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Contents Gajah 27 (2007)

Editorial 1-2
Jayantha Jayewardene

Notes from the Co chairs IUCN/SSC Asian Elephant Specialist Group 3
Simon Hedges and Ajay Desai

Correspondence 4-5

Implementation of Regular Veterinary Care for Captive Sumatran Elephants 6-14
Christopher Stremme, Anhar Lubis and Mohammad Wahyu

Asian Elephants Are Loosing Their Seasonal Traditional Movement Tracks 15-26
Ritesh Joshi and Rambir Singh

Feeding Behaviour of Asian Elephants in the Northwestern Region of Sri Lanka 27-34
K. A. P. Samansiri and Devaka K. Weerakoon

Current Conservation Status and Research Progress on Asian Elephants in China 35-41
Li Zhang

Measures Adopted to Combat Migratory Elephants in South West Bengal Forests 42-47
Ajit Kumar Santra, Ashis Kumar Samanta and Subhransu Pan

A Preliminary Study of Dung Decay in the Yala National Park, Sri Lanka 48-51
Jennifer Pastorini, H. G. Nishantha and Prithiviraj Fernando

Asian Elephants in the Seima Biodiversity Conservation Area, Mondulkiri, Cambodia 52-55
Edward Pollard

Slippery Bed – An Effective Indigenous Method for Preventing Crop Damage by Elephants 56
Kannan Govindaraj

Gobal Elephant Management Program 57-60
Harald M. Schwammer

Assam Elephant Foundation – Prelude to a Solution 61
Kaushik Barua

Request for Information on Elephant Behaviour 62
Jeheskel Shoshani

Book Review: The Aisan Elephant in Captivity by F. Kurt and M. E. Garaï 63-64

News Briefs 65-67

GAJAH

Journal of the Asian Elephant Specialist Group
Number 27 (2007)

This journal is intended as a medium of communication on issues that concern the management and conservation of Asian elephants (*Elephas maximus*) both in the wild and in captivity. It is a means by which members of the AsESG and others can communicate their experiences, ideas and perceptions freely, so that the conservation of Asian elephants can benefit. All articles published in *Gajah* reflect the individual views of the authors and not necessarily that of the editorial board or the AsESG.

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Instructions for Contributors

Gajah welcomes articles on all aspects of Asian elephants, of interest to those involved in conservation, management and research on Asian elephants and the general public. Articles may include but are not limited to research findings, opinions, commentaries, anecdotal accounts and book reviews. Readers are encouraged to submit comments, opinions and criticisms of articles published in *Gajah*. Such correspondence should be a maximum of 300 words, and will be edited and published at the discretion of the editorial board.

Manuscripts should be in British English and double-spaced on A4 paper. An article may have a maximum of 5000 words.

Tables and figures should be kept to a minimum. Each needs to be on a separate page at the end of the manuscript. Legends should be typed separately (not incorporated into the figure). Use of black and white figures is encouraged to facilitate reproduction. Refer to figures and tables in the text as (Fig. X) and (Table X). Include tables and figures in the MS WORD document you submit.

References should be indicated in the text by the surnames(s) of the author(s) with the year of publication as in the example below:

(Baskaran & Desai 1996; Rajapaksha *et al*. 2004)

If the name forms part of the text, it may be cited as in the following example:

Sukumar (1989) demonstrated that…

Avoid if possible, citing references which are hard to access (e.g. reports, unpublished theses). Format citations in the 'References' section as in the following examples, writing out journal titles in full.

Baskaran, N. & Desai, A.A. (1996) Ranging behavior of the Asian elephant (*Elephas maximus*) in the Nilgiri biosphere reserve, South India. *Gajah* **15:** 41-57.

Olivier, R.C.D. (1978) *On the Ecology of the Asian Elephant*. Ph.D. thesis, University of Cambridge, Cambridge, UK.

Rajapaksha, R.C., Mendis, G.U.S.P. & Wijesinghe, C.G. (2004) Management of Pinnawela elephants in musth period. In: *Endangered Elephants, Past Present and Future*. Jayewardene, J. (ed.) Biodiversity & Elephant Conservation Trust, Colombo, Sri Lanka. pp 182-183.

Sukumar, R. (1989) *The Asian Elephant: Ecology and Management*. Cambridge University Press, Cambridge, UK.

Manuscripts should be submitted as a MS WORD file by e-mail to the editor <romalijj@eureka.lk>. If unable to do so, a hard copy can be sent to: Jayantha Jayewardene, 615/32 Rajagiriya Gardens, Nawala Road, Rajagiriya, Sri Lanka.

Deadline for submission of manuscripts for the next issue of Gajah is 31st March 2008.

Gajah 27 (2007) 1-2

Editorial

Jayantha Jayewardene

The conservation of a species necessitates the provision of all resources (habitat, security, food, water etc.) necessary to maintain a stable population into the long-term future. Conservation has two aspects; one is the protection of the species and the other, scientific management of the species and the resources necessary for its conservation. The continued existence of the Asian elephant in the wild is threatened not only by the actions of those whose interests are counter to elephant conservation, but also due to the non action or incorrect actions of those who are responsible for their conservation.

If Asian elephants are to be conserved each country needs to have a policy for elephant management and conservation. One of the first steps that have to be taken when revamping or stepping up a conservation programme is to take stock of the present situation. Therefore, obtaining baseline data on the populations in question is of critical importance. Based on such data, first one has to identify the problems facing the conservation of elephants. Then assess what the causes for those problems are, and the options that are available to address the causative factors. All too often conservation of elephants has been limited to treatment of the symptoms rather than addressing the root causes.

The behaviour and ecology of elephants may differ from country to country. Accurate data, for each country is essential if conservation efforts in those countries are to be successful. Hitherto management and conservation actions have been based on outdated beliefs handed down from earlier times. The non-availability of actual data on which to base management plans, has been a major drawback in most of the range states.

Research results are very important, because they may modify or disprove the assumptions, perceptions and beliefs that our conservation activities have been based on for a long time. They can identify and focus attention on the causes of problems rather than the obvious symptoms, which has been the main focal point of elephant conservation in most of the range states.

For instance in Sri Lanka elephant conservation has largely been driven by the need to mitigate the human-elephant conflict. Based on the belief that elephants live in forests, elephant conservation over the past few decades has focused on setting up protected areas and pushing elephants into them, where they would be safe and not come into conflict with people. Recent research in Sri Lanka has found that, the best habitat for elephants is not mature forest but disturbed or regenerating forest, which occurs almost entirely outside protected areas as a result of slash-and-burn agriculture, and that pushing elephants into protected areas by elephant drives and capture translocation does not work. Herds so driven and restricted decline and die off, while males so translocated simply do not stay. Based on these and other research results, a National Policy has been developed, which attempts to address the root causes of elephant decline and directs elephant conservation and management in a new direction. Heretofore, elephants will be managed *in situ* both in and outside protected areas, through integration of conservation and human activities that promote habitat suitability for elephants.

One of the major setbacks to the conservation of the Asian elephant, in almost all its range states, is the fact that it is the governments of those countries that have to play the major role. Given the scale of the actions that have to be undertaken to manage elephants, and the conservation politics in Asia we have necessarily

to deal with governments, if elephant conservation programs are to be effective. In the case of some governments the conservation of elephants is not a priority. Others lack the motivation, technical capacity and funds to undertake research, develop management plans, and implement them.

The need of the hour is for the Asian Elephant Specialist Group to step into fill the gap. To persuade governments to make elephant conservation a priority, to provide motivation where it is lacking, technical capacity where it is wanting, access to funding sources or canvassing for funds from international agencies where it is needed. We have to look at the scientific management and research needs of each country, prioritise them, seek sufficient funding and ensure the proper implementation of each project. A great effort by many from many places is necessary to ensure the continuance of the Asian elephant in the wilds.

The need of the hour is for all concerned to get together and make a concerted and cooperative effort to save our elephants for their longterm future. Otherwise, as is happening now, whilst we are criticizing, bickering and fighting, elephants in the wild are dying by the day. We have to get away from our lethargy and take positive action toward successful conservation. However, from a pragmatic point of view, we must realize and accept the fact that every wild elephant in most of these countries cannot be saved. If we are to conserve the species we need to focus on the issues that threaten the survival of the species and we need to proritize populations for conservation based on their conservation potential. While the welfare of individual elephants is important, we should not lose sight of the wood for the trees.

What we must strive to achieve, in our efforts at elephant conservation, is to ensure that viable populations of wild elephants will continue to flourish in adequate numbers, in different locations, that they will reproduce successfully, and that the survival of offspring would be sufficient to maintain their numbers into the future.

Two bull elephants next to the electric fence in the Udawalawe National Park, Sri Lanka (2006)
Photo by Jennifer Pastorini

Notes from the Co-chairs IUCN/SSC Asian Elephant Specialist Group

Simon Hedges and Ajay Desai

Once again we would like to begin by thanking Jayantha Jayewardene for his time and efforts as the editor of Gajah. Following the first-ever simultaneous publication of Gajah in both print and electronic (PDF) versions in June 2007, we intend that Gajah will continue to be published twice a year: in June and December. As ever, we encourage you all to submit articles for publication in Gajah as its continuing success will depend on the willingness of the AsESG's members to publish in the group's journal.

As Co-chairs, we have continued to make sure that the group's members are made aware of the funding opportunities that are available for Asian Elephant conservation projects, and to inform members about people or institutions who wish to seek help from, or work with, the group. As ever, we would be grateful if members could continue to keep us informed of such opportunities so that we can circulate them to the wider group as appropriate.

This last six month period has also seen the AsESG sponsor several Asian Elephant specialists' participation in a number of international fora. To this end we have provided travel grants for Mukti Roy to present his work on the "Use of habitat by Asian Elephants (*Elephas maximus*) in the Buxa Tiger Reserve and adjoining areas of northern west Bengal, north eastern India" at the Society for Conservation Biology's Annual Meeting in South Africa in July; as well as travel grants for Govindaraj Kannan to present his work on "Testing the efficacy of chilli-based repellents to deter crop damage by elephants in India", N. Baskaran to present his work on the "Conservation of Asian Elephants (*Elephas maximus*) in southern India: a GIS analysis of the Anamalai elephant landscape", and C Arivazhagan to present his work on the "Population structure of Asian Elephants in Kaziranga National Park, Assam, India", all at the International Elephant Research Symposium in Florida in November.

The last six months have also seen the creation of five AsESG Task Forces and one Working Group, namely the Wild Elephant and Elephant Habitat Management Task Force (co-coordinators Arnold Sitompul and Christy Williams); the Human–elephant conflict (HEC) Task Force (coordinator Ravi Corea); the Illegal Killing and Trade Task Force (coordinator Vivek Menon); the Captive Elephant Management Task Force (co-coordinators S. Wijeyamohan and Heidi Riddle); the Veterinary Task Force (co-coordinators Jacob V. Cheeran and Susan Mikota); and the Database Working Group (coordinator Simon Hedges). Creation of this working group and the task forces will, we believe, help the AsESG deliver a number of products and services including an Asian elephant database, a human–elephant conflict mitigation review, and new methods for the standardized registration of captive elephants all of which received range state government support at the Asian Elephant Range States' Meeting in 2006. We thank all those AsESG members who have volunteered their time and efforts for these endeavours and wish the whole group a happy and productive 2008 working to conserve Asia's elephants.

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Correspondence

With very great pleasure I read carefully the last issue of Gajah. Congratulation! It is really very good – *hari hari hondai!*. I read the volume word by word from the first to the last contribution. Some of the contributions I read several times. Already the cover picture is great. The 14 contributions from seven countries of origin are not too long, well readable (text and print) and cover different interests. Your "Editorial" as well as the "Notes of the Co-chairs" clarify the position of AsESG. There are highly technical articles like e.g. the "Practical Guidelines for Users of the ARGOS Satellite – Telemetry System" or the "Investigation of Asian Elephant Semen", but there are also contributions interesting for a wide public like e.g. Prithiviraj Fernando's excellent "Tsunami and Elephant 'Sixth Sense' in Sri Lanka" or the outstanding "Commentary" of Simon Hedges, concerning the recent report of Charles Siebert in the New York Times on Gay Bradshaw's PTSD – hypothesis and HEC. Every member of AsESG should be proud of the high standard of Gajah.

Of course, one finds always some reasons to grumble. I miss a consequent system of the addresses of the authors. Furthermore I miss pictures of Bets Rasmussen and Lyn de Alwis in the appreciation. But these are tiny shotcomings as compared to the contents of the present issue. Their mix is perfect and the authors and their findings and backgrounds are so diverse and so inviting for discussions that you should receive some comments from the readers. I believe it is a characteristic of a good journal when authors are allowed to publish their own opinions and the texts are stimulating readers for thinking and critical comments. Here 2 comments from my side:

Page 16: Several authors, including myself, believed so far that "bounce trunk tip on the ground" (Sukumar 2003) is a threat display. Now I can read: "Do not approach the animal until and unless the animal shows welcome response signs, which is expressed by making the grunting sound as well as by repeatedly tapping the trunk on the ground." Is "repeatedly tapping the trunk on the ground" really a "welcome response sign"?

On page 31 I read: "Reproductive technolo-gies such as artificial insemination (AI) and sperm cryptopreservation (i.e. freezing) have become high priorities for increasing reproductive success in captive elephants throughout the world." Although I admire the results on many studies on elephant reproduction in context of AI, I can hardly believe that AI and "freezing" are becoming so paramount for captive elephant reproduction throughout the world. It can be the case for North America, but already in Europe captive elephant reproduction has become increasingly successful after facilities were improved and elephants were finally considered as captive wild animals and not domesticated animals like cattle, horses or pigs (Kurt & Garai 2007). Accordingly there social and ecological environments were adapted to nature-like conditions.

In the countries of origin some populations live under nature-like conditions and breed on a regular basis. They are socially hetero-genous, live in or close to forests, and a considerable number of captive offspring have a wild father. Accordingly these populations function as gene traps, i.e. their genetic diversity is relatively high, as compared to the offspring created by AI, where suitable sperm donors are rare. I am well aware that there are many more pros and cons of AI.

Once more, I find the new Gajah just great.

Fred Kurt

Correspondence

Congratulations for this great piece: layout, collection of articles, pictures. I did not read all the articles in detail in great details but I took the time to read Jayantha's editorial and Ajay's and Simon's contributions.

I have a few comments about your editorial if I may. I found errors (date of the last meeting for example, which I attended, in 2002) and a misunderstanding of the relationship between IUCN Secretariat and SSC Specialist Groups regarding finances. There is no budget for any Specialist Group but the Secretariat can assist to secure and manage funds for the Specialist Groups and we have done this in the recent past. I found your tone very negative and was wondering why after a decision had been made to change the management of the Group, to keep Gajah alive you did not show a more positive tone and optimism.

