conservation plans, whether in undisturbed habitats or in highly human-dominated landscapes (e.g. Minhas et al., 2010). A study about the feeding behaviour of *S. entellus* in Bangladesh is necessary for the creation of a more informed local conservation strategy in the country.

The aim of this study was to investigate and provide information on the seasonal variation in plant food choices and species used by *S. entellus.* This baseline information will provide needed insights for future conservation efforts of the species in Bangladesh.

METHODS

Study sites

This study was conducted in Keshabpur (22°54′29.71″N, 89°13′9.18″E) and Manirampur (23°1′0″N, 89°14′0″E) sub-districts of Jessore district

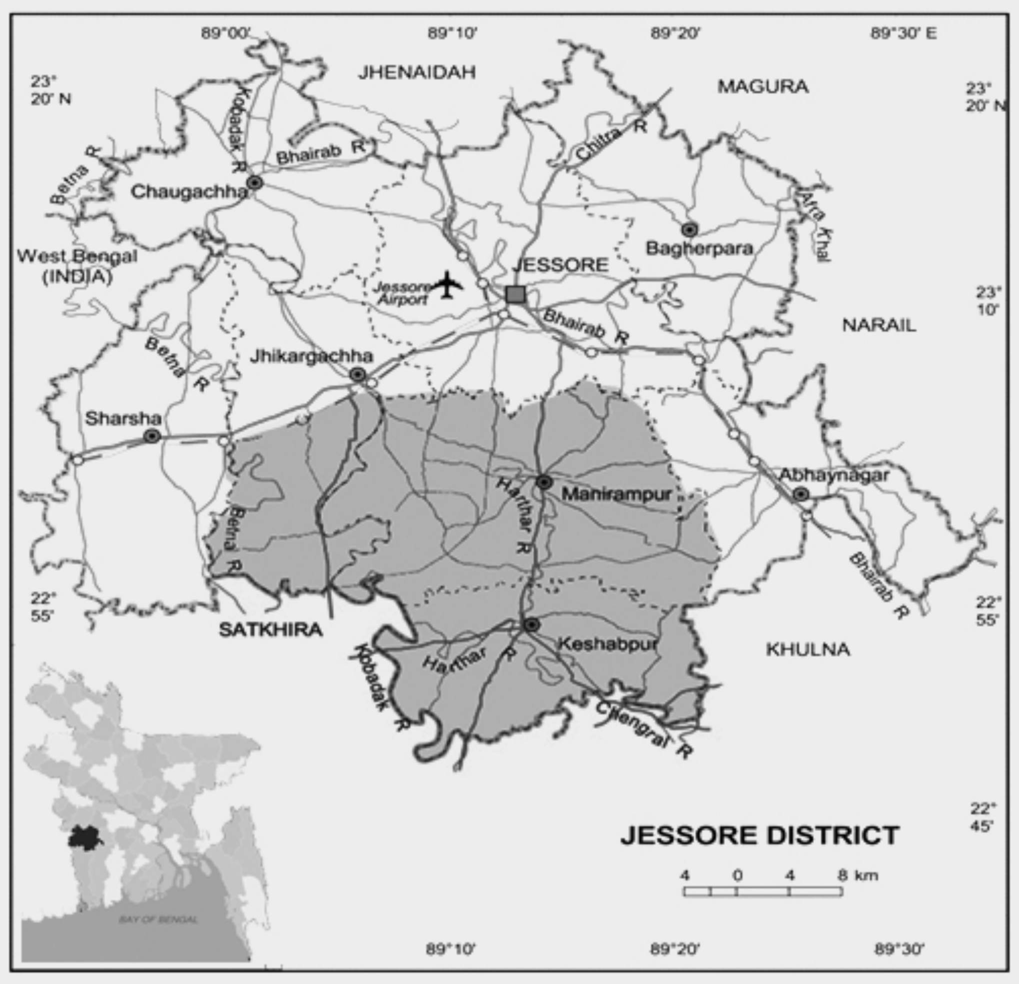

Fig. 1. Jessore District.

located in southwest Bangladesh (Fig. 1). Together, both sub-districts cover an area of 703 km², with a human population density of 953 individuals/km² (Bangladesh Bureau of Statistics, 2011). Annual temperatures in the two areas range between 11.2°C (minimum) around January, and 37.1°C (maximum) around June. Annual rainfall from September 2012 to August 2013 was 1,537 mm.

The topography of Keshabpur and Manirampur is primarily open plains. At the time this study was conducted, there was no existing conservation legislation for the protection of biodiversity in either sub-district. Vegetation in the area is dominated by economically important human crops and plantations. There are fragmented patches of natural vegetation like herbs and shrubs, found mostly in fallow lands.

Study subjects

There were eight groups of *S. entellus* living in Keshabpur and Manirampur when this study was conducted. Each group had a definable home range. Group size varied from 11 to 29 individuals (Table 1). All individuals in each group were made recognizable by marking them with a non-toxic dye; this was done by spraying with a syringe, from a concealed position. A combination of two colours was used consistently according to age-sex class, based on group consensus adopted during our preliminary field observations prior to this study. These colour markings were redone after an individual was estimated to have moved into the next age category.

Age-sex categories used in this study were determined according to age estimates as follows: adult male (>5 years old), adult female (>2.9 years old), sub-adult male (2-5 years old), sub-adult female (2-2.9 years old), juvenile (9 months-2 years old) and infant (<8 months old) (Gron, 2008). Adults are capable of

Table 1. Age-sex composition of Northern Plains Sacred Langur groups in the two study sites.

Groups	Age-sex class						
	AdM	AdF	SaM	SaF	Juv	Inf	Total
Keshabpur							
K-G 1	2	4	3	6	3	2	20
K-G 2	3	5	4	7	4	3	26
K-G 3	2	4	5	7	2	2	22
K-G 4	4	6	4	8	3	4	29
K-G 5	1	3	3	6	3	-	16
K-G 6	7	-	4	-	-	-	11
Manirampur							
M-G 1	4	5	3	6	2	3	23
M-G 2	2	4	4	6	0	2	18

AdM=Adult male, AdF=Adult female, SaM= Sub-adult male, SaF= Sub-adult female, Juv=Juvenile, and Inf=Infant

reproduction (i.e. hormone production, descended testicles in males, sexual activity, menstrual signs in females and mating behaviour), whereas sub-adults are still not able to reproduce, although they might already display mating behaviours during the breeding period (Lynch et al., 2002).

Observations and sampling protocol

We collected data from September 2012 to August 2013 using 10-minute continuous focal animal sampling (Altmann, 1974; Martin & Bateson, 2007). Data used for our analyses were collected, with a more-or-less equal amount of data from each age-sex class (for adult males 429 focal observations, adult females 478, sub-adult males 436 and sub-adult females 475), of every group at the two study sites by two well-trained field researchers over three consecutive days each month. Each day we collected about 50 focal samples, totaling 1,818 focal samples in 303 hours for the entire study. The study period was divided into three seasons: rainy (July-October), winter (November-February) and summer (March-June). In all months across all seasons, we sampled all focal subjects equally across the four time blocks in a day: early morning (06:00-09:00), late morning (09:00-12:00), mid-day (12:00-15:00) and afternoon (15:00-18:00).

We recorded each behaviour displayed, assigning a time and location. When focal subjects fed, the plant species and plant parts ingested were recorded. Unidentified plant species were collected and labelled for later identification in the laboratory. Plant parts ingested were classified as leaf, fruit/seed, bud, flower, bark, nut or bread (provisioned). Provisioned food was provided at four selected sites once a day, year round, by the local staff of the Forest Department as a conservation measure to prevent the langurs from going hungry, thus helping to reduce human-langur conflict related to crop raiding. For this purpose, the study groups were followed and the type and number of food items taken into the mouth were recorded. During focal observations, if the animal ran away or was out of sight within the last minute we noted down the last behaviour observed, otherwise we discarded the focal sample. On the day prior to the commencement of data collection, the trees on which the focal group roosted overnight were noted. This strategy facilitated our starting observations the next day before the group left its sleeping trees in the early morning.

Data analysis

Equal amounts of observation time were collected (around 75 hours in each category) from the sub-adult and adult age-sex classes, which were equally distributed across time periods of the day, months and seasons. All analyses were done using nonparametric statistics. We examined seasonal variation of plant food consumption and the number of plant species utilized as food items. We used the Friedman test to examine seasonal variation of the number of plant species utilized for different plant parts across seasons. We performed a Wilcoxon Signed Ranks test to find the differences in the number of plant species utilized for each food item between any two seasons. We employed the Chi-square test to examine variation in the number of plant species in different months and different time periods. We present exact *P* values for each analysis in the results and set the level of statistical significance at α=0.05. All data were analyzed using MS-Excel and SPSS (version 17).

RESULTS

Diet and feeding behaviour

The langurs spent 60.2% (N=1,094) of the total observation time feeding. They consumed different plant parts from 54 plant species (from 33 trees, 8 shrubs and 13 herbs; see Table 2). Among them, nine species were cultivated seasonal crops (constituting 10.2% of total diet). Their folivorous diet came mainly from five plant species, according to frequency and time spent feeding (Table 2). Thirty-seven plant species were consumed in the rainy season, 49 in the winter and 48 in the summer. Langurs fed both on the natural foods available in their home ranges and on provisioned foods and cultivated crops.

Of the total time spent feeding on identified plant parts, langurs spent more than half of their feeding time eating leaves (57.5%, n=629), followed by fruits/seeds (20.7%, n=226) (usually unripe, but occasionally ripe) and buds (8.5%, n=94) (Fig. 2). Less time was spent feeding on flowers (3.9%, n=43) and bark (0.5%, n=6). Provisioned food (8.7%, n=96) consisted of nuts, bananas and bread. Occasionally, they also fed on soil, water and fungi in different seasons. We also observed some group members licking the surface of walls, but not during focal observations. They consumed termites (*Zootermosis* spp.) and body lice eggs (*Pediculus* spp.), which were picked off their own body or from other individuals during grooming. We also observed langurs ingesting insect larvae from stacks of logs at a sawmill.

Monthly and seasonal variation of dietary composition

Semnopithecus entellus consumed the greatest number of plant species in March (n=38) and the least in September (n=25). They spent more or less similar amounts of time feeding on leaves throughout the year and there was no significant variation in the number of

Table 2. Plant food species and the average time spent feeding by food items.

No.	Family	Scientific name	Local name	Vegetation Type	Average feeding time/day (min)	%	Leaf	Fruit	Bud	Flower	Bark
1	Acanthaceae	*Justicia adhatoda* L.	Bashok	Shrub	0.51	0.3	0.3				
2	Anacardiaceae	*Mangifera indica* L.	Aam	Tree	14.19	8.8	3.1	1.8	2.2	1.7	
3		*Spondias dulcis* Parkinson	Misty amra	Tree	7.98	4.2	3.4	0.3	0.4		0.1
4	Annonnaceae	*Annona squamosa* L.	Ata	Tree	0.31	0.2	0.1	0.1			
5	Apocynaceae	*Carissa carandas* L.	Koromca	Shrub	5.59	3.1	2.5	0.6			
6		*Catharanthus roseus* (L.) G.Don	Noyontara	Herb	0.15	0.1	0.1				
7	Arecaceae	*Phoenix dactylifera* L.	Khejur	Tree	0.05	0.03		0.03			
8	Asteraceae	*Mikania scandens* (L.) Willd.	Taralota	Herb	1.44	1.3	1.3				

No.	Family	Scientific name	Local name	Vegetation Type	Average feeding time/day (min)	%	Leaf	Fruit	Bud	Flower	Bark
9	Brassicaceae	*Brassica oleracea** L.	Badhakopi	Herb	0.1	0.04	0.04				
10	Caricaceae	*Carica papaya** L.	Papaya	Tree	6.62	4.1	2.9	1.2	0.1		
11	Combretaceae	*Terminalia arjuna* (Roxb. ex DC.) Wight & Arn.	Arjun	Tree	1.17	0.8	0.5		0.1		0.2
12	Cucurbitaceae	*Coccinia cordifolia* (L.) Cogn.	Talakocu	Herb	2.38	1.6	1.6				
13	Fabaceae	*Acacia nilotica* (L.) Delile	Babla	Tree	11.03	5.9	5.5		0.3		
14		*Albizia saman* (Jacq.) Merr.	Koroi	Tree	6.77	4.6	2.9	0.6	1.1		
15		*Bauhinia variegata* L.	Kanchon	Tree	1.99	1.4	1.4				
16		*Dalbergia sissoo* DC.	Sisoo	Tree	8.67	5.2	4.7		0.5		
17		*Delonix regia* (Hook.) Raf.	Krisnocura	Tree	0.75	0.5	0.5				
18		*Lablab purpureus** (L.) Sweet	Sheem	Herb	3.22	1.4	0.5	0.4		0.5	
19		*Lathyrus sativus** L.	Khasary	Herb	0.71	0.4	0.3	0.1			
20		*Lens calinaris** Medik.	Mosur	Herb	0.08	0.06		0.06			
21		*Leucaena leucocephala* (Lam.) de Wit	Epil-epil	Tree	1.85	1.2	0.5	0.7			
22		*Tamarindus indica* L.	Tatul	Tree	8.97	6	5.3	0.4	0.3		
23	Lamiaceae	*Ocimum tenuiflorum* L.	Tulsi	Herb	0.78	0.5	0.5				
24	Malvaceae	*Corchorus capsularis** L.	Pat	Shrub	2.95	2	2				
25	Meliaceae	*Melia azadirachta* L.	Neem	Tree	0.47	0.3	0.3				
26		*Swietenia mahagoni* (L.) Jacq.	Mahogony	Tree	0.3	0.2	0.2				
27		*Syzygium cumini* (L.) Skeels	Jaam	Tree	5.05	3.3	1	1.4	0.4	0.4	0.1
28		*Syzygium paniculatum* Gaertn.	Bon jam	Shrub	1.47	0.9		0.9			

No.	Family	Scientific name	Local name	Vegetation Type	Average feeding time/day (min)	%	Leaf	Fruit	Bud	Flower	Bark
29	Moraceae	*Artocarpus heterophyllus* Lam.	Kanthal	Tree	0.11	0.1	0.1				
30		*Artocarpus lakoocha* Ruxb.	Deuwa	Tree	0.49	0.3	0.2				0.1
31		*Ficus benghalensis* L.	Bot	Tree	0.79	0.5	0.3		0.2		
32		*Ficus carica* L.	Dumur	Tree	2.61	1.8		1.8			
33		*Ficus congesta* Roxb.	Jag dumur	Tree	1.11	0.6		0.6			
34	Moringaceae	*Moringa oleifera* Lam.	Sojina	Tree	6.35	3.7	3.7				
35	Musaceae	*Musa sapientum* L.	Kola	Herb	4.67	3.3		3.3			
36	Myrtaceae	*Eugenia javanica* L.	Jamrul	Tree	2.32	1.6		0.9	0.7		
37		*Psidium guajava* L.	Payara	Tree	4.12	2.4	1.5	0.7	0.2		
38	Oleaceae	*Nyctanthes arbor-tristis* L.	Seuli	Tree	0.22	0.1				0.1	
39	Oxalidaceae	*Averrhoa carambola* L.	Kamranga	Tree	2.54	1.7	1.1	0.4	0.2		
40	Phyllanthaceae	*Phyllanthus acidus* (L.) Skeels	Royel boroi	Tree	1.05	0.6	0.6				
41		*Phyllanthus emblica* L.	Amloki	Tree	1.35	1.6	1.6				
42		*Phyllanthus reticulatus* Poir.	Khud	Shrub	0.3	0.2	0.2				
43	Poaceae	*Cynodon dactylon* (L.) Pers.	Durba	Herb	3.66	2.1	2.1				
44		*Cynodon incompletus* Nees	Ghass	Herb	1.75	1.2	1.2				
45	Rhamnaceae	*Ziziphus mauritiana* Lam.	Boroi	Tree	4.14	2.6	0.9	0.8	0.1	0.8	
46	Rubiaceae	*Ixora chinensis* Lam.	Rongon	Shrub	0.28	0.2	0.2				
47	Rutaceae	*Aegle marmelos* (L.) Corrêa	Bael	Tree	0.75	0.4	0.3		0.1		
48		*Citrus aurantiifolia* (Christm.) Swingle	Labu	Shrub	1.35	0.9	0.7	0.2			
49		*Limonia acidissima* Groff	Kodbael	Tree	0.4	0.3	0.3				
50	Sapindaceae	*Litchi chinensis* Sonn.	Litchi	Tree	1.61	0.9	0.3	0.2	0.2	0.2	

No.	Family	Scientific name	Local name	Vegetation Type	Average feeding time/day (min)	%	Leaf	Fruit	Bud	Flower	Bark
51	Sapotaceae	*Manilkara zapota* (L.) P.Royen	Sofeda	Tree	2.73	1.7	0.4	1.3			
52	Solanaceae	*Lycopersicon esculentum** Mill.	Tomato	Herb	0.56	0.4		0.4			
53		*Solanum melongena** L.	Bagun	Shrub	1.82	1.2	0.2	1			
54		*Solanum tuberosum** L.	Aalu	Herb	1.01	0.6	0.3	0.3			
		Provisioned food									
		Banana			6.69	4.3					
		Bread			2.31	1.6					
		Nut			7.94	3.3					
		Non plant food									
		Soil, water and fungi			1.41	1					
Total					162	100					

* cultivated/ seasonal crops

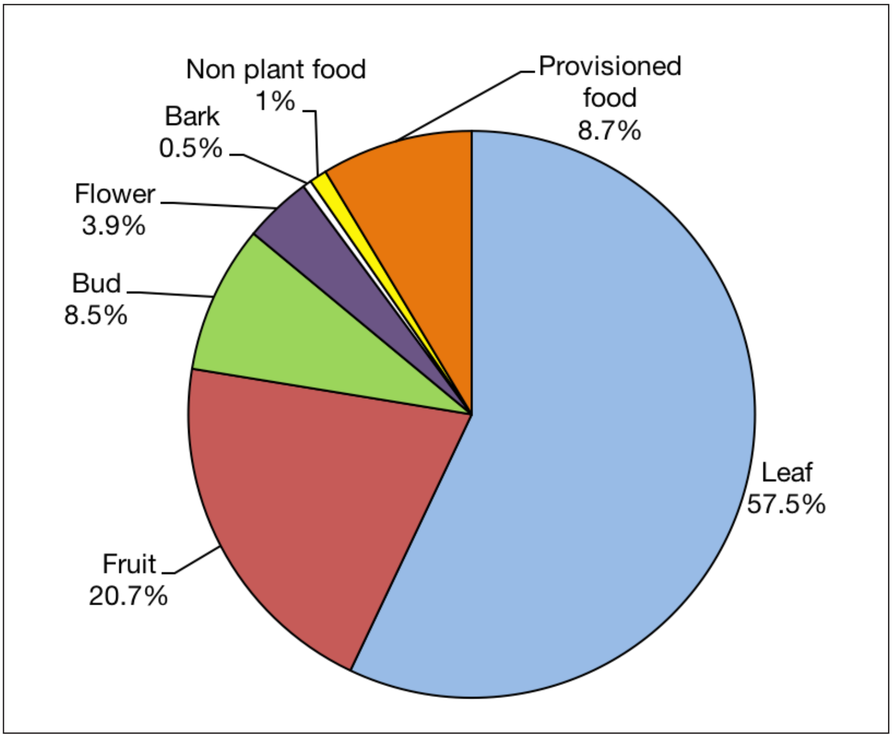

Fig. 2. Time spent feeding on different food items (N=1,094).

plant species whose leaves were fed on each month (χ^2=7.68, df=11, p>0.05, n=629). The consumption of fruit, bud and flower peaked in June, October and February, respectively. Statistically-significant variation in the number of plant species whose fruits and buds were eaten each month was found (fruit: χ^2 =20.13, df=11, p<0.05; and bud: χ^2 =20.8, df=11, p<0.05; Fig. 3).