Something happened last year which I think was a key achievement and was a strong support to the AsESG: the Range State Dialogue that IUCN (AsESG, SSC, Regional Office and Headquarters) facilitated. It could have been highlighted and was mentioned in the note from the Chairs. I found odd to have their essential note among short technical documents towards the end of the journal. Gajah is the "Journal of the Asian Elephant Specilaist Group" and I think that as such the note from the Chairs, detailing achievements, future plans and thanking Charles and Jayantha should have come in first position.

Jean-Christophe Vié
Deputy Head, Species Programme
IUCN - The World Conservation Union

A rogue makhna in Cumbum valley, Tamil Nadu, which is responsible for five human casualties and several lakhs of crop damage during his regular visit to a cashew plantation at dusk
Photo by Kannan Govindaraj

Gajah 27 (2007) 6-14

Implementation of Regular Veterinary Care for Captive Sumatran Elephants (*Elephas maximus sumatranus*)

Christopher Stremme, Anhar Lubis and Mohammad Wahyu

Veterinary Society for Sumatran Wildlife Conservation – Elephant Health Care Program
Medan, North Sumatra, Indonesia

Background

As a result of capturing elephants from the wild in order to reduce human elephant conflicts during the period between 1985 and 2000, today there are about 600 captive elephants throughout Sumatra (Lair 1997; PHKA 2006). These elephants are kept in about 320 government run Elephant Training Centres (ETC), zoos, recreation and safari parks, and timber companies. Due to a lack of funds, a lack of dedicated and experienced camp managers and veterinarians, and a lack of ideas about how to integrate captive elephants in a conservation strategy, in most locations this captive population lacks sufficient maintenance, health and welfare management, resulting in poor health conditions and losses (Lair 1997; Lewis 1998; IEF 2001; Suprayogi *at al.* 2001; PHKA 2006).

In order to improve management conditions for captive Sumatran elephants, in November 2006 the Sumatran NGO, Veterinary Society for Sumatran Wildlife Conservation (VESSWIC) started its Elephant Health Care Program (EHCP) for which it receives funding from the UK based charity, Elephant Family. The EHCP is implemented by three veterinarians, who are employed full time and who have been working in the healthcare of Sumatran elephants for more than three years prior to starting EHCP. This program aims to implement regular health care for captive Sumatran elephants. Due to funding limitations at the moment the EHCP is active with regular veterinary care only in the provinces of North Sumatra, Aceh and Lampung. Presently in other areas the EHCP can only provide veterinary support by formal request of the responsible governmental departments in special cases. All activities are conducted in cooperation with the agencies for Forest Protection and Nature Conservation on the provincial and national levels (BKSDA and PHKA).

Area of activity

VESSWIC is based in Medan, the capital of the province of North Sumatra, and from there reaches out to provide regular veterinary care to seven locations in the provinces of North Sumatra, Aceh and Lampung which manage a total of 127 elephants (see Table 1).

Table 1. List of locations where elephants are being managed and details of managed elephants.

Location	Province /District	Male	Female	Distance from Medan [km]
ETC Holiday Resort	North Sumatra/Labuhan Batu	7	13	380
Forest Park Brastagi	North Sumatra/Tongkoh	0	2	65
CRU Tangkahan	North Sumatra/Langkat	1	6	105
UPG Aras Napal	North Sumatra/Langkat	2	2	125
ETC Saree	Aceh/Aceh Besar	14	14	580
ETC Teladan	Aceh/Aceh Besar	4	1	590
ETC Way Kambas	Lampung	40	21	1600
Total numbers		68	59	

Health management

The locations listed in Table 1 in North Sumatra and Aceh are visited at least once per month to conduct regular health-checks and treatments (Fig. 1). Regular visits to ETC Way Kambas are conducted at three-month intervals. The ETC Way Kambas, in contrast to all other locations, has its own veterinarian; therefore not all veterinary work has to be conducted directly by the VESSWIC veterinarians, who focus more on providing continuing material and technical support, backing up the implementation of more structured veterinary care and preventative schemes, and support for the diagnosis and treatment of special cases. More frequent visits to all of the camps are conducted if special medical cases need more intensive attention, or an emergency response is requested.

Preventative schemes

Parasites - During every visit microscopic investigations of faeces are conducted. De-worming is undertaken at 3 to 4 month intervals with different kinds of anti-parasitic drugs (see Table 2) according to the intensity of infestation and the parasite species.

Table 2 Anti parasitic drugs

Drug	Dosage [mg/kg BW]	Route of ad–ministration
Albendazol	10 – 12	oral
Triclabendazol	7.5 – 10	oral
Ivermectin	0.1	subcutaneous or oral
Ivermectin	0.2	rectal
Niclosamid	50 – 75	oral

Tetanus - Tetanus vaccinations for all elephants were initiated at the beginning of 2006 using horse toxoid vaccines, following dosage recommendations for horses. The first vaccination is repeated after 4 weeks and after this the elephants are re-vaccinated once a year. Post vaccination serum titre evaluations are planned, and a Memorandum of Understanding between the Indonesian Veterinary Research Agency (BALITVET), the agencies for Forest Protection and Nature Conservation (PHKA) and VESSWIC is underway.

Nutrition - In the ETC Holiday resort the availability of natural fodder is very poor due to the encroachment of the ETC area by oil palm plantations, and the supplemented food is monotonous, therefore it seems obvious that the diet in this location is lacking energy, minerals and vitamins. To improve the nutrition in this location a special high energy supplement containing minerals and vitamins is cooked (composition listed in Table 3).

Table 3 Elephant diet supplement

Item	Amount per elephant
Rice	2 kg*
Sticky rice	1 kg*
Corn	1 kg*
Palm sugar	1 kg
Vitamin-mineral powder	60 g

*weight before boiling

This supplement is provided once a week for all elephants and three times per week for nursing mothers. In addition, during every visit in all locations about 50 bundles of bananas and 5 pineapples or papayas are provided per elephant.

Figure 1. Training for local vets and vet technicians during a field visit.

Table 4 Commonly used drugs

Drug	Dosage	Treatment intervals
Povidone-Iodine 1% and 10%	Ad libitum / local	Twice a day
Peroxide 2,5%	Ad libitum / local	Twice a day
Povidone-Iodine ointment	Ad libitum / local	Twice a day
Penicillin-Streptomycin 200.000 IU – 200 mg/ml	10.000 IU – 10 mg/kg BW / i.m.	At 24 h intervals for 7 days
Amoxicillin LA 150 mg/ml	12 mg/kg BW / i.m.	At 48 h intervals for 7 days
Oxytetracyclin LA 200 mg/ml	12 mg/kg BW / i.m.	At 72 h intervals for 7 days
Ibuprofen 400 mg/tablet	5 mg/kg BW / p.o.	Twice a day for 5-10 days
Etamidon (NSAP drug combination)	5 ml/100 kg BW / i.m.	At 24 h intervals for 3-7 days
Dichlofention (Gusanex Spray)	Ad libitum / local	Twice a day

Body-condition monitoring – Body measurements are taken twice a year and the body condition evaluated with standardised body condition formula and recorded, to document the general health and nutritional condition of all elephants.

Unfortunately regular blood samples of all elephants cannot be analysed yet due to budget limitations, therefore blood analyses are only used as a diagnostic tool in elephants showing some signs of illness.

Treatment of diseases and disorder

The most frequent disease and disorders that the VESSWIC veterinarians have documented and which needed intervention in captive Sumatran elephants during the past years were: wounds, endo- and ecto-parasites, foot diseases, keratoconjunctivitis, stereotype behaviour and malnutrition

Wounds – Fights between elephants left unattended or chained close to wild elephant habitat, sharp foreign bodies from items such as old nails, sharp metal or glass debris thrown away in the surroundings, and improper use of management and restraint tools such as ropes, chains, elephant hooks, and unhygienic handling of darting equipment during the capture of wild elephants often cause serious wounds and abscesses needing treatment (Mikota *et al.* 2003). If treatment is administered immediately after the occurrence, usually the wounds are simple to treat and heal easily. Besides washing the wound with clean water, it is flushed with antiseptic solutions, deeper wounds or abscesses are also stuffed with antibiotic tablets, and large superficial wounds are covered with antiseptic ointment. Whichever drugs are used for wound cleaning and disinfections, the most important issue is to continue the treatment twice a day until the wound is healed, usually about 10 days to 6 weeks. If wounds are not immediately noted or regarded as serious and reported to the veterinarian by the mahout, delayed treatment can cause complications like swellings, myasis (maggot infestation) and generalized infections, needing more intensive and longer lasting treatment with systemic antibiotics and NSAPs (see drugs listed in Table 4). Handling and management advice to mahouts and camp managers about the above mentioned wound-causing reasons reduce their occurrence.

Parasites - Regular microscopic investigations (Fig. 2) of faeces (flotation and sedimentation) detected that different roundworms species (*Strongyloides sp., Strongylidae Ascaridae*) and Trematodes (*Fasciola sp., Paramphistomidae*) are the most frequent endo-parasites, and macroscopically elephant lice (*Haematomyces elephantis*) were detected to be the most frequent ecto-parasite. Permanent burdens for most elephants are different blood sucking flies. Whether these flies transmit other diseases (bacterial and/or protozoan) has not been investigated and would need further research.

Figure 2. Microscopic investigations.

Foot diseases – The most frequent foot disease needing treatment was Podo-dermatitis, injuries of the footpad (Fig. 3), improper wear of the foot-pad resulting in double layers and potential infections between these layers, caused by unhygienic and permanently wet areas where the elephants are kept. Cracked toenails due to overgrown nails were rarely found and rarely required treatment. For treatment of Pododermatitis, the foot is washed with water and affected areas flushed with disinfectant solutions, overgrown toenails and footpad layers are trimmed down to the extent possible. Overgrown tissue of collagen fibre from deeper layers is trimmed to its physiological layers until blood vessels appear. All infected and necrotic material is removed. Bordering areas of overgrown collagen fibre and epidermis are trimmed to the area where the connection between epidermis and corium appears. This is repeated regularly (about every 2-3 weeks) until recovery, because the connective tissue from the corium and digital cushion grows faster than the epidermis and hinders complete healing if not trimmed. Trimmed areas are treated with antiseptic and astringent solutions, like Kaliumpermanganat 1 - 2%, Coppersulfate 3%, and Formalin 5%. Treatments are done twice a day for several weeks until completely healed. Advice about regular checks of toenails and foot-pad, conducting pedicures and promoting awareness amongst the camp staff about general hygienic management of the elephant stabling areas have reduced cases of Pododermatitis.

Keratoconjunctivitis – This problem is often found and is characterized by increased tears, inflammation of mucous membranes, slightly milky discolored cornea and appearance of milky, opaque spots on the cornea. Dusty, dry and hot surroundings often cause this disorder, but it seems that often bacterial infection, suspected to be transmitted by flies, can be the main reason for this disorder or at least complicate a climate induced keratoconjunctivitis. In some cases healing can happen without any treatment and the first minor signs must not necessarily be treated immediately but the condition of the surroundings should be improved. If increased signs of this illness are not treated it can lead to corneal ulcers, total blindness and total loss of the eye. For local treatment with antibiotic eye-ointment chloramphenicol ointment was found to be most effective. When using eye-ointment it is crucial to repeat the treatment several times a day (at least 3 times a day or more often) to be effective. If local treatment cannot be administered reliably (due to the unreliability of mahouts or reduced acceptance of the elephant) systemic treatment can be given. Oxytetracyclin LA 12 /kg i.m. repeated four times in 72 hour intervals was found to be effective.

Figure 3. Footpad injury.

Stereotype behaviour - In all locations visited some elephants were found that exhibited stereotype behaviour, often weaving. This can be described as permanent repetition of the same movements in the same rhythm without attaining a specific result. This is usually caused by stress and boredom due to a lack of occupation or social contacts and interaction.

Although a sufficient number of elephants of both gender and various ages are managed in all camps, the animals are managed in a way that they stay alone more than 90% of the day. During the day the elephants are brought to areas where they are chained for foraging, and in the evening (sometimes also in the morning) taken for a bath then chained with their supplemental fodder somewhere near the campsite. Although often the elephants can hear and sometimes can see each other, they cannot have direct contact with each other. Usually the elephants only have regular direct contact with each other during bathing and then the elephants still need to be under the command of their mahouts and can not freely socialise with each other. In none of the camps is time regularly given to the elephants for free roaming and socialisation. In almost all camps visited the regular workloads and occupation for the elephants are very low or nonexistent. This management structure leaves the elephants unoccupied and bored after they have eaten their food as they are unable to interact socially due to their restriction.

Unfortunately knowledge about elephant behaviour and mental wellbeing is very low amongst the camp staff; therefore stereotype behaviour is not recognized as a problem that needs to be addressed. Education about elephant behaviour and different management systems are crucial to build awareness amongst mahouts and camp managers about the mental wellbeing of elephants. Improvements happen slowly and depend on the long-term continuation of regular education and advice about this subject.

Figure 4. Baby elephant getting food supplements.

Malnutrition – Beside the visual appearance of unnatural bony and skinny body condition, values of total blood protein is used to determine malnutrition. Adult animals with a total blood protein below 7.0 g/dl (mean standard for blood protein: 7.9 – 8.4 g/dl and standard deviations are: 0.6 – 0.8 g) are regarded as suffering from malnutrition (ISIS 2002).

In all locations with more than ten individuals, some elephants were found to be suffering from malnutrition. Besides a general lack of food availability, this problem is often related to management and handling insufficiencies such as the following:

- Available resources for supplementary fodder are not used sufficiently, e.g. lacking in quality and variability, or amounts not equally distributed.
- Natural food resources in and around the camp are not sufficiently utilized.
- Elephants are not moved often enough from the places where they are tethered.
- In the past no regular de-wormings (if at all) were conducted, therefore a very high infestation with endo-parasites exists.

For treating malnutrition it is crucial to somehow influence the above mentioned management weaknesses, to raise awareness about this amongst the camp staff and to

mprove utilisation of existing resources. Regular anti-parasitic treatments have been implemented (see above) since the EHCP started and contribute to the reduction of malnutrition. It appears that animals suffering from chronic malnutrition exhibit physical weakness and sometimes show signs of mental depression leading to a lack of interest in intensively and actively searching for food, as well as reduced appetite to consume available food, which might be less tasty. Providing Vitamin injections, high-energy food supplements and sweet fruits usually help overcome this condition (Fig. 4).

Other less frequent diseases

The above described diseases represent not all but only the most frequent diseases and disorders needing medical intervention in Sumatra. Beside these there are also single cases of gastrointestinal diseases (colic, constipation, diarrhea), tetanus infections, sunburns, navel infections, tail bites followed by amputation, hyperkeratosis, dermatitis, *E. coli* infection, etc. needing treatment during the past years (Fig. 5).