In contrast, we found that the number of plant species utilized for leaf food items differed significantly across three seasons, while the consumption of other plant parts did not (leaf: χ^2=8.16, df=2, p=0.017; bud: χ^2=2.92, df=2, p>0.05; fruit: χ^2=4.09, df=2, p>0.05; and flower: χ^2=3.5, df=2, p>0.05; Fig. 4). While langurs are known to be folivorous, they also opportunistically fed on other food items when available. Pair-wise comparison showed that the study animals consumed buds from more species in winter than summer or the rainy season (p<0.05 for each comparison), more fruit species in summer than other seasons (p values were the same for each comparison; p=0.018), more leaf species in winter than other seasons (p values were the same for each comparison; p<0.01), and more flower items in winter than other seasons (p values were the same for each comparison; p<0.05; Fig. 4).

The percentage of consumption of natural food by the langurs dominated over cultivated food across the entire study period. Percentage of cultivated food in the diet during the winter season was 5.7% (n=62), followed by other seasons (5.0%, n=55) in summer and 1.8% (n=20) in the rainy season).

Age-sex class differences in time spent feeding on natural foods

A different number of plant species were consumed by adults (n=53 plant species) and sub-adults (n=48 plant species). Time spent feeding on natural foods by adults differed notably between males and females, while sub-adults did not show any significant difference according to sex (Fig. 5). These findings suggest that sex did not affect the feeding time of sub-adults, while adult females spent more time than adult males feeding on natural foods. Adults spent approximately 13.6% (n=149) of their feeding time in the upper canopy layers, whereas sub-adults spent almost double (23.6%, n=258) that amount of time there. Conversely, adults and sub-adults spent 24.2% (n=265) and 17.09% (n=187) of the time feeding on the ground, respectively.

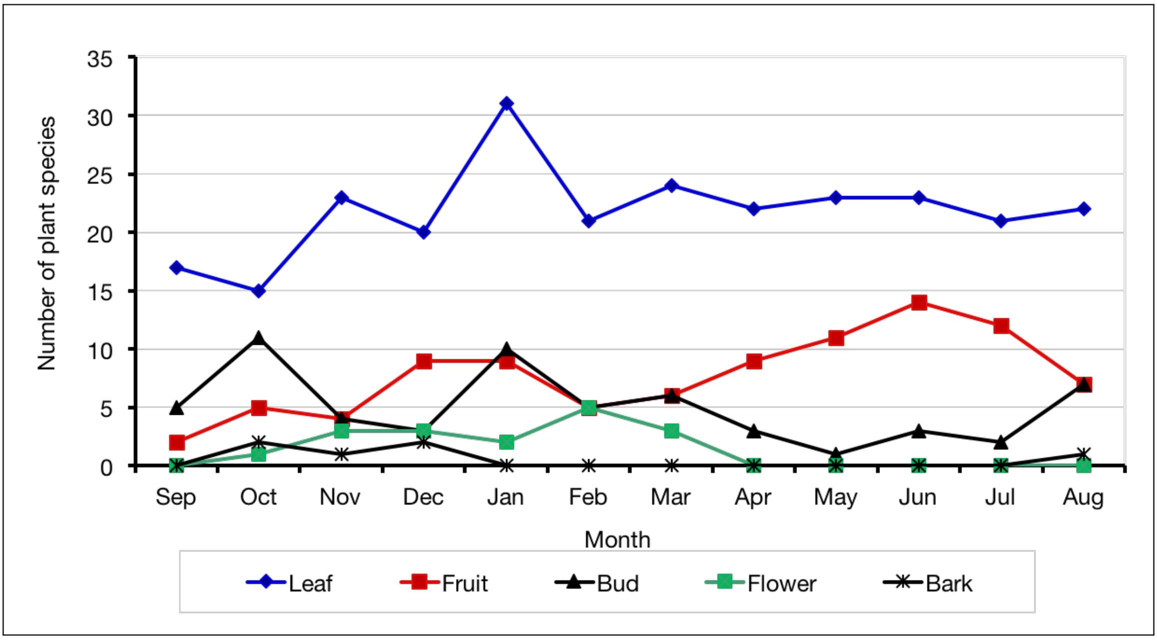

Fig. 3. Monthly variation in the number of plant parts and species ingested (N=1,094).

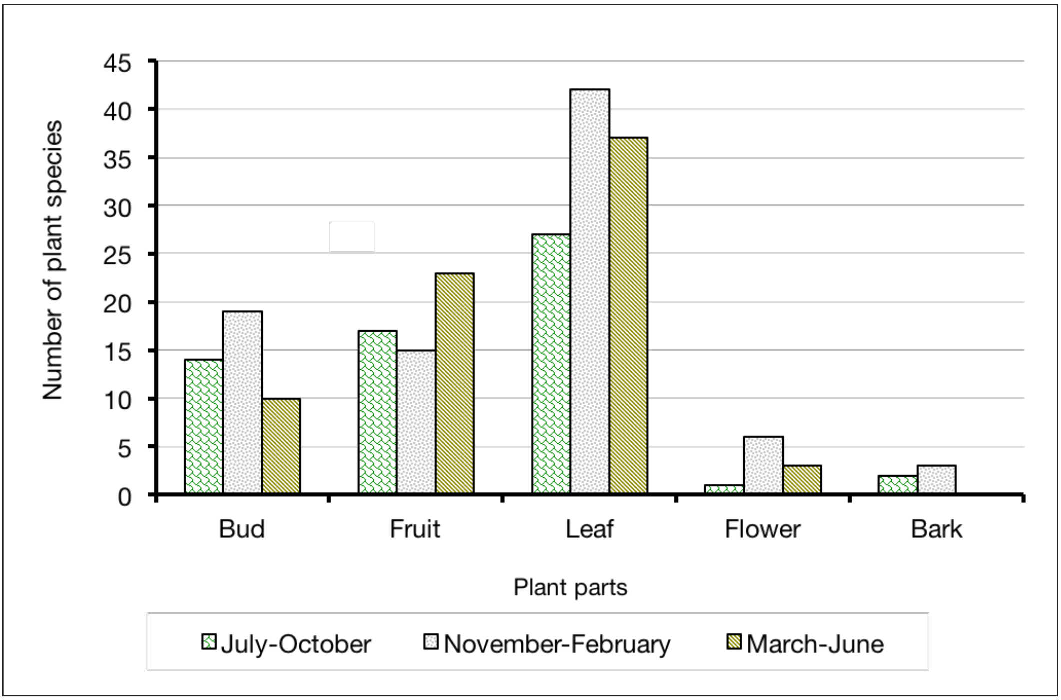

Fig. 4. Seasonal variation of plant species and plant parts consumed (N=1,094).

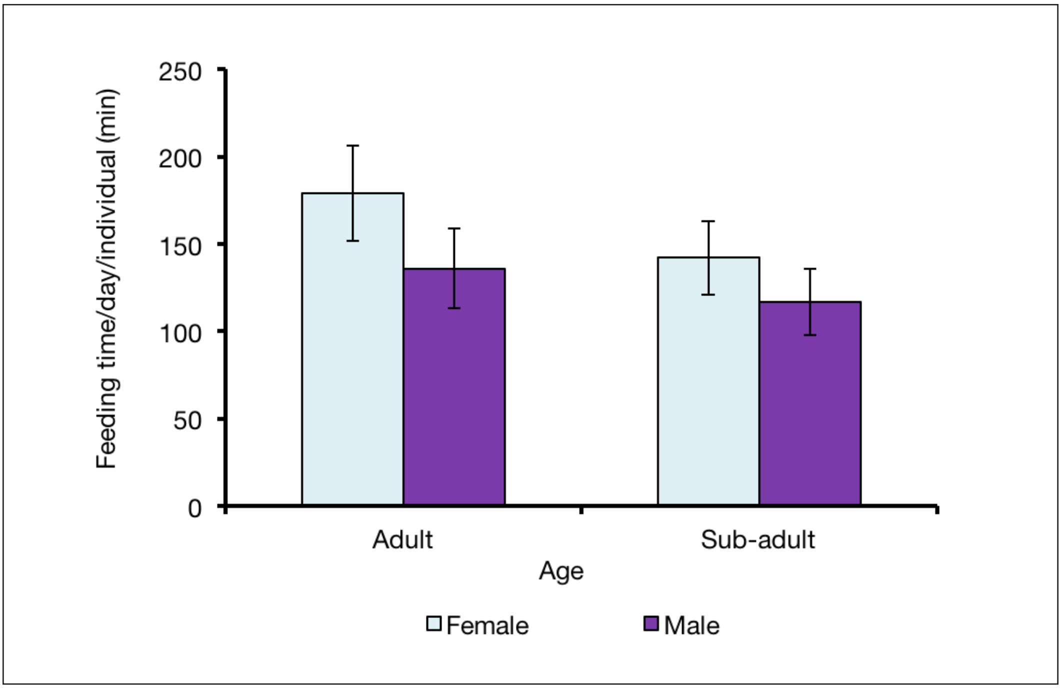

Fig. 5. Age-sex differences in time spent feeding on natural foods (N=1,094).