EEHV and TB – Infections with the Elephant Endotheliotropic Herpes Virus and Tuberculosis (TB) caused by *Mycobacterium tuberculosis* have been reported during the past years by colleagues working with captive elephant populations in other countries (Binkley 1997, Dunker & Rudovsky 1998, Richman *et al.* 2000, Fickel *et al.* 2001, Fowler 2006, Mikota 2006, Montali *et al.* 2001). These diseases, which are considered to be able to badly affect captive populations, have so far not been reported in Sumatran elephants. But this absence of evidence is just the result of a lack of any investigations or research about these two important diseases in Sumatran elephants and should not be misunderstood as evidence of the lack of these diseases in the Sumatran elephant population.

Figure 5. Tetanus infected elephant receives I.V and rectal fluid therapy.

Unfortunately, it is not unlikely that Sumatran elephants are also affected by TB and/or EEHV. Indonesia ranks third in the list of 22 high burden tuberculosis countries, having more than 530,000 new human infections and more than 91,000 people dying from tuberculosis in 2005 (WHO 2007). Therefore it is not impossible that TB might occur amongst mahouts and due to daily close contact between mahouts and their elephants it might be transmitted to elephants.

During the past years the VESSWIC-EHCP veterinarians have found three young elephants (age below 6 years) with wart like skin lesions, two adult elephants with small round lesions in the mouth mucosa, and post-mortem findings in one two-year-old pre-mortem healthy looking elephant calf that suddenly died, that looked very similar to findings described from other authors in elephants that were confirmed positive for EEHV. Of course these findings do not confirm existence of EEHV in Sumatran elephants and could also be caused by other diseases, but it seems sensible during the next years to establish sufficient cooperation between responsible governmental agencies and international and national institutions, organizations and specialist groups to conduct research regarding these two diseases amongst Sumatran elephant populations.

Staff training

To successfully conduct veterinary work good cooperation between camp staff (mahouts, veterinary technicians and camp managers) and the VESSWIC-EHCP veterinarians is crucial. Therefore amongst the camp staff a good understanding about elephant biology, behaviour, welfare needs, and how proper healthcare management contributes to this is important. The camp staff's willingness to cooperate with the VESSWIC-EHCP veterinarians depends very much on trust and belief in the veterinarians' work and recommendations for improvements and modifications of established management structures and/or handling procedures. This trust did not automatically exist at the beginning of the VESSWIC-EHCP work, but was built due to reliable and regular visits. It was also possible because the VESSWIC-EHCP team not only provides pure veterinary care but during every visit also conducts some training and/or information sessions for the camp staff.

Mahouts – No structured education and training scheme exists for the mahouts in Sumatra. Once people are recruited for the job of mahout they have to try to learn somehow from the more senior mahouts in the camps how to handle and train elephants. Although after some time many mahouts develop reasonable to good skills of handling the individual elephant they are in charge of, knowledge about elephant biology, behaviour, different management and handling systems, basic knowledge about health care and medical procedures and treatments is very limited. The VESSWIC-EHCP team tries to address this issue by training sessions using slide shows, video films and practical demonstrations about the following subjects:

- Elephant biology and behaviour
- Basic elephant anatomy and physiology
- Prevention and treatment of basic medical problems
- Different elephant handling, training and restraint techniques
- Training elephants for medical procedures (e.g. foot care, mouth inspection, blood sampling, rectal intervention, treatments)

Veterinary technicians – the local "paramedics" have undergone basic education in a government or government licensed school about the basics of veterinary management, disease and treatments. But this education focuses on livestock and does not include any special elephant related training. Often this occurred a long time ago and, as there is no continuing education and often only few if any medical supplies exist in the camps, much of the previously gained knowledge has been forgotten. The VESSWIC team tries to address this issue by training sessions using slide shows, video films and practical demonstrations about the following subjects:

- Elephant anatomy and physiology
- Elephant diseases
- Obtaining samples and analyses

- Treatment schemes and drug dosages
- Record keeping
- Elephant handling and management
- Waste management/camp hygiene

Local veterinarians – Only a few of the government departments in charge of elephants have their own veterinarians. However, even when they do, none of them stay in the camp permanently and for the most part they have more administrative than veterinary duties. Nevertheless the VESSWIC-EHCP veterinarians try to involve these colleagues, as well as interested local colleagues, as much as possible in the veterinary work. Veterinarians from other areas in Sumatra have been invited and have volunteered with the VESSWIC-EHCP team in the past. Beside this, the VESSWIC-EHCP team has presented its work for elephants in national veterinary meetings and workshops to raise awareness amongst local colleagues about the veterinary needs and problems of elephants in Indonesia.

Veterinary student education – VESSWIC-EHCP veterinarians have been invited as guest lecturers by the veterinary faculties of the universities in Banda Aceh and Bogor to lecture about elephant diseases and health management. Currently VESSWIC-EHCP has started to involve veterinary students from the veterinary faculty in Bogor as volunteers in the fieldwork to gain hands on experience in elephant health management. As VESSWIC has received a request from the Veterinary faculty in Bogor to conduct more regular lectures and courses about elephant health care, VESSWIC is now seeking the necessary resources to design and implement a structured student training course about veterinary management of elephants, more intensively involving students in field work.

Mahout welfare

Salaries of the mahouts are very low, and living conditions in the camps are mostly very basic and monotonous, not providing many possibilities for recreation and information exchange. The possibility for the VESSWIC-EHCP to assist with these conditions is very limited due to budget considerations, but with some basic support tries to attain improvements for the camp staff with the following activities.

Mahout uniforms – Every year a basic uniform set consisting of trousers, shirt, etc. for each mahout in the 7 locations is provided.

Social networking and information meetings – During these meetings newspapers are distributed, information about situations/ problems in other elephant camps (elephant and non elephant issues) and other actual news from Sumatra is exchanged and discussed. Snacks, drinks and cigarettes are provided during these informal meetings, which are attended not only by the mahouts but by their whole families.

Incentives – Small stipends are paid as a type of reward to mahouts who have performed extraordinary care for their elephants requiring increased work loads for the mahout, such as reliably and successfully continuing treatments advised by the veterinarians, providing intensive care for mothers and new born calves during the first weeks after birth, successfully training the elephant for special medical procedures, etc.

Conclusion

The captive population of the Sumatran elephant (*E. m. sumatranus*) today represents approximately 20% of the overall population of this subspecies. If carefully managed this genetically valuable population can play an important role for the conservation of this unique subspecies by focusing on conservation and self-sustainability. The experience of the VESSWIC-EHCP activities show that there is a chance to implement sufficient veterinary care, and that changes in handling and management can be accomplished for these captive elephants if support is long term, focused and conducted in close cooperation with camp staff and government agencies in charge.

For the future the VESSWIC-EHCP team hopes to be able to intensify its activities in the current areas of the project and enlarge such support to camps in other areas in Sumatra. The VESSWIC-EHCP team also hopes to accomplish a more intense knowledge exchange with other

colleagues in Indonesia about elephant veterinary care, and conduct courses for students on this subject in order to increase the number of colleagues able and willing to provide veterinary care for Sumatran elephants.

References

Binkley, M. (1997) Tuberculosis in captive elephants. *Proc. Amer. Assoc. Zoo Vet*. Huston, Texas. pp. 116-119.

Dunker, F. & Rudovsky, M. (1998) Management and treatment of a Myco-bacterium Tuberculosis positive elephant at the San Francisco Zoo. *Proc. Amer. Assoc. Zoo Vet.* pp. 122-123.

Fickel, J., Richman, L.K., Montali, R., Schaftenaar, W., Göritz, F., Hildebrandt, T.B. & Pitra, C. (2001) A variant of the endotheliotropic herpesvirus in Asian (*Elephas maximus*) in European zoos. *Veterinary Microbiol*ogy **82:** 103-109.

Fowler, M. (2006) Important viral diseases. In: *Biology, Medicine and Surgery of Elephants.* Fowler, M. & Mikota, S. (eds,) Blackell Publishing, Ames, Iowa. pp 132-133.

IEF (2001) *Support for the Improved Health and Health Care Management of Captive Populations of Sumatran Asian Elephants*. Final Report.

ISIS (2002) www.isis.org. Apple Valley, USA.

Lair, R. (1997) *Gone Astray, the Care and Management of the Asian Elephant in Domesticity*. FAO/ROP, Bangkok.

Lewis, J. (1998) *A Veterinary Assessment of Sumatran Elephant Training Centres*. Fauna and Flora International, Cambridge.

Mikota, S. (2006) Important bacterial diseases. In: *Biology, Medicine and Surgery of Elephants.* Fowler, M. & Mikota, S. (eds.) Blackwell Publishing, Ames, Iowa. pp 138-140.

Mikota, S., Hammat, H., Finnegan, M. (2003) Occurrence and prevention of capture wounds in Sumatran elephants. *Proc. Amer. Assoc. Zoo Vet.* pp 291-293.

Montali, R., Richman, L., Mikota, S., Schmitt, D., Larsen, R., Hildebrandt, T., Isaza, R. & Lindsay, W. (2001) Management aspects of Herpesvirus infections and Tuberculosis in elephants. In: *A Research Update on Elephants and Rhinos*. Proceedings of the International Elephant and Rhino Research Symposium, Vienna, 7-11 June 2001. pp 83-95.

PHKA (2006) *Asian Elephant Conservation in Indonesia.* Country Report Progress 2004-2006 for Asian Range State Meeting in Kuala Lumpur, 24-26 January 2006.

Richman, L.K., Montali, R.J., Cambre, R.C., Schmitt, D., Hardy, D., Hildebrandt, T., Bengis, R.G., Hamzeh, F.M., Shahkolahi, A. & Hayward, G.S. (2000) Clinical and pathological findings of a newly recognized disease of elephants caused by endotheliotropic herpesvirus. *Journal of Wildlife Diseases* **36:** 1-12.

Suprayogi, B., Sugardjito, J. & Lilley, R. (2001) Management of the Sumatran elephants in Indonesia: Problems and challenges. In: *Proceedings of the International Workshop on the Domesticated Asian Elephant.* Bangkok. pp 183-193.

WHO (2007) *Country profile Indonesia 2005.* http://www.who.int/GlobalAtlas/predefinedReports/TB/PDF_Files/idn.pdf.

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Asian Elephants are Losing Their Seasonal Traditional Movement Tracks: A Decade of Study in and Around the Rajaji National Park, India

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Introduction

Rajaji National Park (RNP) was notified in 1983 by amalgamating three erstwhile wildlife sanctuaries namely, Rajaji, Chilla and Motichur. The park is a prime habitat of Asian elephants and is the northwestern most limit of distribution of Asian elephants and tiger in the Indian subcontinent. The Shivalik foothills are one of the world's most spectacular landscapes, encompassing the tall grasslands and the *Shorea robusta* (Sal) forests. This entire belt is the natural home of Asian elephants (*Elephas maximus*) besides many other mega wild animals like tiger, leopard, spotted deer, sloth bear etc. The Ministry of Environment and Forests, Government of India has declared this area as an Elephant Reserve (RNP) with the sole aim of conserving Asian elephants in their natural habitat.

The Shivalik landscape is one of the last few places in the world where Asian elephants exist, hence is in urgent need for conservation. This protected area (PA) in India's lesser Himalayan region falls under sub tropical moist deciduous forest type with extensive stands of *Shorea robusta* (Sal), *Mallotus phillipinensis* (Rohini), *Acacia catechu* (Khair), *Adina cordifolia* (Haldu), *Terminalia bellirica* (Bahera), *Ficus bengalensis* (Bar), *Dalbergia sissoo* (Shisham) etc. besides many other important fodder plant species. From tourism point of view it appears to be one of the most successful National Parks in India and its development has helped boost the economy of Uttarakhand State, which lies in the Lesser Himalayan region. However, presently many of the traditional routes are denied to elephants, which are replaced by industrial area, human settlements and road network etc.

Since Independence, forests were cleared and felled and bought under the plough on a large scale. Construction of projects of public utility, for hydrel, irrigation, roads etc. entailed deforestation of large tracts and colonisation brought in its wake have resulted in significant shrinkage in the habitat of wild animals (Singh 1969). Presently, elephant habitats are destroyed by various developmental activities or for human needs. Shrinkage of habitat has forced competition among the same species for the food, shelter and other basic requirements.

The status of the elephant in the adjoining countries is equally poor. Nepal, which has the lowest country population, has lost over 80% of its elephant habitat on account of human settlement. Bangladesh, Myanmar, Cambodia, Vietnam, Laos and Sri Lanka etc. are also rapidly losing natural forest cover, specially the elephant habitats. In Thailand in spite of the elephant having been a protected species since the 18th century, over exploitation of the habitat and the pressure of human population has made the species highly vulnerable (Daniel 1996). The present study is a part of our long-term study on the behavioural biology of Asian elephant in and around the RNP area.

Study area

Rajaji National Park [$29^0$15' to $30^0$31' North Latitude, $77^0$52' to $78^0$22' East Longitude] is spread over an area of 820.42 km^2 in and around the Shivalik foothills, which lies in the Lesser Himalayas and the upper Gangetic plains (Fig. 1). Spread across Hardwar, Dehradun and Pauri districts of Uttarakhand state, Rajaji National Park has been designated as a reserve area for the "Project Elephant" by the Ministry of Environment and Forests, Government of India

with the sole aim of maintaining a viable population of Asian elephants in their natural habitat. The Shivalik hills offer the most prominent geomorphic features of this tract. The river Ganges has cut across these hills at Hardwar. The Chilla forest area of the Rajaji National Park lies to the East of the river Ganges and is attached by the Garhwal Forest Division. The study is ongoing in Hardwar (District-Hardwar), Chilla (District-Pauri) and Motichur (District-Dehradun) forest ranges of the RNP. The altitude lies between 302 - 1000 m asl.

Methods

For studying the movement pattern of elephant three forest ranges were selected and surveyed in-depth for about 10 years. The traditional movement tracks along with feeding grounds of elephants were searched and observed and plotted on a map. Different forest blocks of concerned forest ranges were chosen one after another sequentially and searched for elephants for about 10 – 12 h (depending upon weather conditions) in a single day search. The observations started at early hours in the morning being the best time to search and observe the elephant in open areas and four hours in the afternoon i.e. before the sunset. Field binocular was also used for observing their movement behaviour without disturbing the animal from an adequate safe distance.

The data collected is part of the animal monitoring activities. The daily record is based on direct sighting of animals, indirect evidences like feeding sign and footprints (Santiapillai & Suprahman 1986; Ramakrishanan *et al.* 1991; Dawson & Dekker 1992). The direct sightings were noted in duly prepared proformas, recording the group composition, age and sex, if observed in groups and also the place of sighting, time and vegetation type.

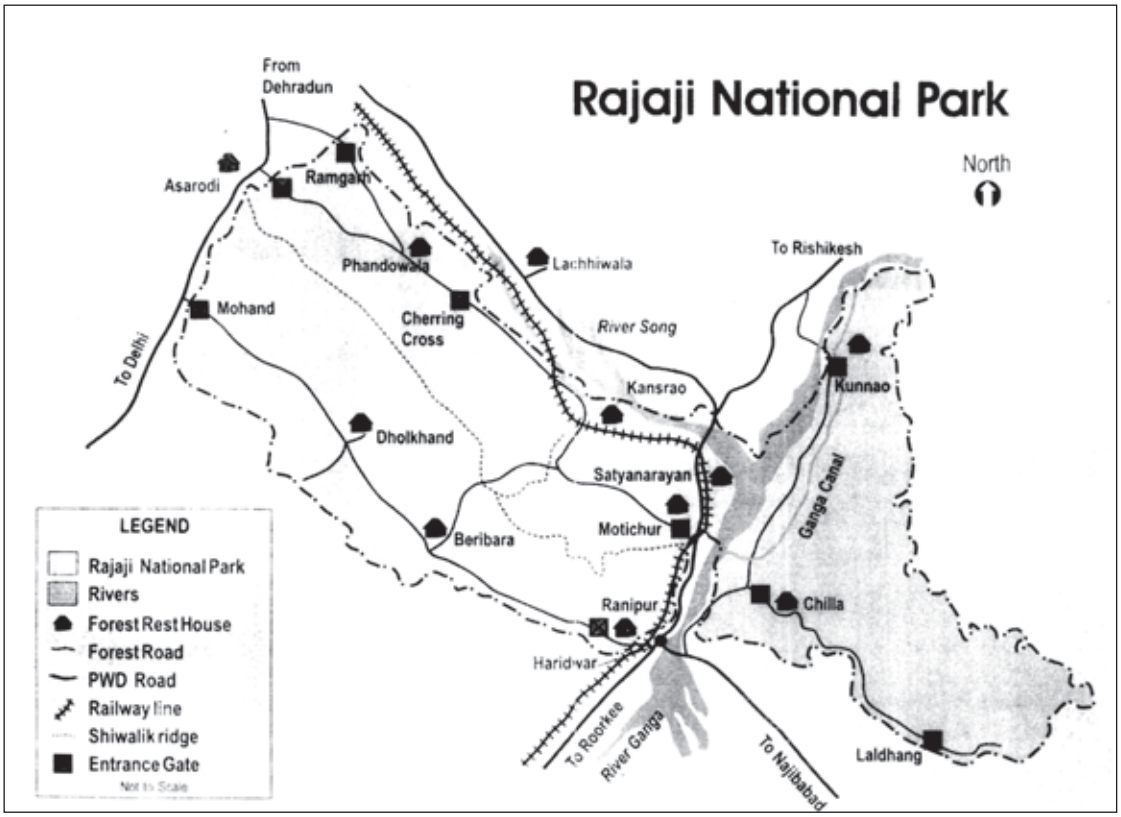

Figure 1. Map of the study area.

Besides, villagers of adjoining areas, Gujjars (where available), staff of Forest Department, the researchers from various scientific institutions and non-government organizations and other individuals working on this problem, were interviewed.

Identification of the elephants is important to verify their movement as in the same area there is a possibility that the same group was observed in the different forest beats so, for each individual bearing distinctive features, identification marks were noted like shape of the ears, tusk size and shape, scars and tubercles on the body, tail length, total number of individuals (all ages separately), body mass and nature of group or solitary bull.

Results and discussion

Movement is one of the most important ecological factors that represent the home range as well as habitat utilization of an animal. Both movement and migration depends upon the availability of natural food and water. Changes in season and scarcity of water and natural fodder species force wild animals to leave a place for a few months and reach new feeding grounds for fulfilling their feeding, water and other routine requirements. There are seasonal variations in fodder species as RNP area falls under sub-tropical moist deciduous forest vegetation type. Elephants use the whole of the park area as their natural habitat but mostly they leave some of the areas having less vegetation cover and water for a few months and move towards other ranges richer in fodder species and natural water. Although at that time a few of them (mostly solitary bulls) use the same feeding grounds or move frequently in all the forest beats of the park as a general rule of migration of any species. Selected range wise movement pattern of the elephants is described below.

Hardwar forest range

With the onset of winter from the month of mid-October, when there is slight scarcity of fodder species elephants move towards the Dholkhand forest range, which is situated towards south-west/north and towards Kansrao forest range, situated south-east / north through crossing Motichur forest range. Study revealed that elephants move from Hardwar forest range to the adjoining ranges on the arrival of winter and also at the onset of summer period especially from the month of March to June, which are also known as the forest fire months. But the movements of a few of the solitary bulls and occasionally groups (very rare) have been observed in whole of the range. Most of these movements are obviously being restricted by various villages, temples, railway tracks etc. that are present in the vicinity or inside the park area. Hardwar forest range is partially covered on one side by villages (Nai Basti-Bhimgoda, Lodha Mandi, Ravli-Mehdood, Roshnabad, Aehtampur Aanaeki and Aurangabad), therefore, instances of man-elephant conflicts are relatively more in this area, than in other ranges. These conflicts may be in any form viz. crop raiding, manslaughter etc. Dudhia forest beat due to its closeness to the Haripur Kala village and river Ganges is one of the most sensitive areas as far as elephant casualty is concerned.

During the study period, occasionally the movement of solo bulls was observed in this part of the park. Despite the fact that Dudhia area is rich in *Dalbergia sissoo* (Shisham) and *Acacia catechu* (Khair) forest, being the preferred food item of elephants. Group movement is restricted in this forest pocket due to the high level of anthropogenic and developmental activities. Generally, the solo adult bulls follow the city route to reach the Dudhia forest and river Ganges by crossing the railway track and Hardwar–Dehradun National Highway (Fig. 2). They enter the city from northern Kharkhari forest beat and move towards Chilla area after the sun set and re-enter the northern Kharkhari forest beat before dawn. During this long journey of about 2 km elephants crossed many of the minor routes along with various colonies. Besides, solo bulls from Chilla forest also enter this forest beat after passing through the island in between the river Ganges. This track falls under Chilla – Motichur corridor and is one of the important habitats as far as the elephants' conservation is concerned.

During field observations it came to our notice that, this pocket of the area is very sensitive for

the movement of the elephant mainly due to huge scale anthropogenic activities. During 1999 to 2002 few cottages have been constructed in this area inhabited by about two dozens of sadhus and likes. On the other hand this pocket has been part of the traditional route for the elephants to interchange the forest. Due to rapid development and construction activities in Haripur Kala village situated peripheral to the island and in adjoining areas; the elephant movements have been disturbed. The residents of the area inferred that seven years ago an adult tusker was killed by electrocution by a villager. However, no human casualty has been reported till now.

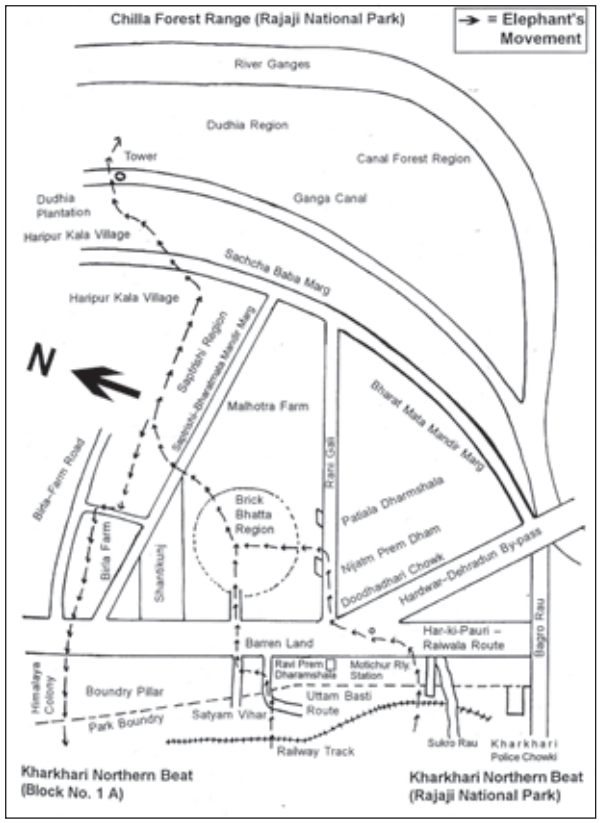

Figure 2. Range used by elephants outside the park area from Kharkhari forest beat to Dudhia forest beat of Hardwar forest range (before 2002).

Chilla forest range

Elephants use this forest range round the year because of altitude wise variation of rich fodder species. On the arrival of winter elephant's movement is towards lower areas like Chilla, Mundal and Khara forest beats. At the same time elephants also utilize the adjoining forest of river Ganga, which spreads up to Rishikesh along the river. On the arrival of rainy season they migrate towards upper areas like Luni, Pulani, Rawasan and Kasaan forest beats and this is the time when elephants start their long term migration towards Garhwal forest division. Many of the groups and solitary bulls use all of the forest beats for their local movement. During the summer elephants also use the Gohri forest range, which is in the north of the Chilla forest range, to fulfill their various routine requirements.

A large mammal like the elephant could be expected to cover considerable distances even within a short period, and families of a clan seem broadly coordinated in their seasonal movements (Sukumar 1989). In the dry months i.e. from January to April, when no rainfall occurs, the groups seek the neighbourhood of streams and shady forests. From the month of July, after the first showers, they start roaming and feed on the fresh grass. This grass in hill tracts becomes long and coarse by July and August, and the elephants then show upward movements. The reason for the elephants and other animal's migration in to the high land continuous and uninterrupted hilly terrain, is for grazing, assured food, ideal breeding grounds and thick population (Sinha 1981).

Elephants also use the Ghasiram and Mundal water streams for visiting river Ganges especially when their local movement is frequent in and adjoining forest beats, which are attached to river Ganges along with few bridges, which are in Ganga canal of Chilla hydro electric power plant (Fig. 3). Few of the groups were also reported to use the Shyampur and Chiriapur forest ranges of Hardwar forest division during rainy season as east Ganga canal is in full flow during this period. At the same place elephants move towards river Ganges through crossing the Hardwar-Bijnor National highway. It is interesting to mention here that currently only bull elephants cross this track and no groups were reported during the last 2 years. In the past 4-5 years elephant groups were reported in the same area but rapid developmental activities have restricted the frequent movement of elephant groups towards river Ganga in this part.

During the last 4-5 years, the State Government has constructed about four flyovers on Hardwar – Bijnor National Highway. As a result of anthropogenic activities, about 18 km of forest existing on both sides of the highway has got disturbed. Besides, agricultural expansion near river Ganges has lead to the loss of forest, which has also hindered the traditional movement of elephants. This forest stretch is one of the major corridors for elephant movement and presently has got disturbed due to habitat loss around the national highway. Sometimes a few of the male elephants associate to enter the forest near river Ganges through this route.

Elephants cross the National Highway in the evening hours and come back to the forest area in early morning hours. Besides, elephants also utilize the Gaziwali bridge, Shyampurwali bridge and Pili bridge situated peripheral to the canal road in Ganga canal for their outside movement and to feed on the cultivated crops in nearby villages. During the study period all the villages suffering from crop raiding have been investigated. The affected villages are Jagjeetpur, Mishrpur, Panjneri, Ajeetpur and Jaipota in the western side of the conservation area and all these villages are situated peripheral to river Ganges. Villages Kangri, Ghaziwali, Shyampur, Sajanpura, Pili and Rasiabad are located peripheral to the forest area and National Highway whereas villages Gaindikhata, Lahadpur, Chiriapur, Vasuchandpur and Naurangabad are also situated adjacent to the forest area and National Highway south west of the conservation area.

The villages along the river Ganges are situated on land that was once part of the elephant's home range. Therefore, the increasing elephant – man conflict is unfortunate but inevitable. The electric fence erected along with these villages and river Ganges has presently got damaged due to lack of proper maintenance. It was observed that elephants are utilizing their traditional feeding grounds in few of these areas, which are . presently denied to them and are replaced by human settlements

Figure 3. Ghasiram water stream - one of the oldest natural corridors for elephant movement in between Chilla-Motichur area.

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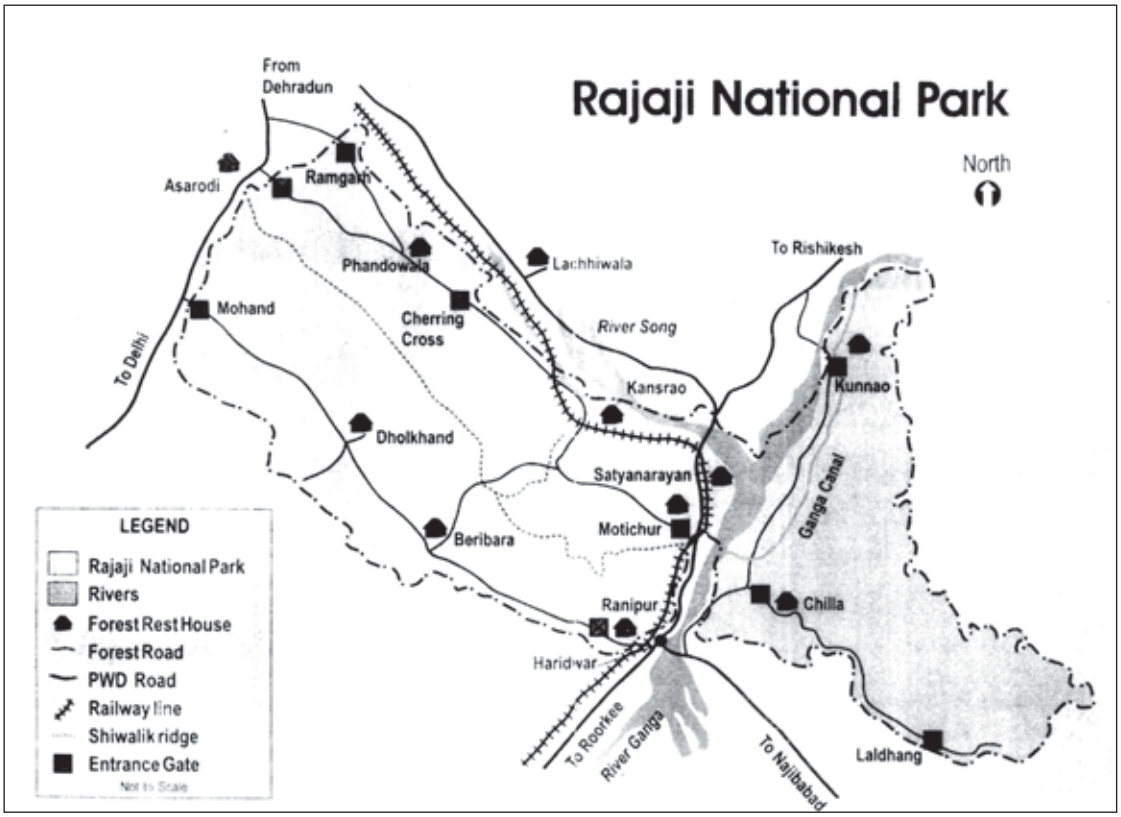

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Movement is one of the most important ecological factors that represent the home range as well as habitat utilization of an animal. Both movement and migration depends upon the availability of natural food and water. Changes in season and scarcity of water and natural fodder species force wild animals to leave a place for a few months and reach new feeding grounds for fulfilling their feeding, water and other routine requirements. There are seasonal variations in fodder species as RNP area falls under sub-tropical moist deciduous forest vegetation type. Elephants use the whole of the park area as their natural habitat but mostly they leave some of the areas having less vegetation cover and water for a few months and move towards other ranges richer in fodder species and natural water. Although at that time a few of them (mostly solitary bulls) use the same feeding grounds or move frequently in all the forest beats of the park as a general rule of migration of any species. Selected range wise movement pattern of the elephants is described below.