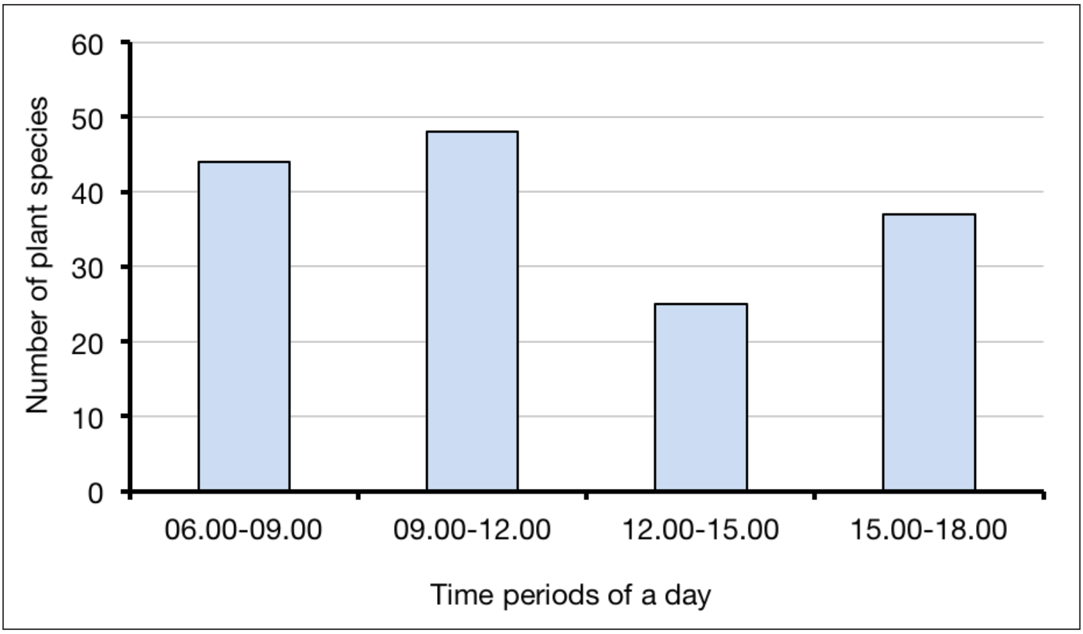

Fig. 6. Number of plant species used in different time blocks.

Variation of food consumption across different time periods of the day

We found that the number of plant species consumed by langurs differed significantly at different time periods of the day (χ^2=7.9, df=3, p<0.05; Fig. 6). They consumed the highest number of different plant species in late morning (n=48) and the lowest at mid-day (n=25). Regardless of season and age-sex class, they allocated the maximum time for feeding in the early morning (c. 50 minutes out of 180, or 28%) and the minimum time at mid-day (c. 30 minutes out of 180, or 20%).

DISCUSSION

Food items and feeding behaviour

Most studies categorize *Semnopithecus* spp. as being highly folivorous, but this is a narrow interpretation of the actual situation. In some habitats they are known to consume many other parts of plant food species when seasonally available, as well as various types of human-provisioned or cultivated crops in areas where they are commensal (Rajpurohit, 2005; this study). Various studies have shown that *Semnopithecus* spp. eat between 49 and 184 different flowering plants in their habitat (see Table 3) and different plant parts are consumed at different study sites (see Table 4). Observations of *S. entellus* in the open scrub forest of Jodhpur, India, revealed that insects may also constitute a regular part of the diet (Srivastava, 1991). The percentage of food items consumed (Table 4) do not total 100% because cultivated crops were excluded from the analysis.

In Sri Lanka, *S. priam* and *S. vetulus* are categorized as folivorous (Amerasinghe et al., 1971). However, more recent studies have also shown that *S. vetulus* consumes a variety of different food items, including fruits when available (Dela, 2007; Nijman, 2012).

Monthly and seasonal variation in food consumption

The dietary diversity of langurs in our study was quite high. Cultivated crop consumption seemed to play a role in influencing the monthly and seasonal variation in food consumption by *S. entellus* at Keshabpur and Manirampur although the total time spent feeding on these items was comparatively low overall. They consumed the highest number of different plant species in March, with access to seasonal food sources obtained by raiding cultivated fields, consuming the leaves and flowers from these crop species during their growing cycles. The lowest number of plant species utilized was in September, a period of lower availability of cultivated crops. As a result, consumption of cultivated crops in the rainy season was almost half of that consumed in other seasons. A similar study done by Minhas et al. (2010) in Pakistan showed that *S. ajax* consumed the greatest number of plant species in August (n=27), during the monsoon, when the number of new-growth plant food species increased to a yearly maximum.

Table 3. Comparison of plant food species diversity among *Semnopithecus* spp.

Species*	Location	No. of plant food species	Reference
Malabar Sacred Langur *Semnopithecus hypoleucos*	Madhya Pradesh, India	54	Majumder et al. (2010)
Chamba Sacred Langur *Semnopithecus ajax***	Machiara National Park, Pakistan	49	Minhas et al. (2010)
Northern Plains Sacred Langur *Semnopithecus entellus*	Jessore, Bangladesh	More than 60	Ahsan & Khan (2006)
Northern Plains Sacred Langur *Semnopithecus entellus*	Kumbhalgarh Wildlife Sanctuary, Rajasthan, India	184	Changani (2004)
Malabar Sacred Langur *Semnopithecus hypoleucos*	Western Ghats of Maharashtra, India	126	Punekar (2002)
Northern Plains Sacred Langur *Semnopithecus entellus*	Western Uttar Pradesh, India	51	Kar-Gupta & Kumar (1994)
Northern Plains Sacred Langur *Semnopithecus entellus*	Keshabpur, Jessore, Bangladesh	91	Khatun (2011)
Northern Plains Sacred Langur *Semnopithecus entellus*	Keshabpur, Jessore, Bangladesh	54	This study

*Taxonomic reference based on Mittermeier et al., 2013; Roos et al., 2014; Ashalakshmi et al., 2015.

**The taxonomic designation of *S. ajax* as a distinct species is still under molecular investigation.

The number of plant species utilized varied considerably across seasons at our study site. Compared to other seasons, in winter, the largest number of plant species were consumed (Fig. 4). Minhas et al. (2010) reported that there were notable differences in the number of plant species in the *S. ajax* diet between summer (n=37) and winter (n=22), due to plant availability and cold weather, respectively. Differences in altitude, hence in environmental attributes such as temperature and humidity, are likely responsible for the differences in diet seasonality between this study site and ours.

We found that the number of food items from different plant species consumed by *S. entellus* varied significantly across seasons. Consumption of leaves and buds from different species were the highest in winter, most likely due to their greater availability. After dropping off mature leaves, plants flush with new leaves in the winter season. At this time, the immature leaves and buds became their main food items. In addition, there were some cultivated winter crops to consume, allowing them to utilize more plant species than in other seasons. On the contrary, bud consumption in terms of time spent feeding by these langurs, reached its peak in the rainy season. This may be due to the heavy rainfall that stimulated the budding of food plants, increasing their abundance (Minhas et al., 2010).

The results of our study also suggest that *S. entellus* ingested more immature leaves than mature leaves, which is also common in other colobine species, and has been suggested to be due to the high protein-to-fibre ratio of young leaves (e.g. Davies et al., 1988) and also because they can better meet their water requirements from immature leaves in this dry environment (e.g. Jildmalm et al., 2008). In summer, *S. entellus* at our study site utilized a large number of plant species and more time was spent feeding on fruit, suggesting that they are opportunistic in terms of the seasonal variation of food sources. Fruit was not available in winter.

We observed the langurs drinking water only in the summer, the period when immature leaf food items were also absent. Group members also ingested dead wood in the rainy season, though this was not observed during focal animal sampling. It might be that dead wood is softer at this time due to water absorption; in which case it might be an alternative source of water and fibre. Alternatively, consumption of the wood pulp of some species has also been shown to be an important source of minerals like sodium, medicine

Table 4. Comparison of the distribution of (non-cultivated) food items consumed by *Semnopithecus* spp. across study sites.

Species*	Location	Percentage of food items**				Reference
		leaves	fruits	buds	flowers	
Northern Plains Sacred Langur *Semnopithecus entellus*	Jodhpur, India	6	23	-	7	Rajpurohit (2005)
Northern Plains Sacred Langur *Semnopithecus entellus*	Rajaji National Park, Uttarakhand, India	52.6	11-12	-	11-12	Kar-Gupta & Kumar (1994)
Grey langur *Semnopithecus priam*	Arid zone of Sri Lanka	71.9-83.7	7.9-12.5	-	7.9-6.8	Hladik & Hladik (1972)
Northern Plains Sacred Langur *Semnopithecus entellus*	Gir Sanctuary, Gujrat	85.4		-	-	Rahman (1973)
Malabar Sacred Langur *Semnopithecus hypoleucos*	Dharwar	94.6	1.7	-	1.2	Yoshiba (1967)
Northern Plains Sacred Langur *Semnopithecus entellus*	Keshabpur, Jessore, Bangladesh	57.5	20.7	8.5	3.9	This study

*Taxonomic reference based on Mittermeier et al., 2013; Ashalakshmi et al., 2015.

**Cultivated crops were omitted, therefore consumption does not total 100%.

and toxins in primates (Oates, 1978; Huffman, 1997; Reynolds et al., 2009). We found budding at its peak during the rainy season, which is most likely why buds constituted a major part of the diet in this season. Bark was eaten for more or less similar amounts of time across all seasons (Fig. 3 & 4).