Hardwar forest range

With the onset of winter from the month of mid-October, when there is slight scarcity of fodder species elephants move towards the Dholkhand forest range, which is situated towards south-west/north and towards Kansrao forest range, situated south-east / north through crossing Motichur forest range. Study revealed that elephants move from Hardwar forest range to the adjoining ranges on the arrival of winter and also at the onset of summer period especially from the month of March to June, which are also known as the forest fire months. But the movements of a few of the solitary bulls and occasionally groups (very rare) have been observed in whole of the range. Most of these movements are obviously being restricted by various villages, temples, railway tracks etc. that are present in the vicinity or inside the park area. Hardwar forest range is partially covered on one side by villages (Nai Basti-Bhimgoda, Lodha Mandi, Ravli-Mehdood, Roshnabad, Aehtampur Aanaeki and Aurangabad), therefore, instances of man-elephant conflicts are relatively more in this area, than in other ranges. These conflicts may be in any form viz. crop raiding, manslaughter etc. Dudhia forest beat due to its closeness to the Haripur Kala village and river Ganges is one of the most sensitive areas as far as elephant casualty is concerned.

During the study period, occasionally the movement of solo bulls was observed in this part of the park. Despite the fact that Dudhia area is rich in *Dalbergia sissoo* (Shisham) and *Acacia catechu* (Khair) forest, being the preferred food item of elephants. Group movement is restricted in this forest pocket due to the high level of anthropogenic and developmental activities. Generally, the solo adult bulls follow the city route to reach the Dudhia forest and river Ganges by crossing the railway track and Hardwar–Dehradun National Highway (Fig. 2). They enter the city from northern Kharkhari forest beat and move towards Chilla area after the sun set and re-enter the northern Kharkhari forest beat before dawn. During this long journey of about 2 km elephants crossed many of the minor routes along with various colonies. Besides, solo bulls from Chilla forest also enter this forest beat after passing through the island in between the river Ganges. This track falls under Chilla – Motichur corridor and is one of the important habitats as far as the elephants' conservation is concerned.

During field observations it came to our notice that, this pocket of the area is very sensitive for

the movement of the elephant mainly due to huge scale anthropogenic activities. During 1999 to 2002 few cottages have been constructed in this area inhabited by about two dozens of sadhus and likes. On the other hand this pocket has been part of the traditional route for the elephants to interchange the forest. Due to rapid development and construction activities in Haripur Kala village situated peripheral to the island and in adjoining areas; the elephant movements have been disturbed. The residents of the area inferred that seven years ago an adult tusker was killed by electrocution by a villager. However, no human casualty has been reported till now.

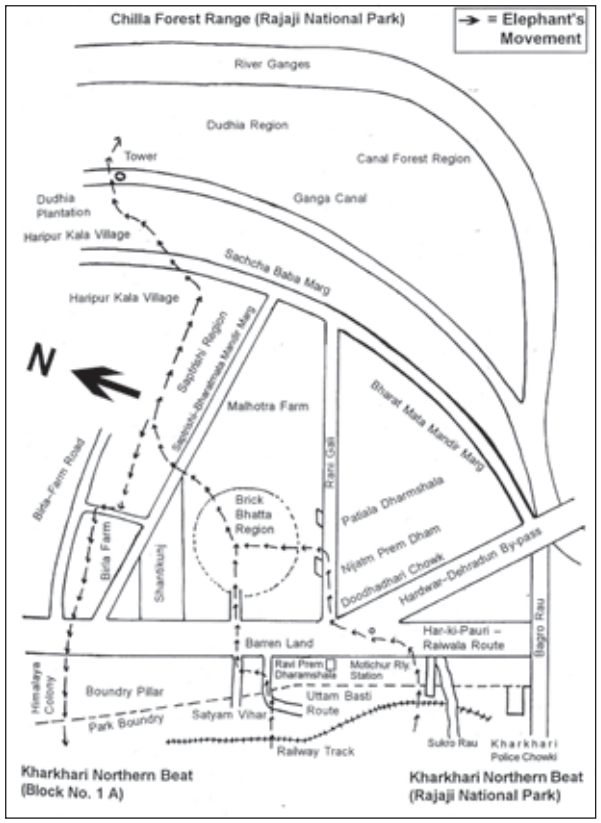

Figure 2. Range used by elephants outside the park area from Kharkhari forest beat to Dudhia forest beat of Hardwar forest range (before 2002).

Chilla forest range

Elephants use this forest range round the year because of altitude wise variation of rich fodder species. On the arrival of winter elephant's movement is towards lower areas like Chilla, Mundal and Khara forest beats. At the same time elephants also utilize the adjoining forest of river Ganga, which spreads up to Rishikesh along the river. On the arrival of rainy season they migrate towards upper areas like Luni, Pulani, Rawasan and Kasaan forest beats and this is the time when elephants start their long term migration towards Garhwal forest division. Many of the groups and solitary bulls use all of the forest beats for their local movement. During the summer elephants also use the Gohri forest range, which is in the north of the Chilla forest range, to fulfill their various routine requirements.

A large mammal like the elephant could be expected to cover considerable distances even within a short period, and families of a clan seem broadly coordinated in their seasonal movements (Sukumar 1989). In the dry months i.e. from January to April, when no rainfall occurs, the groups seek the neighbourhood of streams and shady forests. From the month of July, after the first showers, they start roaming and feed on the fresh grass. This grass in hill tracts becomes long and coarse by July and August, and the elephants then show upward movements. The reason for the elephants and other animal's migration in to the high land continuous and uninterrupted hilly terrain, is for grazing, assured food, ideal breeding grounds and thick population (Sinha 1981).

Elephants also use the Ghasiram and Mundal water streams for visiting river Ganges especially when their local movement is frequent in and adjoining forest beats, which are attached to river Ganges along with few bridges, which are in Ganga canal of Chilla hydro electric power plant (Fig. 3). Few of the groups were also reported to use the Shyampur and Chiriapur forest ranges of Hardwar forest division during rainy season as east Ganga canal is in full flow during this period. At the same place elephants move towards river Ganges through crossing the Hardwar-Bijnor National highway. It is interesting to mention here that currently only bull elephants cross this track and no groups were reported during the last 2 years. In the past 4-5 years elephant groups were reported in the same area but rapid developmental activities have restricted the frequent movement of elephant groups towards river Ganga in this part.

During the last 4-5 years, the State Government has constructed about four flyovers on Hardwar – Bijnor National Highway. As a result of anthropogenic activities, about 18 km of forest existing on both sides of the highway has got disturbed. Besides, agricultural expansion near river Ganges has lead to the loss of forest, which has also hindered the traditional movement of elephants. This forest stretch is one of the major corridors for elephant movement and presently has got disturbed due to habitat loss around the national highway. Sometimes a few of the male elephants associate to enter the forest near river Ganges through this route.

Elephants cross the National Highway in the evening hours and come back to the forest area in early morning hours. Besides, elephants also utilize the Gaziwali bridge, Shyampurwali bridge and Pili bridge situated peripheral to the canal road in Ganga canal for their outside movement and to feed on the cultivated crops in nearby villages. During the study period all the villages suffering from crop raiding have been investigated. The affected villages are Jagjeetpur, Mishrpur, Panjneri, Ajeetpur and Jaipota in the western side of the conservation area and all these villages are situated peripheral to river Ganges. Villages Kangri, Ghaziwali, Shyampur, Sajanpura, Pili and Rasiabad are located peripheral to the forest area and National Highway whereas villages Gaindikhata, Lahadpur, Chiriapur, Vasuchandpur and Naurangabad are also situated adjacent to the forest area and National Highway south west of the conservation area.

The villages along the river Ganges are situated on land that was once part of the elephant's home range. Therefore, the increasing elephant – man conflict is unfortunate but inevitable. The electric fence erected along with these villages and river Ganges has presently got damaged due to lack of proper maintenance. It was observed that elephants are utilizing their traditional feeding grounds in few of these areas, which are . presently denied to them and are replaced by human settlements

Figure 3. Ghasiram water stream - one of the oldest natural corridors for elephant movement in between Chilla-Motichur area.

During rainy season elephants were seen moving towards upper areas of the park. Reasons affecting local movement of elephants in the rainy season are:

- The low lying areas become swampy and unfit for free movement of elephants.
- The increase in abundance of a blood sucking fly locally called "daans" in low lying areas which irritates these elephants by hovering around their ears and trunk. This fly is commonly found affecting the cattle stock of Gujjars.

Forest fires also force elephants to areas where fire has not been so extensive.

Motichur forest range

Elephants in summer use this forest range more frequently as compared to winter but on the arrival of winter they move towards Kansrao forest range and Chilla forest range by crossing the river Ganges. In summer, elephants were observed more around the natural water hole areas like in Koyalpura west, compartment no. 4c. Besides, few of the group and solitary bulls use whole of the range for their movement related activities. Elephants use frequently the Motichur rau (seasonal water stream) as a corridor for going to river Ganges. Occasionally they also follow the forest route between Motichur Forest Range office and Raiwala area for going to river Ganges by crossing the Hardwar – Dehradun National Highway and railway track. Establishment of Satyanarayan area, Raiwala area and Khand village has created a permanent barrier on free movement of elephants to different forest ranges. In this way they are forced to restrict themselves in lowland areas as all of these areas lie in between the park area.

This is one of the important and crucial corridors for elephant movement from Rajaji to Corbett National Park. This corridor is known as Chilla – Motichur corridor. Rivers Song and Suswa flow through this range and elephants from Motichur and Kansrao forest ranges utilize the thick vegetation cover near the river especially during the dry season. Elephant movements from Kharkhari forest Beat to Motichur forest Beat represents their seasonal movement as they leave the Kharkhari forest for a few months mainly due to scarcity of water sources.

Typical tracks

An interesting feature related to unusual movements of the elephants was observed during the study period. The elephants were seen mounting foothills and sliding down from there. They sometimes used sharp slopes for their movement over which human beings can't slide down easily. During the study period on many occasions their movement on foothills and slopes were observed. The movement of the elephants was also confirmed by examining signs and impressions like: presence of dung piles, footprints, damage of the vegetation etc. This kind of movement was seen to be exercised even by juveniles as they can also mount on foothills and use the slope areas of the forest. This type of movement behaviour of elephants sometimes may prove fatal to them, as there have been reports of death of the elephants especially calves due to falling down from these foothills.

The present study reveals that elephants utilize the whole of the park area for their movement, but leave some of the areas for a few months, as part of their seasonal migrational activities. The local movement and long term migration of elephants within the RNP shows a definite pattern. After the isolation of Chilla forest and Motichur forests the elephant population of the RNP has divided into two parts. Presently, elephants of Chilla and adjoining areas in the eastern part of river Ganges show migration between the Chilla area and Dogadda area (Garhwal forest division). Large-scale developmental activities inside the Dogadda forest area have caused hindrances in their corridor area. Seasonal movements and migratory routes have also undergone minor changes. Elephants in North Bengal are pocketed but these pockets have increased in number and also changed their locations with the passage of time. Elephants are trying to adapt themselves to the changing environment by changing their ranges, moving on to new areas and by adopting new routes (Barua & Bist 1996).

The reasons for migration of elephants can be annual fire, drought, non-availability of fodder, paucity of drinking water and absence of cool green shades in their respective areas (Ramachandran 1990). In Chilla, the elephants, which were deep in the Northern hilly terrain in the rainy season, gradually start moving towards the south due to scarcity of water in the winter season in the hilly areas. The study further reveals that the animals are directly affected by water availability and availability of fodder species inside the park area. Presence of river Ganges in Chilla area further ensures the migration of animals at the onset of summer.

Groups generally comprise adult cows, sub adult cows, infants (both sexes) and occasionally a mature bull was also seen within a group (Fig. 4). Different groups generally do not mix up except during large scale migrations. Members of a group during feeding are usually spread within an area of 50 - 100 m. However, the calves are always under direct touch and close to their mother. The young bulls on reaching the age of 12-14 years tend to prefer the solitary life, but at times two adult bulls may associate temporarily for their mutual understanding such as feeding together and crossing of their traditional corridors now converted into high traffic zones.

Outside movement of elephants

Movement of the elephants on a few routes around the park area was studied during the study period. The areas, which are nearer to the boundary of the National Park, have been subjected to rapid development over the past 6-7 years. Elephants used to move through all of these routes traditionally and especially during the night but presently all of their routes are replaced by agricultural land and human settlements etc. The known areas are BHEL main hospital, main gate of BHEL sector 1, main gate of BHEL sector 2, Subhash Nagar Colony, Tehri Dam Colony, Provincial Armed Constabulary (PAC) campus, Aurangabad village, Aanaeki village, Aehtempur village, Ravli-Mehdood village, Roshnabad village etc.

Figure 4. Elephants in the Rajaji National Park.

During the study period few of the groups and solo adult bulls were observed regularly during whole night for checking their fixed routes for entering the populated areas and re-entering the Park. While in certain fixed places their movement could be observed by viewing them directly with the help of high power torch light (sometimes even under moon light) and the noise created by them while feeding. During dark fortnight periods, it becomes difficult to locate the wandering elephants anywhere. However, the silence of night helps villagers if elephants have strayed or encroached into their fields by their occasional munching sounds. The villagers on such occasions beat drums or other noise creating instruments to drive away these animals from their crop fields or orchards. If elephants feel any disturbance they move inside the nearby thick vegetated area. At that time it is quite difficult to observe them due to lack of sufficient light and risk of casualty. The cultivators sometimes are complled to allow them to raid crops as they could not drive them off due to unavailability of light sources and drive off devices.

During the past decade it was observed that before 2002 elephants strayed in adjoining populated areas of Hardwar forest range of the RNP area. At that time their straying was quite frequent in Shivlok colony, industrial area, Bilkeshwar colony, BHEL area, Subhash Nagar, PAC campus, Shivalik Nagar, Tehri Dam colony, Salimpur village, Jamalpur village, Ravli-Mahdood, Roshnabad, Aahtampur, Aanaeki and Aurangabad villages. Variance in routine movement was observed in Aurangabad village and Tehri Dam colony, due to their proximity to the park boundary. The straying is not only towards crop fields, but also in non-agricultural areas. It was observed that sometimes the elephants are attracted towards fodder like trees near the human settlement areas, in search of their pasture. Elephants come out from the national park boundary after sunset to reach different areas and return back before dawn. The elephants raid the paddy (*Oryza sativa*) and sugarcane (*Saccharum officinarum*) fields in different villages, which are in close vicinity of the park area. The elephants show a natural preference for sugarcane crops because of the juicy and highly energetic nature of the crop. During this study it was found that group movement was increased during November, leading to highest frequency of raids during December being the maturity period of the sugarcane and decreases in March.

Stray behaviour among elephants has been more common for the last two years as compared to previous years (Joshi & Joshi 2001). In our observations it was conspicuous that at few places their departure was delayed by 2-3 hours after dawn. In Subhash Nagar area one particular group was seen straying continuously for about 14-15 days, which was unusual. The bulls show more individualistic or solitary straying movements. At times these bulls wander alone or in pairs of 2-3, in certain localities. A characteristic feature was that only identified solo bull elephant and groups were more frequently straying, causing damage to various categories of vegetation in the area. These crop raids are the indications of attempts by some of the elephants to use their traditional routes leading to their feeding grounds, which are now denied to them and are replaced by human settlements. Occasionally the solitary movement of an adult bull elephant was also seen outside the park area after mid-day. Dorji (1997) pointed out that one of the reasons for raiding of crops by elephants is due to unavailability of natural food.

Other developmental activities

Developmental projects such as railway track, road network, canals, industrial establishments, expansion of agricultural area and the encroachments by human habitation are also responsible for fragmentation of elephant's natural habitat and blockage of their movement tracks.

State Infrastructure and Industrial Develop-ment Corporation of Uttarakhand Limited

After the separation of Uttarakhand state from Uttar Pradesh state (2000), Hardwar city was finalized to establish one of the industrial areas of the state, which was named as State

Infrastructure and Industrial Development Corporation of Uttarakhand Limited (SIDCUL). And for this purpose the adjoining area (2034 acres) of the Hardwar forest range was selected. From 2002 rapid expansion of construction activities nearer to the forest area have caused obstruction in frequent movement of elephants besides many other wildlife in peripheral forest beats. Tiger movement was frequently recorded before 2002 whereas after the same year tiger movement in these forest tracks has got obstructed. As a result of establishment of more than a dozen industries, requirement of water is continuously going to increase and to resolve this, ground water was utilised by various industries and that has caused a major impact on the level of ground water of adjacent areas. Industries are frequently discharging the effluent to the ground because of the absence of any appropriate outlet. Hardwar forest comprises many wells constructed before the declaration of park area with the sole aim of maintaining the water quality especially during dry periods. It was observed during the present study that the water level has decreased in the wells especially during summer. According to our measurements about 1.5 m of the water level has decreased during the last 4 years.

Railway track

Hardwar - Dehradun railway track, which passes through the RNP area acts as a death trap for several wild animals and the major species - elephant. This 16 km railway track passes through the Hardwar, Motichur and Kansrao forest ranges of the Park area and the maximum number of deaths occurred in the railway track, which lies in Hardwar and Motichur forest ranges. The part of the railway track between Motichur to Kansrao (Hardwar – Dehradun rail section) has caused the accidental death of 19 elephants since 1987 besides many other wildlife (Fig. 5). This 105 year old railway track has now become very busy due to the introduction of many fast moving trains. Approximately 29 passenger trains (express/mail) and 3-4 goods trains pass daily on this track.

Figure 5. Cow elephant died through collision with train (2000).

Road network

Dehradun-Hardwar National Highway on the west bank of river Ganges and Hardwar-Bijnor National Highway are the major hurdles as far as road networks are concerned. As per a preliminary study, the average number of vehicles passing on Dehradun-Hardwar road per day is 7929 and all the wild animals, including elephants, are not in a position to cross this track at any time due to the presence of heavy traffic (Singh & Sharma 2001). Kotdwar – Lansdowne road runs parallel to the river Kho and crosses the Rajaji-Corbett corridor, the main movement track of northwestern elephant populations between the Yamuna and river Sharda. This road serves as the major transport link between Pauri town and Kotdwar area. The presence of traffic on the road, construction of steep retaining walls by the side of road and the presence of humans along the entire corridor area have restricted the migration of elephants using this corridor (Johnsingh & Williams 1999).

Hydro-electric and irrigation canal

A major developmental project, which has divided the Rajaji – Corbett elephant habitat into two regions is the 14 km long Kunaun – Chilla power channel, which was constructed on the east bank of river Ganges. In the early 1970s, this canal was twenty-two meters wide, nine meters deep and with full flow of water. The side of the canal is at an angle of 45^0 and cemented except for 500 m; therefore, do not offer foot-holds to elephants (Kumar 1995). There are three

places at which bull elephants and groups cross the power channel and go to Ganges.

(i) Binj / Been rau (dry river bed) – in Gohri forest range.

(ii) 60 m long aqueduct connecting Dogadda with Ganges – in the edge of Gohri and Chilla forest ranges.

(iii) Bridge across the power channel, 2 km from Chilla – in Chilla forest range (Soni Shroath).

In summer, more bulls were observed to use these tracks for their movement but occasionally groups also followed this route for going towards riverside forest beats and for fulfilling their routine requirements. Herds generally use the Ghasiram and Mundal water streams for their movement towards river Ganges but during the summer period herds also follow this route for their frequent movement. The elephants use Mundal stream to go to Ganges, but in the bridge, which is near Chilla-Rishikesh motor road they cross the road to re-enter the stream because they can't cross the narrow lower passage of the bridge easily whereas they used frequently Ghasiram Shroath for going to Ganges.

Another Ganga canal was constructed parallel to Hardwar – Bijnor National Highway, which has divided the protected forest in two parts. During extreme dry period elephants use the ladders constructed over the canal, to fulfill their water needs. Besides, traffic that is running over the highway also acts as a barrier to elephant movements towards Anjani forest beat (Fig. 6).

Figure 6. Bull elephants walking along the Hardwar - Bijnor National Highway.

The RNP represents one of the important sub-tropical moist deciduous protected areas for elephants in India. At present, observations from this study indicate that the elephant population is below carrying capacity of the park since there are no obvious signs of any over utilization and habitat deterioration. The long term survival of elephants and the viability of the park itself as a self sustaining eco-system would depend very much on wise management practices that incorporate both socio-economic as well as ecological considerations. This protected area serves as a good natural home for Asian elephants, but increasing crop raiding / straying tendencies, reveal their increasing uneasiness within their habitat, which is forcing them to move out of their traditional habitat, the park area. On the basis of present study, previous information available and by looking the seriousness of the man-elephant problem in this region, the following recommendations are proposed for consideration.

Recommendations

1) Construction of a fly-over is desirable to control the heavy traffic between Haridwar and Raiwala. This will help in reducing the road accidents and death of wild animals. There is also need to educate and convince the people not to feed monkeys in the forest stretch, which also attracts other wild animals, to feed on the remains.
2) Gujjar relocation from Rajaji – Corbett corridor area.
3) Establishment of the Chilla –Motichur corridor and strengthening of the Rajaji – Corbett corridor.
4) The army ammunition dump should be shifted elsewhere along with their settlements.
5) Island on the river Ganges should be restored and freed from any anthropogenic disturbances.
6) Traffic should be stopped in the Chilla – Rishikesh road during night hours.
7) As the park area mainly comprises of Dehradun / Hardwar region so it is proposed that the time of the night trains be shifted approximately half an hour earlier than the present schedule time. By employing this method the train could be made to move slowly and can be easily stopped in emergency, through the park area up to Hardwar.
8) Few sub-ways (elephant under path way) may be constructed on the sharp places from where elephants cross the railway track and the National Highway.
9) Artificial water holes must be created, spread within the park area at short distance. For solving the problem of water, pumps can be used to uplift the well water during the day, which will help during hot periods. Besides, a few of the water sources may be linked with Ganga canal.

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References

Barua, P. & Bist, S.S. (1996) Changing patterns in the distribution and movement of wild elephants in North-Bengal. In: *A Week With Elephants*. Daniel, J.C., Hemant, S. & Datye,

B.N.H.S. (eds.) Oxford University Press. pp 66-84.

Daniel, J.C. (1996) Conservation of Asian elephant. *Gajah* **16:** 9-16.

Dawson, S. & Dekker, A.J.F.M. (1992) *Counting Asian Elephants in Forests. A Technique Manual.* RAPA Publication 1992/11. RAPA and FAO, Bangkok.

Dorji, P.J. (1997) Status, distribution and conservation of the Asian elephant in Bhutan. *Tiger Paper* **24(1):** 1-3.

Johnsingh, A.J.T. & Williams, A.C. (1999) Elephant corridors in India: Lessons for other elephant range countries. *Oryx* **33:** 210-214.

Joshi, R. & Joshi, B.D. (2001) Stray behaviour of elephants (*Elephas maximus*) around Rajaji National Park area, India. *Himalayan Journal of Environment and Zoology* **15(1):** 81-85.

Kumar, D. (1995) *Management Plan of Rajaji National Park, Dehradun. Vol. 1 (1995-96 to 2005-06), UNDP / WII.*

Ramachandran, P.V. (1990) Migration of elephants in Wayanad Wildlife Sanctuary. In: *Ecology, Behaviour and Management of Elephants*. Karunakaran, C.K. (ed) Wildlife Wing, Kerala Forest Department. pp 109-113.

Ramakrishnan, U., Santosh, J.A. & Sukumar, R. (1991) Censusing elephants in forests. In: *Proceedings of an International Workshop, Technical Report No. 2*. AECC–IUCN / SSC.

Santiapillai, C. & Suprahman, H. (1986) *The Ecology of the Elephant (*Elephas maximus *Linn.) in the Way Kambas Game Reserve, Sumatra*. WWF / IUCN Final Report, Bogor.

Sukumar, R. (1989) *The Asian Elephant: Ecology and Management*. Cambridge University Press, Cambridge, UK.

Singh, V.B. (1969) The elephant (*Elephas maximus* Linn.) in Uttar Pradesh. *J. Bom. Nat. Hist. Soc.* **66:** 239-250.

Singh, A.P. & Sharma, R.C. (2001) Conflicts between linear developments and Asian elephants in sub-Himalayan zone of Uttaranchal. In: *Proceedings of the 2001 International Conference on Ecology and Transportation*. Irwin, C.L., Garrett, P. & McDermott, K.P. (eds.) Centre for Transportation and the Environment, North Carolina State University, Raleigh, NC. pp 423-432.

Sinha, M.K. (1981) Elephant migration in Kaziranga. *Tiger Paper* **8(1):** 16-18.

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Feeding Behaviour of Asian Elephants in the Northwestern Region of Sri Lanka

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Introduction

The Northwestern region of Sri Lanka supports a substantially large elephant population. Population estimates range from 591 (Hendavitharana 1993) to 1500 animals (de Silva & Attapattu 1998). However, there are only a few protected areas in this region of which Wilpattu National Park is the largest intact natural habitat available for elephants. Apart from the protected areas, the only other intact natural vegetation patches are found in the catchment areas of large tanks. The remaining natural habitats include man modified habitats such as forest plantations and abandoned agricultural lands which are in different stages of natural succession.

Elephants are classified as megaherbivores and consume up to 150 kg of plant matter per day (McKay 1973; Vancuylenberg 1977). Therefore availability of food is a major determinant of carrying capacity of elephants in a given area. Previous studies on feeding behavior of Sri Lankan elephants have shown that they are generalists that feed on a wide variety of food plants (Mueller-Dombois 1972; McKay 1973; Ishwaran 1983). However all of these studies have been conducted in protected areas such as Gal Oya National Park and Ruhunu National Park. As majority of the elephants in the northwestern region occupy habitats outside protected areas, it is important to understand the availability of food for these elephants in order to properly manage this population. The aim of this investigation was to identify the food plants of elephants that range in the northwestern region and to assess their availability both in and outside protected areas.

Materials and methods

Study area: The study area is located in the northwestern region of Sri Lanka encompassing the Mahaweli system H and adjoining areas. The study area is demarcated by the towns of Puttalam in the East, Mahawa in the South, Habarana in the West, and Anuradhapura in the North. The extent of the study area is approximately 3000 km^2 and includes 15 administrative divisions. Human use patterns found within the study area can be grouped into three categories as, low use, high use and very high use.

Study animals: The exact number of elephants in the study area is not known. A census carried out by the DWLC revealed that there are 591 elephants inhabiting the northwestern region (Hendavitharana 1993). However, de Silva and Attapattu (1998) reported that this number could be as high as 1500 elephants. During the course of this study nine elephants, three adult males, a sub-adult male, three adult females and two sub-adult females were collared within the study area. Of these, three elephants were selected from a low human use area, one female was selected from a medium human use area, and the remaining five elephants were selected from very high human use areas. A summary on these elephants is given in Table 1. These elephants were located at least 4 times a month and observations were made on their feeding habits during the period January 1998 to December 1999. In addition to the elephants that were

Table 1. A description of the nine elephants collared during the study.

Location	Height [cm]	Age [years]	Sex	Human use	Social status
Karuwalagas wewa	189	8 -10	Male	Low	Herd (13-15)
Karuwalagas wewa	282	35+	Male	Low	Solitary
Karuwalagas wewa	225	30+	Female	Low	Herd (15-18)
Kumbuk wewa	192	10 - 12	Female	Medium	Herd (8-10)
Usgala wewa	180	9 - 10	Female	High	Herd (21-24)
Kala wewa	210	20 - 25	Female	High	Herd (12-16)
Turuwila	215	25 - 30	Female	High	Herd (25-29)
Turuwila	267	35 - 40	Male	High	Solitary
Galkiriyagama	310	45+	Male	High	Solitary

Feeding behaviour: Feeding behaviour of elephants was determined using both direct and indirect techniques. Whenever possible, feeding behaviour of elephants was observed directly, especially the elephants that were fitted with radio collars or members of the herd to which the collared elephant belongs. However, due to poor visibility of the terrain only a limited number of opportunities were presented to make direct observations. Therefore, three indirect techniques were utilized to determine the feeding behaviour of elephants.