Age-sex class differences in feeding behaviour on natural foods

We found that adults and sub-adults consumed a slightly different number of plant parts; 53 and 48 respectively, but the difference is not great. Females consumed more plant species than males. We also found that females spent less time feeding on provisioned foods, where provided, than did males. Males tended to gain priority of access to these highly sought-after foods, suggesting that feeding competition resulted in the lower intake by females. To overcome this limited access to provisioned foods, females may have spent more time feeding on natural food items, which is supported by our data (Fig. 5) and previously published work on *M. fuscata* (Soumah & Yokota, 1991; Jaman & Huffman, 2011). Several other factors may also be responsible for their food choices. Due to conception, pregnancy and offspring care, females may require more energy than males (e.g. Nakagawa, 1989).

Variation of foods consumed in different time periods of the day

During this study, the number of plant species and the time spent feeding on them fluctuated across time of day. They utilized the greatest number of plant species in the late morning and the lowest number at mid-day. There should be more feeding on plant species in the early morning, but in our study area, the langurs usually fed more on provisioned foods provided by humans in the early morning, though it sometimes was also provided in the afternoon at selected sites. Due to this, they spent considerably more time feeding on provisioned foods rather than natural foods whenever available. The highest feeding rate recorded for natural plant food items was in the afternoon. Conversely, langurs allocated the smallest amount of time at mid-day to feeding on any food item because they rested more at this time, perhaps due to high temperatures, particularly in summer. In winter, they spent more time feeding during all periods of the day compared with other seasons.

Practical implications of this study

Our observations did not show *S. entellus* consuming a whole fruit on any occasion; rather they ate only part of it and dropped the rest. They were also found to break branches of trees frequently while foraging. From this perspective, they can be assumed to play a positive role in the ecosystem by making the upper canopy nutrients (fresh fruit, leaves etc.) available to organisms on the ground. This commensal relationship has been described for a variety of birds, fish, reptiles, primates and other mammals (e.g. Majolo & Ventura, 2004; Heymann & Hsia, 2015). While not originally native to Bangladesh, they have lived there long enough to be considered a naturalized species and they have become an integral part of the ecology across their current habitat. We argue that this makes them a good indicator of the general health of the ecosystem, and special attention to these langurs is required for proper conservation planning. They are currently facing numerous threats, among which include scarcity of natural foods, habitat fragmentation, and conflict with humans. Although globally listed as Least Concern by the IUCN Red List of Threatened Species (Mitra & Molur, 2008), these langurs have been considered Critically Endangered in Bangladesh (IUCN, 2000).

In this study, we recorded the diversity of their feeding habits in relation to season and by the differences in their individual traits. This information will likely have beneficial implications for the conservation planning of this species in Bangladesh. We also noted that to minimize potential human-langur conflicts, some of the important food sources for this species, such as figs and raintrees could be planted in areas currently not intensively used by humans. *Semnopithecus entellus* not only consumed leaf of raintrees, but also used them for roosting. Besides reducing potential human-langur conflicts over food resources, planting these trees may possibly lead to a reduction in provisioning costs. In addition, the trees could also be harvested selectively.

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REFERENCES

Agetsuma, N. 2001. Relation between age-sex class and dietary selection of wild Japanese monkeys. *Ecological Research* **16**: 759-763.

Ahsan, M.F. and Khan, M.A.R. 2006. Eco-ethology of the common langur *Semnopithecus entellus* (Dufresne) in Bangladesh. *University Journal of Zoology, Rajshahi University* **25**: 3-10.

Altmann, J. 1974. Observational study of behaviour: sampling methods. *Behaviour* **49**: 227-267.

Amerasinghe, F.P., Cuylemberg, B.W.B. and Hladik, C.M. 1971. Comparative histology of the alimentary tract of Ceylon primates in correlation with the diet. *Ceylon Journal of Science* (*Biological Sciences*) **9**: 75-87.

Ashalakshmi, N.C., Nag, K.S.C. and Karanth, K.P. 2015. Molecules support morphology: species status of South Indian populations of the widely distributed Hanuman langur. *Conservation Genetics* **16**: 43-58.

Bangladesh Bureau of Statistics. 2011. *Population and Housing Census 2011*. Bangladesh: Bangladesh Bureau of Statistics (BBS).

Barton, R.A. and Whiten, A. 1994. Reducing complex diets to simple rules: food selection by olive baboons. *Behavioural Ecology and Sociobiology* **35**: 283-293.

Brandon-Jones, D. 2004. A taxonomic revision of the langurs and leaf monkeys (primates: Colobinae) of South Asia. *Zoo's Print Journal* **19**: 1552-1594.

Davies, A.G., Bennett, E.L. and Waterman, P.G. 1988. Food selection by two South-east Asian colobine monkeys (*Presbytis rubicunda* and *Presbytis melalophos*) in relation to plant chemistry. *Biological Journal of the Linnean Society* **34**: 33-56.

Dela, J.D.S. 2007. Seasonal food use strategies of *Semnopithecus vetulus nestor*, at Panadura and Piliyandala, Sri Lanka. *International Journal of Primatology* **28**: 607-626.

Di Fiore, A. 2004. Diet and feeding ecology of woolly monkeys in a western Amazonian rain forest. *International Journal of Primatology* **25**(4): 767-801.

Feeroz, M.M. 2000. Height and substrate use during feeding and foraging by the pigtailed macaques (*Macaca nemestrina leonina*) in Bangladesh. *Journal of the Asiatic Society of Bangladesh* **26**: 237-244.

Freeland, W.J. and Janzen, D.H. 1974. Strategies in herbivory by mammals: the role of plant secondary compounds. *American Naturalist* **108**: 269-289.

Gron, K. 2008. Gray langur *Semnopithecus*. **In**: Primate Info Net. <pin.primate.wisc.edu/factsheets/entry/gray_langur>. Downloaded on 28 July 2010.

Hanya, G. 2003. Age differences in food intake and dietary selection of wild male Japanese macaques. *Primates* **44**: 333-339.

Heymann, E.W. and Hsia, S.S. 2015. Unlike fellows – a review of primate-non-primate associations. *Biological Reviews* **90**: 142-156.

Hill, D.A. 1997. Seasonal variation in the feeding behaviour and diet of Japanese macaques (*Macaca fuscata yakui*) in lowland forest of Yakushima. *American Journal of Primatology* **43**: 305-322.

Huffman, M.A. 1997. Current evidence for self-medication in primates: a multidisciplinary perspective. *Yearbook of Physical Anthropology* **40**: 171-200.

IUCN 2000. *Red Book of Threatened Mammals of Bangladesh.* IUCN Bangladesh, Dhaka, Bangladesh.

Jaman, M.F. and Huffman, M.A. 2011. Age class differences in the feeding behaviour of captive Japanese macaques (*Macaca fuscataia*) in the forested and non-vegetated enclosure groups. *Zoo Biology* **30**: 260-274.

Jaman, M.F., Huffman, M.A. and Takemoto, H. 2010. The foraging strategy of Japanese macaques *Macaca fuscata* in forested enclosure: effects of nutrient composition and its seasonal variation on the selection of available plant foods. *Current Zoology* **56**(2): 198-208.

Jildmalm, R., Amundin, M. and Laska, M. 2008. Food preferences and nutrient composition in captive white-hand gibbons, *Hylobates lar. International Journal of Primatology* **29**: 1535-1547.

Kamilar, J.M. and Pokempner, A.A. 2008. Does body mass dimorphism increase male-female dietary niche separation? A comparative study of primates. *Behaviour* **145**: 1211-1234.

Khatun, U.H. 2011. Feeding behavior and ecology of Common langur (*Semnopithecus entellus*) of Keshabpur, Bangladesh. Proceedings of the conference on biodiversity- present state, problems and prospects of its conservation. University of Chittagong, Bangladesh. 21-32 pp.

Khatun, U. H., Ahsan, M. F. and Roskaft, E. 2013. Local people's perceptions of crop damage by common langurs (*Semnopithecus entellus*) and human-langur conflict in Keshabpur of Bangladesh. *Environment and Natural Resources Research* **3**(1): 111-126.

Leighton, M. 1993. Modeling dietary selectivity by Bornean orangutans: evidence for integration of multiple criteria in fruit selection. *International Journal of Primatology* **14**: 257-311.

Lynch, J.W., Ziegler, T.E. and Strier, K.B. 2002. Individual and seasonal variation in fecal testosterone and cortisol levels of wild male tufted capuchin monkeys, *Cebus apella nigritus. Hormones and Behavior* **41**(3): 275-287.

Majolo, B. and Ventura, R. 2004. Apparent feeding associations between Japanese macaques (*Macaca fuscata yakui*) and sika deer (*Cervus nippon*) living in Yakushima Island, Japan. *Ethology Ecology and Evolution* **16**(1): 33-40.

Martin, P.R. and Bateson, P.P.G. 2007. *Measuring Behaviour: An Introductory Guide*. Cambridge University Press, Cambridge, UK.

Minhas, R.A., Ahmed, K.B., Awan, M.S. and Dar, M.I. 2010. Habitat utilization and feeding biology of Himalayan grey langur (*Semnopithecus entellus ajax*) in Machiara National Park, Azad Jammu and Kashmir, Pakistan. *Zoological Research* **31**(2): 177-188.

Mitra, S. and Molur, S. 2008. *Semnopithecus entellus.* **In**: IUCN 2014 Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>. Downloaded on 1 June 2015.

Mittermeier, R.A., Rylands, A.B. and Wilson, D.E. 2013. *Handbook of the Mammals of the World. Vol. 3. Primates.* Lynx Edicions, Barcelona, Spain.

Mukul, S.A. 2007. Biodiversity conservation and sustainable development in Bangladesh: an overview of the present status, management problems and future prospects. Department of Forestry and Environmental Science, Shahjalal University of Science and Technology, Sylhet, Bangladesh. <www.mtnforum.org/sites/default/files/publication/files/1159.pdf>.

Nakagawa, N. 1989. Bioenergetics of Japanese monkeys (*Macaca fuscata*) on Kinkazan Island during winter. *Primates* **30**: 441-460.

Nijman, V. 2012. Purple-faced langurs in human-modified environments feeding on cultivate fruits: a comment to Dela (2007, 2012). *International Journal of Primatology* **33**: 743-748.

Oates, J.F. 1978. Water-plant and soil consumption by guereza monkeys (*Colobus guereza*): a relationship with minerals and toxins in the diet? *Biotropica* **10**: 241-253.

Peres, C.A. 1994. Diet and feeding ecology of gray woolly monkeys (*Lagothrix lagotricha cana*) in central Amazonia: comparisons with other atelines. *International Journal of Primatology* **15**: 333-372.

Rajpurohit, D.S. 2005. *Study the Dominance Hierarchy and its Role in Social Organization in Hanuman langur (Semnopithecus entellus) in India*. PhD dissertation, University of Jai Narain Vyas, India.

Reynolds, V., Lloyd, A.W., Babweteera, F. and English, C.J. 2009. Decaying *Raphia farinifera* palm trees provide a source of sodium for wild chimpanzees in the Budongo Forest, Uganda. *PLoS ONE* **4**(7): e6194.

Roos, C., Boonratana, R., Supriatna, J., Fellowes, J.R., Groves, C.P., Nash, S.D., Rylands, A.B. and Mittermeier, R.A. 2014. An updated taxonomy and conservation status review of Asian primates. *Asian Primates Journal* **4**(1): 2-38.

Soumah, G. and Yokota, N. 1991. Female rank and feeding strategies in a free-ranging provisioned troop of Japanese macaques. *Folia Primatologica* **57**: 191-200.

Srivastava, A. 1991. Insectivory and its significance to langur diets. *Primates* **32**(2): 237-241.

Stevenson, P.R. 2003. Fruit choice by woolly monkeys in Tinigua National Park, Colombia. *International Journal of Primatology* **25**: 367-381.

Strier, K.B. 1991. Diet in one group of woolly spider monkeys, or muriquis (*Brachyteles arachnoids*). *American Journal of Primatology* **23**: 113-126.

Symington, M.M. 1987. *Ecological and Social Correlates of Party Size in the Black Spider Monkey, Ateles paniscus chamek*. PhD dissertation, Princeton University, USA.

Tsuji, Y., Hanya, G. and Grueter, C.C. 2013. Feeding strategies of primates in temperate and alpine forests: comparison of Asian macaques and colobines. *Primates* **54**: 201-215.

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A PRELIMINARY STUDY OF FRUIT HANDLING BY CAPTIVE BORNEAN ORANGUTANS *Pongo pygmaeus pygmaeus* AND THE EFFECTS ON SEED GERMINATION

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ABSTRACT

A preliminary study to investigate the efficacy of Northwest Bornean Orangutans (*Pongo pygmaeus pygmaeus*) as seed dispersers and predators was conducted in Matang Wildlife Centre, Kuching, Sarawak from November 2012 to April 2013. This wildlife facility is one of the official holding centres for orangutans in Malaysian Borneo. Three adult and three juvenile captive orangutans were fed with nine species of locally-available fruits. Approximately 1.5 kg of fruit was given once daily during the study period. Seeds from sieved faecal matter were collected and tested for germination. Three species of small-seeded plants germinated while two medium-seeded plants did not. The seeds from the other four species were damaged and not tested for germination. Fruit and seed-handling behaviour was also observed. A broad range of fruit-processing behaviour such as swallowing, spitting and masticating allows the orangutans to be both seed disperser and predator towards some large-seeded and small-seeded fruits. The morphological characteristics of seeds and age of orangutans appear to influence the fate of seed dispersal.

Keywords: behaviour, fruit-processing, germination, seed dispersal, seed morphology, tropical ecology

INTRODUCTION

Orangutans, with a wide distribution across Borneo and Sumatra, are naturally limited to tropical rainforest although they have been reported in orchards, cultivated fields and gardens (Galdikas, 1988; Nadler et al., 1990). The Bornean species has been classified under three subspecies, namely *P. p. pygmaeus* (Linnaeus), the Northwest Bornean Orangutan, *P. p. wurmbii* (Tiedemann), the Southwest Bornean Orangutan, and *P. p. morio* (Owen), the Northeast Bornean Orangutan (Roos et al., 2014). Orangutans have been reported to utilize more than 500 species of plants (Ancrenaz et al., 2008). The diet breadth of an orangutan is wide and they can consume more than 300 types of fruit available in forests (Harrison, 1962; Galdikas, 1982). They are also known to forage on cultivated fruits such as durians, figs, rambutans and mangoes (Payne & Andau, 1989; Bennett, 1998; Kaplan & Rogers, 2000). Most of their preferred fruits are from large-seeded trees and they may play an important role in dispersal of seasonal tropical fruits in the wild (Galdikas, 1982).

Seed dispersal and seed dissemination, which contributes to the spatial dynamics of plant populations, is important in forest ecology (Cousens et al., 2008). The association of frugivory and seed dispersal has been consistently linked and theoretically framed on the idea of coevolution (Ehrlich & Raven, 1964; Futuyma & Slatkin, 1983; Herrera, 2002). Being the largest primate in Asia, orangutans need large quantities of food for nutrition and energy for their daily activities (Harrison, 1962). Adult orangutans may travel from 300 m to 800 m per day, with a home range of over 6 km^2 (Harrison, 1962; Bennett, 1998). Primates are important seed dispersers because of their varied diet and their ability to travel far which leads to high dispersal distances (Galdikas, 1988; Wehncke et al., 2003; Corlett, 2009; Nielsen et al., 2011). These functions are crucial in many of the degrading Bornean rainforests.

The most common modes of seed handling are seed spitting and swallowing (Lambert, 2002). The size of the seed influences seed handling. Seed-spitting may lead to seed dispersal within a short distance. In contrast crushing of seeds during foraging may result in seed predation. Additionally, seed passage through mammalian guts may facilitate the germination of dormant seeds (Willson, 1993; Ramos et al., 2006). However, the germination of seeds from different plant species will respond differently after ingestion, even by the same animal species (Traveset, 1998). This project was initiated to investigate the efficacy of orangutans as seed dispersers and the germination rates of selected seasonal and domestically available fruits.

MATERIALS AND METHODS

Study area

The study was conducted at Matang Wildlife Centre, Kuching, Sarawak in Borneo for six months from November 2012 to April 2013. Matang Wildlife Centre is an enclosed area of rainforest with captive animal facilities established to conserve endangered species of wildlife in Sarawak.

Six individuals of semi-wild orangutans from two age categories were selected for this experiment. They included three adults, which consisted of two males and a female (13 to 29 years old), and three juvenile males (3-4 years old). The orangutans were fed with seasonally and commercially cultivated local fruits in three seed-size classes (<5mm, small; 5-15mm, medium; >15mm, large) (Table 1). Two to seven types of fruit were given per feeding session, depending on availability. Samples of the fruits were weighed, sliced and their seeds counted or estimated. The number of seeds in small-seeded species (e.g. *Citrullus lanatus* (Thunb.) Matsum. & Nakai) was estimated and the average number of seeds recorded from a sample of eight of each fruit, of a representative range of fruit sizes.

All seeds were retrieved from the faeces of the orangutans for the germination experiment (Table 1). Control seeds were taken from the same batch of fruits for each species. The retrieved and control seeds were identified and numbered and set in germination beds using untreated sandy soil from the forest. All planting was conducted in controlled conditions in the UNIMAS Nursery. Seeds were kept moist and checked daily for germination (emergence of radicle).

RESULTS

The orangutans consumed all the given fruits, with no leftovers. Orangutans spent less than 30 minutes feeding on approximately 1.5 kg of fruits. They were fed fruits with an estimated total of approximately 3,996 seeds, and only 696 (17.4%) intact seeds were retrieved from the faeces. The remaining seeds were either spat out (N=984; 24.6%) or found damaged in the faeces. There was no significant difference in proportion intact between the spat-out seeds and those found in the faeces (paired t-test, df=8, t=0.67 P=0.52). The spat and dropped seeds appeared viable and mostly intact. Smaller seeds (<5mm, i.e. *Carica papaya* L. and *C. lanatus*) were likely to be chewed and digested; thus not many seeds were retrieved from the faeces. Intact seeds from *Artocarpus integer* (Thunb.) Merr., *Dialium indum* L., *Dimocarpus longan* Lour. and *Nephelium lappaceum* L. were not found in the faeces as most of them were spat out. The highest proportion of intact seeds retrieved from the faeces were from *Baccaureum macrocarpa* (Miq.) Muell.Arg (82.8%), *A. integer* (82.2%), *N. lappaceum* (70%) and *Annona muricata* L. (56.1%). In contrast a high proportion of seeds was damaged for *Dialium indum, Dimocarpus longan, Carica papaya* and *Citrullus lanatus* for each of which only a minority (10.8%, 17.4%, 36.3% and 37.2% respectively) of intact seeds were retrieved (Table 1).

There was no significant difference in the number of seeds retrieved from the faeces between the adult and juvenile orangutans (paired t-test, df=8, t=1.6, P=0.15). However the adult and juvenile animals behaved differently in fruit processing and handling where there was a significant difference (paired t-test, df=8, t=3.8, P=0.00) in the proportion of remnant seeds that were spat out, suggesting that juvenile orangutans caused more damage to seeds than adults.

The time of germination was measured in days. Except for the seeds of *Annona muricata* and *Lansium parasiticum* (Osbeck) K.C. Sahni & Bennet most of the intact seeds retrieved from the orangutan faecal samples were successfully germinated (95%, N=618). Egested seeds of *Citrullus lanatus* (watermelon) and *Carica papaya* (papaya) germinated faster than controls while *B. macrocarpa* (Tampoi) showed a similar germination period. This evidence suggests that passage through an orangutan's gut improves the probability of germination and shortens the time taken to germinate for *Citrullus lanatus* and *Carica papaya.*

Table 1. Total seeds retrieved from faeces and spat out by adult and juvenile orangutans. The germination test was only conducted for control seeds and seeds retrieved from faeces.