Figure 1. Feeding signs observed on a food trail.

i. Food trails: The trail taken by an elephant, or a herd of elephants was followed and all the plants showing signs of being fed by elephants (Fig. 1) and the part(s) of the plant eaten were recorded. In addition a herbarium specimen, a leaf sample, a bark sample, and if fruits were available a sample of seeds were also collected to develop a reference collection that was used during the subsequent macroscopic and microscopic analysis of dung samples.

ii. Macroscopic analysis of dung: A total of 145 dung boli were collected from different parts of the study area. The bolus was separated by hand and all identifiable parts were removed (Fig. 2). These parts were identified by comparing it with the reference collection of plant seeds and plant parts constructed during food trails.

iii. Microscopic analysis of dung: This analysis was done to quantify ratios of different food types eaten by the animal in addition to identification of different food types eaten. A total of 113 dung samples were subjected to this analysis. From each dung sample, three sub samples (each weighing approximately 50 g) were removed. Each sub sample was placed in a 50 ml sample tube and 25 ml of boiling water was added, capped and mixed thoroughly, and allowed to sit for 20 minutes. Then the contents were filtered using a sieve (mesh size = 2 mm) and the filtrate was collected. Five ml of household bleach solution was added to the filtrate, mixed thoroughly and allowed to sit for 20 min. The solution was filtered using a 250-micron sieve and the residue was collected.

Figure 2. Macroscopic analysis of dung.

A small amount of the residue was placed in a counting chamber, and a few drops of water added until an even distribution was obtained. A cover slip was placed on the counting chamber and the number of dicot or monocot plant leaf epidermis or woody material that appeared on the cross points of the counting chamber was determined. One hundred such cross points were counted for each sub sample. Whenever possible plant species present in the dung sample were identified by comparing the epidermal tissue with a reference collection of plant epidermal tissue (Fig. 3) constructed from plants collected from food trails. The characters used for identification included shape and arrangement of epidermal tissue and stomata and presence of structure such as thorns hair etc.

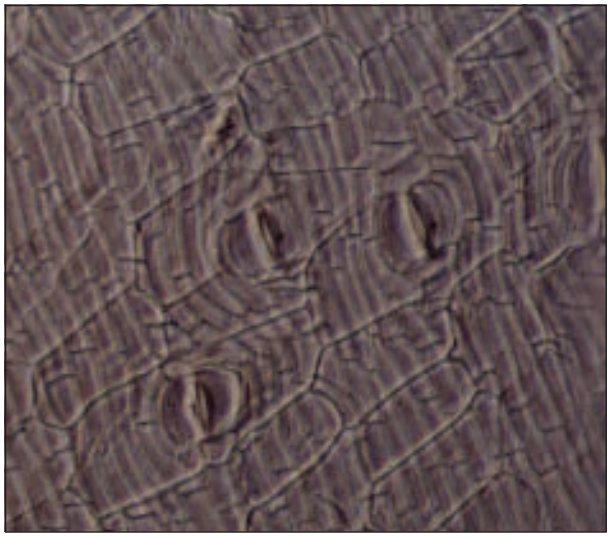

Figure 3. Microscopic analysis of dung: plant epithelium

Food availability: A total of 137, 1 km x 5 m transects were carried out in different regions of the study area. In order to compare the availability of food plants within and outside protected areas 26 of these transects were conducted in the Wilpattu National Park while the remaining 111 transects were carried out in various habitats outside the protected areas. The percentage occurrence of non cultivated plants that were eaten by elephants inside and outside the Wilpattu National park was determined based on the number of transects in which the plant was recorded relative to the total number of transects carried out. The percent occurrences of cultivated plants were not calculated, as they were not considered as naturally available food plants of elephants.

Results

A total of 116 plant species belonging to 35 families were eaten by elephants including 27 species of cultivated plants (see Table 5 for a detailed list of food plants). In many species they fed on bark alone. More than 25% of the plant species eaten by elephants belonged to family Fabaceae while 19% of the plant species belonged to family Poaceae (Fig. 4). Analysis of the habit of these food plants indicates that 53% of the plants are non tree species that can be classified as shrub, herb (including grass), or climbers (Table 2).

Microscopic analysis of dung showed that the monocot:dicot ratio in the food was highly variable within habitats as well as between habitats (Table 3). In 66% of the samples analyzed the amount of monocots was greater than dicots. Further, monocot:dicot ratio of different individuals within the same herd also showed a high degree of variability (Table 4).

Table 2. Distribution of the 116 food plant species according to the habit.

Habit	Number	%
Tree	47	41.2
Shrub	8	7.0
Herb	41	36.0
Climber	20	17.5

Availability of food plants indicated that out of 94 non crop plants eaten by elephants 67% were available in habitats outside protected areas, as opposed to 43% recorded in Wilpattu National Park (Table 5). Further when comparing food plants found both inside and outside protected areas, the percentage occurrence was higher outside the protected areas for all the plant species recorded.

Discussion and conclusions

Elephants that inhabit in the northwestern region can be defined as generalist in selection of food plants and feed on a wide variety of plants. Further, analysis of monocot:dicot ratio in diet showed that food plant selection by elephants is highly opportunistic as a high degree of variation in monocot:dicot ratio was observed both within and between habitats as well as within a given herd, even though they feed in close proximity to each other. These observations are in accordance with observations made in southeastern region of Sri Lanka (Mueller-Dombois 1972; McKay 1973; Ishwaran 1983; Wickramasinghe pers. com.). However, the overall composition of food plants was quite different from the southeastern region as only 33% of the food plants reported in southeastern region were recorded in this study (Table 5). This could be attributed to two reasons. The southwestern studies were done in protected areas (Gal Oya and Ruhunu national Parks) where there are no cultivated species, whereas in this study nearly 25% of the food plants are cultivated species. Second, this difference may have arisen due to differences in species distribution between the two regions.

Table 3. The average dicot:monocot ratios of dung collected from different regions of the study area (N indicates the number of dung samples analyzed per location).

Location	DS division	Habitat	N	Average dicot: monocot
Heeralugama	Galgamuwa	Scrub	18	0.412
Bulnewa	Galgamuwa	Scrub	4	0.133
Gojaragama	Galgamuwa	Scrub	3	1.493
Anderawewa	Galgamuwa	Forest	3	0.219
Siyambalawewa 1	Galgamuwa	Forest	3	0.320
Siyambalawewa 2	Galgamuwa	Forest	3	0.058
Amunukole	Galgamuwa	Scrub	3	1.724
Usgala	Galgamuwa	Forest	3	0.253
Thimbirigaswewa	Galgamuwa	Forest	16	1.440
19 Kanuwa	Karuwalagas wewa	Teak	3	0.022
Erabodugaswewa	Karuwalagas wewa	Forest	3	0.082
Maradankalla	Karuwalagas wewa	Scrub	3	2.556
Veheragala 1	Karuwalagas wewa	Forest	13	0.532
Veheragala 2	Karuwalagas wewa	Forest	3	0.118
Tammanwetiya	Nawagaththegama	Scrub	3	0.336
Turuwila	Tirappane	Teak	9	1.074
Rotawewa	Eppawala	Scrub	3	0.149
Rathmalwetiya	Eppawala	Scrub	3	0.459
Gammanwetiya	Giribawa	Scrub	3	0.370
Weweranwetiya	Giribawa	Scrub	3	3.627
Sangappaliya	Giribawa	Scrub	3	3.375
Nellikulama	Nuwaragam Palatha	Scrub	3	0.308

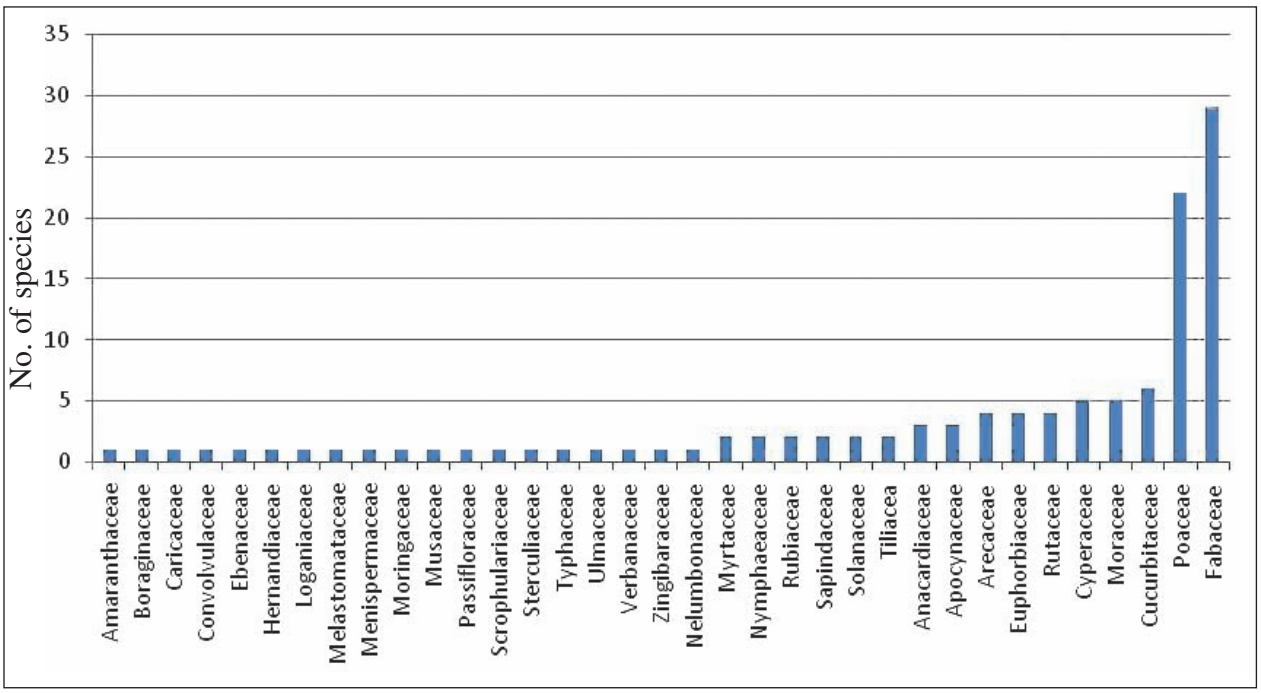

Figure 4. Distribution of food plants by taxonomic family.

Nearly 50% of the food plants of elephants belonged to the families Fabaceae and Poeaceae. This observation also agrees with observations reported in the Southwestern region. It was also observed that more than 50% of the Dicot food plants were non tree species. Further, even though a high degree of individual variation was observed in the monocot:dicot ratio in diet, in more than 66% of the samples analyzed composition was dominated by monocot, especially in juvenile elephants that tend to feed predominantly on grass species. Vancuylenberg (1977) shows that elephants are poor digesters as they can assimilate little over 50% of the food consumed. This is also evident in their dung as most of the plant matter is only partially digested. To compensate for this they consume as much as 150 kg of plant matter per day. Most perenial plant species produce toxins as a form of chemical defense against herbivory. Therefore, heavy reliance shown by elephants for non tree species could be an adaptation to avoid chemical toxin load as most of the non tree species invest less on chemical defense and instead rely heavily on physical defenses such as thorns and hairs.

It was further revealed that availability of food plants is greater in habitats outside protected areas. This could be attributed to the fact that majority of food plants are non tree species that are found in man modified habitats rather than climax vegetation that is likely to be found in the protected areas. Further, nearly 25% of the identified food plants are cultivated species, which indicates that elephants do supplement their diet with crop species. However, it should be noted that the presence of cultivated plants in dung does not result solely due to raiding of crops as it was observed that elephants feed on leftover crop plants in fallow chenas.

Table 4. The dicot:monocot ratios of different individuals of four different herds. Dung samples of different members of the herd were collected on the same date and place after homing and tracking the herd using a radio-collared elephant.

Location	1	2	3	4	5	6
Heeralugama	1.26	0.48	0.12	0.36	0.19	0.68
Thimbirigaswewa	1.90	1.78	0.47	1.70	2.57	
Veheragala	0.42	0.50	0.62			
Turuwila	1.96	0.83				

Table 5. Summary of all the plants observed to be eaten by elephants. Classification is based on Senaratne (2001). The plants were subdivided in to trees (T), shrubs (S), herbs (H) and climbers (C) and provided under the column, habit. The column designated as method indicates whether the plant was identified based on direct observations/ food trails (FT) or macroscopic/ microscopic analysis of dung (MA). The percentage occurrence was determined based on number of transects in which the plant was recorded relative to the total number of transects carried out (111 transects outside Wilpattu NP and 26 transects inside Wilpattu NP). Numbers in superscript indicate previous studies that have recorded the plant species as a food plant of elephants ([1]McKay 1973; [2]Ishwaran 1983; [3]Mueller-Dombois 1972).

Family	Scientific name	Vernacular name	Habit	Method	% occurrence	
					Out-side	Wil-pattu
Arecaceae	*Borassus flabellifer*	Tal	T	FT, MA	33	4
	Caryota urens	Kitul	T	FT	7	0
	Cocos nucifera	Pol	T	FT, MA	31	0
	Phoenix pusilla	Indi	T	FT, MA	34	9
Amaranthaceae	*Achyranthes aspera*	Gas Karalheba	H	FT	54	15
Anacardiaceae	*Anacardium occidentale*	Kadju	T	FT	8	0
	Lannea coromandelica	Hik	T	FT, MA	40	0
	Mangifera indica	Amba	T	FT, MA	16	0
Apocynaceae	*Carissa carandas*	Maha karamba	S	FT	1	4
	Carissa spinarum[1,2,3]	Heen Karamba	S	FT, MA	41	23
	Ichnocarpus frutescens	Kiriwel	C	FT, MA	40	16
Boraginaceae	*Cordia monoica*[1,3]	Lolu	T	FT, MA	25	12
Caricaceae	*Carica papaya*	Pepol	T	FT	-	-
Convolvulaceae	*Ipomoea aquatica*[1]	Kankun	C	FT	36	12
Cucurbitaceae	*Benincasa hispida*	Alu puhul	C	FT, MA	-	-
	Citrullus colocynthis	Yak komadu	C	FT	-	-
	Citrullus lanatus	Komadu	C	FT	-	-
	Cucumis melo	Kekiri	C	FT, MA	-	-
	Cucurbita maxima	Wattaka	C	MA	-	-
	Lagenaria siceraria	Diya labu	C	MA	-	-
Cyperaceae	*Actinoscirpus grossus*	Thun hiria	H	FT	10	8
	Cyperus haspan[1]	Hal pan	H	FT	74	59
	Cyperus pilosus[1]	Thunessa	H	FT	76	55
	Cyperus rotundus[1]	Kalanduru	H	FT, MA	78	58
	Fimbristylis miliacea	Mudu hal pan	H	FT	78	73
Ebenaceae	*Maba buxifolia*[1,3]	Kaluwara	T	MA	0	0
Euphorbiaceae	*Drypetes gardneri*	Eta wira	T	MA	0	0
	Manihot glaziovii	Gas manyokka	T	FT	-	-
	Manihot esculenta	Manyokka	S	FT	-	-
	Phyllanthus polyphyllus[1,2]	Kuratiya	T	FT	44	15
Fabaceae	*Acacia leucophloea*	Maha andara	T	MA	25	0
	Acacia pennata	Goda hinguru	C	FT	15	0
	Aeschynomene indica	Diya siyambala	H	FT, MA	15	8
	Albizia amara	Eaha	T	FT, MA	0	0
	Albizia lebbeck	Siriya mara	T	FT, MA	23	4
	Albizia odoratissima	Huri mara	T	FT, MA	0	0
	Albizia saman	Pare mara	T	FT, MA	0	0
	Alysicarpus vaginalis	Aswenna	H	FT, MA	0	0