Scientific name	Common name	Size	Total intact, damaged and missing seeds from faeces				Intact seeds retrieved from faeces of adults	Intact seeds retrieved from faeces of juvenile	Intact seeds spat out by adults	Intact seeds spat out by juveniles	Germination time/ days	
			Seeds given	Intact seeds %	Damaged seeds %	Missing seeds %					Control	Faeces
*Annona muricata**	Soursop	Medium	173	56.1 (97)**	9.2 (16)	34.7 (60)	8	4	79	6	0	0
Artocarpus integer	Jackfruit	Large	393	82.2 (323)	7.4 (29)	10.4 (41)	0	0	240	83	NA	NA
*Baccaurea macrocarpa**	Tampoi	Small	507	82.8 (420)	0 (0)	17.2 (87)	176	66	177	1	5 to 10	5 to 10
*Carica papaya**	Papaya	Small	895	36.3 (325)	63.7 (570)	0 (0)	90	98	128	9	5 to 10	4 to 10
*Citrullus lanatus**	Watermelon	Small	610	37.2 (227)	62.8 (383)	0 (0)	190	30	3	4	5 to 10	3 to 6
*Dialium indum**	Keranji	Medium	409	10.8 (44)	89.2 (365)	0 (0)	0	0	38	6	NA	NA
*Dimocarpus longan**	Longan	Medium	397	17.4 (69)	82.6 (328)	0 (0)	0	0	55	14	NA	NA
*Lansium parasiticum**	Langsat	Medium	522	21.5 (112)	0 (0)	78.5 (410)	27	7	63	15	0	0
*Nephelium lappaceum**	Rambutan	Large	90	70 (63)	24.4 (22)	5.6 (5)	0	0	54	9	NA	NA
TOTAL			3996	1680	1713	603	491	205	837	147		

*Seeds were counted and estimated; **figures in brackets indicate the sample size; NA=not available for germination test.

DISCUSSION

The finding of this experiment is consistent with that of Galdikas (1982) that orangutans are seed dispersal agents for most fruits and could act as seed predators for some other plant species. In general the balance between egestion (with seeds potentially dispersed further away from the tree) and spitting out (i.e. seeds dropping below and near the tree) is expected to be similar in the wild, with more seeds spat out than retrieved from the faeces. In the wild, 46% of the seeds recovered were from the faeces while the remainder were spat out (Galdikas, 1982). In the present study on captive orangutans fewer intact seeds (41%) were recovered from the faeces compared with the proportion spat out. The sizes of seed appear to be important in determining the fruit-processing behaviour and dispersal distance. This study further supports the postulation of Nielsen et al. (2011) that orangutans are effective seed dispersers for both large- and small-seeded fruits. In general larger-seeded fruits (i.e. *A. integer* and *N. lappaceum*) were not ingested but spat out after consuming the pulp, while less fleshy fruits and tasteless seeds tended to be masticated by the orangutans and thereby destroyed. Spat-out seeds will have a shorter dispersal distance.

The viability of the seeds that are spat out in the wild may be dependent on the microhabitat in which they land. In addition to this, seeds spat out that land directly under a tree, although perfectly intact, may not have much of a chance of survival as they have a high probability of being eaten by seed predators or attacked by fungi or parasites (Wrangham et al., 1994).

Even though the sizes of the seeds were enough to be swallowed by the animal, seed predatory behaviour was observed on the seeds of *Dialium indum* and *Dimocarpus longan* (longan). This finding is consistent with that of Lambert (2002). It has been suggested that orangutans may be able to disperse smaller seeds further (compared with larger, spat-out seeds) because of their long retention in the gut and because they are not affected by the intestinal digestion system (Caton et al., 1999). When compared with adults, the playful juvenile orangutans caused more damage to most of the spat out seeds.

The seasonal ranging pattern and distribution of orangutans in Borneo is mostly influenced by the availability of fruits (Ancrenaz et al., 2008). Therefore availability, foraging behaviour and fruit type may be important factors in determining the success of seed dispersal in a forest. The level of seed predation seems dependent on the sizes of seeds and the age class of the orangutans.

In general, the germination trial demonstrated that most egested seeds were viable and reduced the period of time for germination. Seeds of cultivated species such as *Annona muricata* and *Lansium parasiticum* may have features (toughness, possible content of poisons) affected by the domestication process such that they may not tolerate gut enzymes. Seeds of many *Annona* spp. rapidly lose viability after removal from the fruit and scarification of seeds may also prevent germination or delay germination (George & Nissen, 1987). It is therefore not clear to what extent these results are representative of natural forest conditions.

Further study to explore the behaviour and ability of orangutans to manipulate seeds from various size classes and morphological characteristics will provide additional information to predict the seed dispersal distance and viability in the wild.

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REFERENCES

Ancrenaz, M., Marshall, A., Goossens, B., van Schaik, C., Sugardjito, J., Gumal, M. and Wich, S. 2008. *Pongo pygmaeus*. **In**: The IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>. Downloaded on 13 April 2015.

Bennett, E. L. 1998. *The Natural History of Orang-utan*. Natural History Publications, Sdn. Bhd., Borneo.

Caton, J.M., Hume, I.D., Hill, D.M. and Harper, P. 1999. Digesta retention in the gastro-intestinal tract of the orang-utan (*Pongo pygmaeus*). *Primates* **40**: 551-558.

Corlett, R.T. 2009. Seed dispersal distances and plant migration potential in tropical East Asia. *Biotropica* **41**: 592-598.

Cousens, R., Dytham, C. and Law, R. 2008. *Dispersal in Plants: a Population Perspective*. Oxford University Press, Oxford, UK.

Ehrlich, P.R. and Raven, P.H. 1964. Butterflies and plants: a study of coevolution. *Evolution* **18**: 586-608.

Futuyma, D.J. and Slatkin, M. 1983. *Coevolution*. Sinauer Associates Inc., Sunderland, Mass., USA.

George, A.P. and Nissen, R.J. 1987. Propagation of *Annona* species: a review. *Scientia Horticulture* **33**: 75-85.

Galdikas, B.M.F. 1982. Orangutans as seed dispersers at Tanjung Puting, Central Kalimantan: Implications for conservation. **In**: de Boer, L.E.M. (ed.), *The Orangutan. Its Biology and Conservation*, Dr W. Junk, The Hague, The Netherlands.

Galdikas, B.M.F. 1988. Orangutan diet, range and activity at Tanjung Puting, Central Borneo. *International Journal of Primatology* **9**(1): 1-35.

Harrison, B. 1962. *Orang-utan*. Oxford University Press, New York, USA.

Herrera, C.M. 2002. Seed dispersal by vertebrates. In: *Plant-animal Interactions: An Evolutionary Approach*, C.M. Herrera and O. Pellmyr (eds), pp. 185-208. Blackwell Publishing, Oxford, UK.

Kaplan, G. and Rogers, L.J. 2000. *The Orangutans: Their Evolution, Behavior and Future.* Perseus Publishing, Cambridge, Mass., USA.

Lambert, J.E. 2002. Exploring the link between animal frugivory and plant strategies: the case of primate fruit processing and post-dispersal seed fate. **In**: *Seed Dispersal and Frugivory: Ecology, Evolution and Conservation*, D.J. Levey, W.R. Silva and M. Galetti (eds), pp. 365-379. CABI Publishing, USA.

Payne, J. and Andau, M. 1989. *Orangutan, Malaysia's Mascot*. Berita Publication Sdn. Bhd., Borneo.

Ramos, M., Robles, A.B., and Castro, J. 2006. Efficiency of endozoochorous seed dispersal in six dry-fruited species (Cistaceae): from seed ingestion to early seedling establishment. *Plant Ecology* 185: 97-106.

Roos, C., Boonratana, R., Supriatna, J., Fellowes, J.R., Groves, C.P., Nash, S.D., Rylands, A.B. and Mittermeier, R.A., 2014. An updated taxonomy and conservation status review of Asian primates. *Asian Primates Journal* **4**(1): 2-38.

Traveset, A. 1998. Effect of seed passage through vertebrate frugivores' guts on germination: a review. *Perspectives in Plant Ecology, Evolution and Systematics* **1**(2): 151-190.

Willson, M.F. 1993. Dispersal mode, seed shadows, and colonization patterns. *Vegetatio* 107/108: 261-280.

Wrangham, R.W., Chapman, C.A., and Chapman, L.J. 1994. Seed dispersal by forest chimpanzees in Uganda. *Journal of Tropical Ecology* **10**(3): 355-368.

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A SHORT NOTE ON A FIRST DISTRIBUTION RECORD OF WHITE-CHEEKED MACAQUE *Macaca leucogenys* FROM INDIA.

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The White-cheeked Macaque *Macaca leucogenys* Li, Zhao & Fan is a newly described species of macaque from Medog County in Southeastern Tibet, China (Li et al., 2015). The species, which has been described on the basis of photographs, is distinguished from all potential sympatric macaque species, viz. *Macaca mulatta* (Zimmermann), *M. thibetana* (Milne-Edwards), *M. assamensis* (McClelland) and *M. munzala* Sinha et al., in exhibiting a suite of pelage characteristics including relatively uniform dorsal hair pattern; hairy ventral pelage; relatively hairless short tail; prominent pale to white side- and chin-whiskers, creating a white cheek and round facial appearance; dark facial skin on the muzzle and long and thick hairs on its neck (Fig. 1) and the glans penis looks like a ring (Fig. 2).

In China the species has been reported from different habitat types: tropical forest at 1,395 m, evergreen broad-leaved forest at 2000 m, as well as mixed broadleaf-conifer forest at 2,700 m. The Northeast of India, comprising the states of Assam, Arunachal Pradesh, Meghalaya, Mizoram, Tripura, Nagaland, Manipur and Sikkim, is part of the Eastern Himalayas Biodiversity Hotspot (Myers et al., 2000). The region is biogeographically unique, being located in the tri-junction of the Indo-Myanmar, Indo-Chinese and Indo-Malayan sub-regions. However, the rich floral and faunal diversity of the region is yet to be properly explored and assessed. As far as primate diversity of the region is concerned there is tremendous potential of finding species other than the identified and described

Fig. 1. The White-cheeked Macaque in Arunachal Pradesh

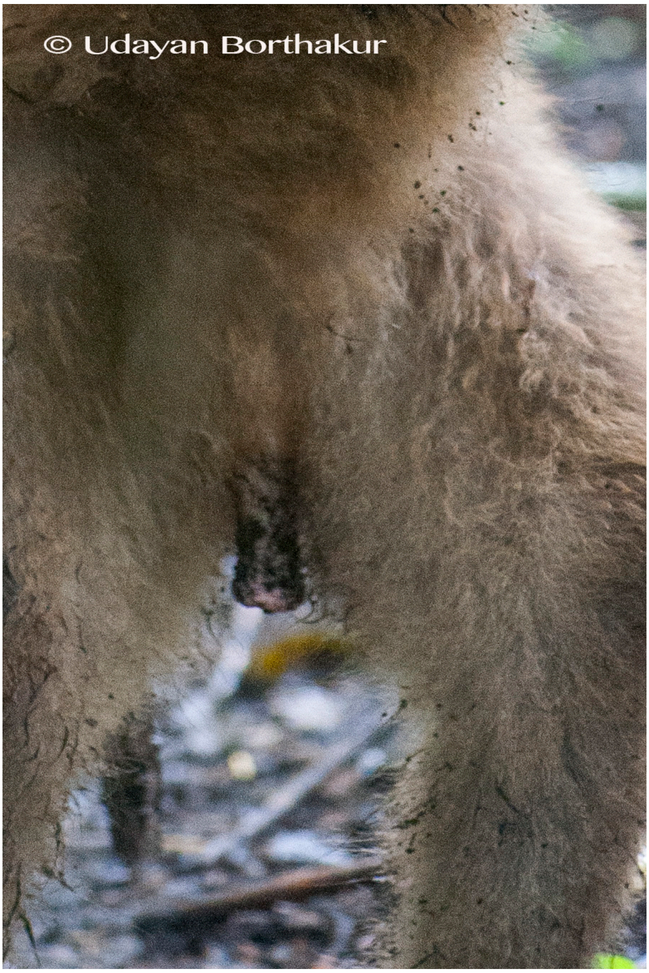

Fig. 2. Characteristic ring-like glans penis

ones. *Macaca munzala*, an entirely new species, was discovered in the state of Arunachal Pradesh just in the last decade (Sinha et al., 2005). Similarly, Das et al. (2006) and Chetry et al. (2008) reported the Eastern Hoolock Gibbon *Hoolock leuconedys* (Groves) from the region.

Here we report another new species record from Arunachal Pradesh. In March 2015, during a birding trip to the Anjaw district of Arunachal Pradesh (Fig. 3), we encountered a very shy group of macaques (approx. 20 individuals) at Hayuliang (N28° 04.776', E96° 28.117', altitude 795m). The macaques fled rapidly but we were able to take a photograph of an adult female and juvenile male. During the observation of a few seconds it seemed to us that the macaques were somewhat different from the known macaque species of the region. Therefore, upon returning from the field we concentrated on the photograph, and we found most similarities with White-cheeked Macaques. For further verification we consulted the recent literature (Biswas et al., 2011; Li et al., 2015). We also sent the photographs to Prof. Colin P. Groves, Dr Long Yongcheng, Prof. Jiang Xuelong and Dr Fan Pengfei. We also had a discussion with Chinese experts (Dr Long Yongcheng, Prof. Jiang Xuelong and Dr Li Baoguo) during the Asian Primate Red List Assessment Workshop held in Singapore from 19 to 24 November 2015. On the basis of our observations, the photographs and experts' comments, we conclude that the macaques we observed in Hayuliang are White-cheeked Macaques (*Macaca leucogenys*). Illegal hunting, and Cardamom and Jhum cultivation, are some of the threats to the wildlife in this region. We hope that finding this new macaque species enhances the prospects of biodiversity conservation in the region and give impetus for more field studies, research and conservation initiatives.

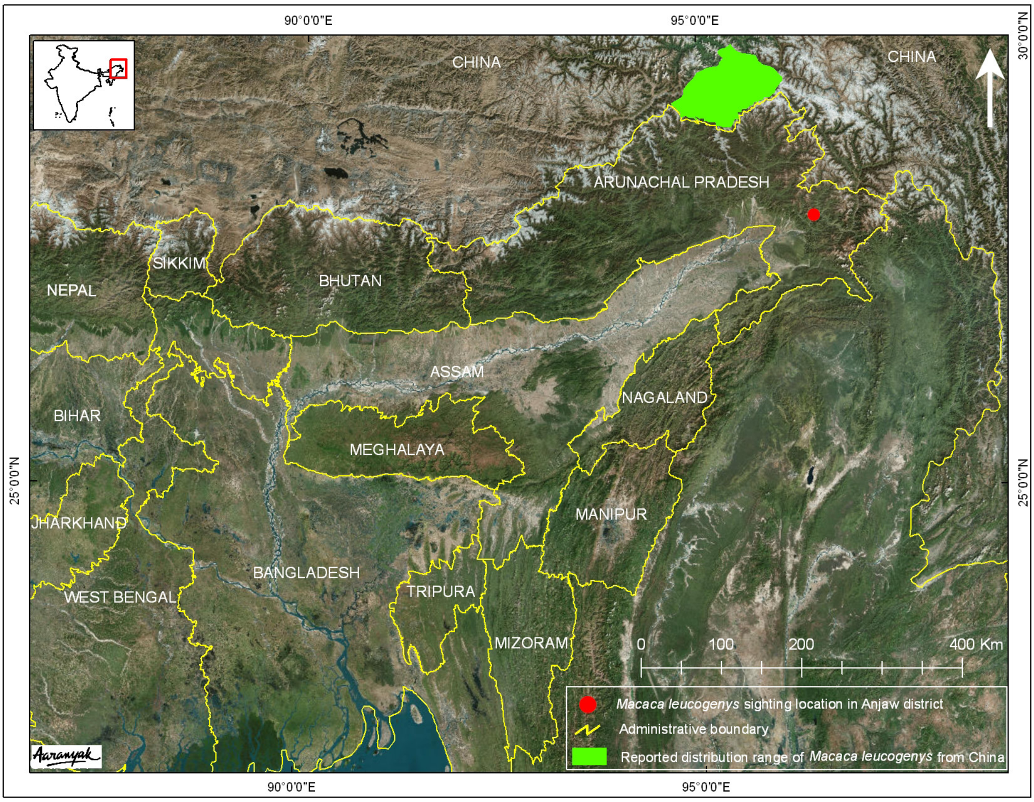

Fig. 3. Anjaw District, Arunachal Pradesh

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REFERENCES

Biswas, J., Borah, D.K., Das, A., Das, J. and Bhattacharjee, P.C. 2011. The enigmatic Arunachal macaque: its biogeography, biology and taxonomy in northeastern India. *American Journal of Primatology* **73:** 1–16.

Chetry, D., Chetry, R., Das, A., Loma, C. and Panor, J. 2008. New distribution records for *Hoolock leuconedys* in India. *Primate Conservation* **23:** 125–128.

Das, J., Biswas, J., Bhattacharjee, P.C. and Mohnot, S.M. 2006. First distribution records of the Eastern Hoolock Gibbon *Hoolock hoolock leuconedys* from India. *Zoos' Print Journal* **21:** 2316–2320.

Li, C., Zhao, C. and Fan, P.F. 2015. White-cheeked macaque (*Macaca leucogenys*): a new macaque species from Medog, Southeastern Tibet. *American Journal of Primatology* **77:** 753–766.

Myers, N., Mittermeier, R.A., Mittermeier, C.G., da-Fonseca, G.A.B., Kent, J. 2000. Biodiversity hotspots for conservation priorities. *Nature* **40:** 853–858.

Sinha, A., Datta, A., Madhusudan, M.D. and Mishra, C. 2005. *Macaca munzala*: a new species from western Arunachal Pradesh, north-eastern *India. International Journal of Primatology* **26:** 979–989.

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Hohmann, G.M. and Fruth, B. 1995. Loud calls in great apes: sex differences and social correlates. **In**: *Current Topics in Primate Vocal Communication*, E. Zimmerman, J.D. Newman and U. Juergens (eds.), pp. 161–184. Plenum Press, New York, USA.

Book

Niemitz, C. 1984. *The Biology of Tarsiers*. Gustav Fischer, Stuttgart, Germany.

Thesis/Dissertation

Barrett, E. 1984. *The Ecology of some Nocturnal, Arboreal Mammals in the Rainforests of Peninsular Malaysia.* PhD dissertation, Cambridge University, UK.

Report

Eudey, A.A. 1987. *Action Plan for Asian Primate Conservation: 1987–1991.* IUCN/SSC (Species Survival Commission) Primate Specialist Group, Gland, Switzerland.

Electronic reference

Nadler, T., Timmins, R.J. and Richardson, M. 2008. *Trachypithecus germaini.* **In**: The IUCN Red List of Threatened Species 2008: e.T39874A10278272. http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T39874A10278272.en. Accessed on 18 February 2016.

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