Family	Scientific name	Vernacular name	Habit	Method	% occurrence	
					Out-side	Wil-pattu
	Arachis hypogaea	Rata kadju	H	FT	-	-
	Atylosia scarabaeoides	Wal kollu	C	FT, MA	0	0
	Bauhinia racemosa[1,3]	Maila	T	FT, MA	76	0
	Cassia siamea	Wa	T	FT	0	0
	Cassia tora	Peti tora	S	FT	63	23
	Clitoria ternatea	Katarodu	C	FT, MA	22	23
	Dalbergia lanceolaria	Bol mara	T	FT	0	0
	Derris scandens[2,3]	Bokalawel	C	FT, MA	59	39
	Derris trifoliata[2,3]	Kalawel	C	FT, MA	1	0
	Dichrostachys cinerea[1,3]	Andara	S	FT, MA	63	0
	Indigofera tinctoria	Nil awari	H	FT, MA	0	0
	Leucaena leucocephala	Ipil ipil	T	FT	42	0
	Macrotyloma biflorus	Kollu	C	FT	-	-
	Mimosa pudica[1]	Nidikumba	H	FT, MA	76	12
	Pongamia pinnata	Karanda	T	FT	58	19
	Tamarindus indica	Siyambala	T	FT, MA	40	23
	Tephrosia purpurea	Pila	H	FT	67	31
	Vigna marina	Me karal	C	FT, MA	-	-
	Vigna mungo	Undu	H	FT	-	-
	Vigna radiata	Mung	H	FT	-	-
	Vigna unguiculata	Cowpea	C	FT, MA	-	-
Hernandiaceae	*Hernandia nymphaeifolia*	Palatu	T	MA	0	0
Loganiaceae	*Strychnos nux-vomica*[1,2]	Goda kaduru	T	FT, MA	30	4
Melastomataceae	*Memecylon rostratum*[1,2]	Kuratiya	T	MA	0	0
Menispermaceae	*Cissampelos pareira*	Diyamittha	C	FT	0	0
Moraceae	*Artocarpus heterophyllus*	Kos	T	FT, MA	10	0
	Ficus benghalensis[1]	Mah nuga	T	FT	15	4
	Ficus racemosa[1]	Attikka	T	FT, MA	22	0
	Ficus religiosa[1]	Bo	T	FT	24	0
	Ficus virens[1]	Ahetu	T	FT	0	0
Moringaceae	*Moringa oleifera*	Murunga	T	FT	6	0
Musaceae	*Musa paradisiaca*[1]	Kesel	T	FT, MA	-	-
Myrtaceae	*Syncarpia glomerulifera*	Terpentine	T	MA	5	0
	Syzygium gardneri[1,2]	Damba	T	MA	0	0
Nelumbonaceae	*Nelumbo nucifera*	Nelum	H	MA	25	12
Nymphaeaceae	*Nymphaea nouchali*	Manel	H	MA	3	0
	Nymphaea pubescens	Olu	H	FT, MA	35	23
Passifloraceae	*Passiflora fitida*	Dal batu	C	FT, MA	47	0
Poaceae	*Cymbopogon nardus*	Heen pengiri	S	MA	13	0
	Dactyloctenium aegyptium	Putu tana	H	FT	0	0
	Echinochloa colona	Gira tana	H	FT, MA	0	0
	Echinochloa crusgalli	Wel-marakku	H	FT	0	0
	Eleusine coracana	Kurahan	H	FT, MA	-	-
	Eleusine indica[1]	Bela-tana	H	FT, MA	0	0
	Eragrostis unioloides[1]		H	FT	0	0
	Imperata cylindrica[1]	Illuk	H	FT, MA	10	0

Family	Scientific name	Vernacular name	Habit	Method	% occurrence	
					Out-side	Wil-pattu
	Isachne globosa	Batadella	H	FT	0	0
	Ischaemum rugosum[1]	Kudu kedu	H	FT	0	0
	Ischaemum timorense	Rila rat tana	H	FT	0	0
	Leersia hexandra	Layu	H	FT	0	0
	Oryza sativa[1]	Wee	H	FT, MA	-	-
	Panicum curviflorum	Meneri-thana	H	MA	0	0
	Panicum maximum	Guinea tana	H	FT, MA	49	0
	Panicum miliaceum	Meneri	H	FT. MA	-	-
	Panicum repens[1]	Etora	H	FT, MA	0	0
	Paspalum conjugatum[1]		H	FT	0	0
	Paspalum scrobiculatum[1]	Wal-amu	H	FT	0	0
	Pennisetum spicatum	Bajiri	H	MA	0	0
	Sacciolepis indica		H	FT	0	0
	Zea mays	Bada iringu	H	FT, MA	-	-
Rubiaceae	*Mitragyna parviflora*[3]	Helamba	T	FT, MA	63	35
	Morinda umbellata	Kiriwel	C	MA	25	8
Rutaceae	*Limonia acidissima*[1,3]	Diwul	T	FT, MA	42	46
	Micromelum minutum	Wal karapincha	T	FT	12	8
	Murraya koenigii[3]	Karapincha	T	FT, MA	20	4
	Pleiospermum alatum[1,3]	Tunpath kurundu	T	FT, MA	15	4
Sapindaceae	*Lepisanthes tetraphylla*[1,2]	Dambu	T	FT	52	9
	Schleichera oleosa[3]	Kon	T	MA	59	12
Scrophulariaceae	*Bacopa monnieri*	Lunuwila	H	FT	13	23
Solanaceae	*Capsicum annum*	Miris	H	FT, MA	-	-
	Solanum melongena	Ela batu	H	FT, MA	-	-
Sterculiaceae	*Pterosperomum suberifolium1*	Welan	T	FT	18	4
Tiliacea	*Grewia orientalis*[1,2]	Keliya	S	FT	80	16
	Grewia helicterifolia1	Bora damaniya	T	FT, MA	22	8
Typhaceae	*Typha angustifolia*	Hambu pan	S	FT	47	8
Ulmaceae	*Trema orientalis*	Gadumba	T	FT	22	0
Verbanaceae	*Tectona grandis*	Thekka	T	FT	16	0
Zingibaraceae	*Alpinia calcarata*	Katukiriwel	C	MA	0	0

Therefore it can be concluded that food is not a limiting factor for elephants that live outside the protected areas. However, the habitat patches that contain these food plants are small and scattered and as a result elephants have to extend their range to satisfy their dietary requirements. This would invariably bring them into conflict with man which is the main constraint in conserving these elephants.

References

Ishwaran, N. (1983) Elephant and woody-plant relationships in Gal Oya Sri Lanka. *Biological Conservation* **26:** 255-270.

McKay, G.M. (1973) *Behaviour and Ecology of the Asiatic Elephants in Southeastern Ceylon*. - Smithsonian Contributions to Zoology 125, Smithsonian Institution Scholarly Press, Washington D.C.

Mueller-Dombois, D. (1972) Crown distortion and elephant distribution in the woody vegetation of Ruhunu National Park, Ceylon. *Ecology* **53:** 208-226.

Vancuylenberg. B.W.B. (1977) Feeding behavior of the Asiatic elephant in southeast Sri Lanka in relation to conservation. *Biological Conservation* **12:** 33-54.

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Current Conservation Status and Research Progress on Asian Elephants in China

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The general situation of the Asian elephant

As a large territorial herbivorous mammal, the Asian Elephant (*Elephas maximus*) or Indian elephant, mainly inhabits forests and jungles, and often occurs in the gullies, river side and bamboo-broadleaf mixed forest with altitudes under 1000 m. It is a class I protected animal in China, and listed as an endangered species by the International Union for the Conservation of Nature and Natural Resources (IUCN).

Historically, the Asian elephant was widely distributed. It is estimated that there were about 100,000 elephants scattered from the drainage area of Tigris and Euphrates of Syria and Iran to the West, the Yellow River in China in the East, and Indonesia in the South at the beginning of 12th century. But their habitats have reduced rapidly because of climate change, sharply increased population and forest loss. Therefore, they only occur in some fragmented habitats in their historical distribution range. At present, the wild Asian elephant population is about 34,390~56,045, and the area of their habitat is about 436,230 km^2, in which an area of approximately 131,820 km^2 are National Parks or Nature Reserves (Sukumar 2003). Habitat loss and fragmentation are the main threats to elephant survival, and may increase the extinction risk of isolated populations.

The previous estimated number of wild elephants in China was about 200~250 (Zhang *et al.* 2003) based on limited field surveys and published data. Many surveys have been done on the population number of wild elephants in China; however, due to the different survey methods and the improvement and amending of survey techniques, the estimated values fluctuated from 1960s. This fluctuation was not due to the alteration of the number of elephants, but caused by the limitations of survey methods and survey times, movement of elephants among different habitats, or the transfer between neighboring countries such as Laos and Burma.

Since 1999, our group has made detailed investigation on the distribution (Fig. 1) and the number of Asian elephant populations, and estimated the current population to be 165-213 (Table 1) (Zhang *et al*. 2006). We also began to use morphological characteristics to identify individual elephants. We have also used molecular markers to identify individuals more accurately in the conservation genetic field. Consequently we can get to know the conservation genetic characteristics, population number and the social structure of wild Asian elephants in China.

The research status of elephant population ecology in China

Research on Asian elephant ecology mainly refers to individual physiological ecology, behavioral ecology, and population ecology. On the aspect of population number and distribution of Asian elephant, Sun *et al*. (1998) analyzed the space-time rules and the reasons for regional terrain withdrawal through historical data, and indicated that the increasing growth of human population pressure was the primary reason for the rapid southwards withdrawal of Asian elephants in China.

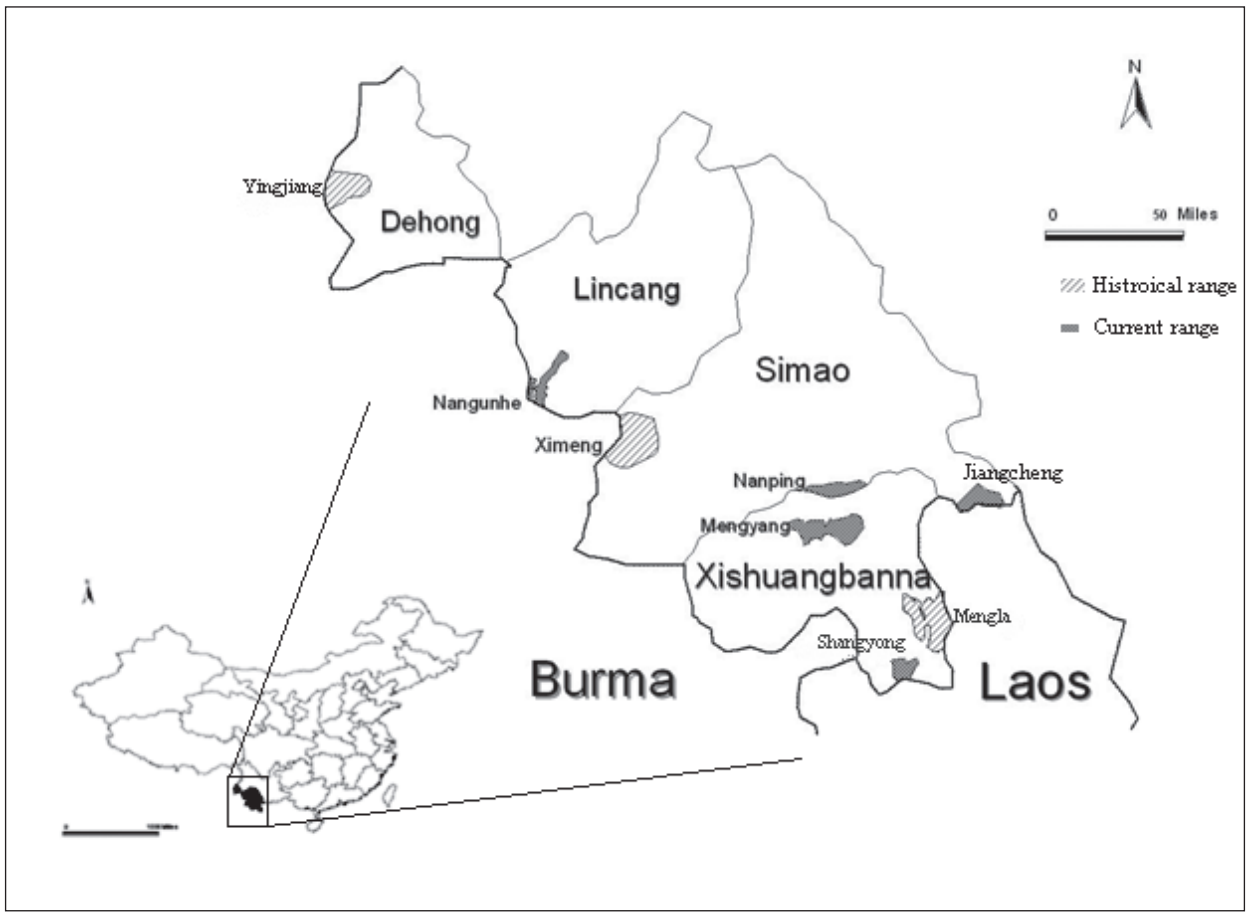

Figure 1. Distribution map of Asian elephants in China (Zhang *et al*. 2006).

On the aspect of Asian elephant habitat, Zhang *et al.* (2003) made a preliminary study on the habitat selection of 5 Asian elephants in Simao. Via trace-tracking and transect techniques, they found that the home range size of the herd during the dry seasons was 35.67 km^2, with 3 core foraging areas used circularly; while during the rainy season it was 18.42 km^2, with only one core foraging area. They also recorded the species of wild plants that elephants eat (Fig. 2). By applying remote sensing and geographic information system techniques, Li (1996) established the primary information database of Asian elephant habitat in Mengyang Nature Reserve, and assessed the habitat. Feng *et al.* (2005) found that Asian elephants preferred valley habitats where the altitude was less than 1000 m and the slope less than 10°, facing north or south. The selected habitats were bamboo-evergreen-broadleaf mixed forest, shrub and grassland. Furthermore, the main threats to the survival of Asian elephants were habitat loss and increasing illegal hunting in Shangyong Nature Reserve.

Research on the behavior, anatomy and physiology of elephants was mostly on captive elephants. Although there were significant differences between wild and captive elephants, they also had many common behaviours. It was confirmed that the estrus in Asian elephants was 16 weeks, including a luteal stage of 8-12 weeks and a follicular stage of 4-6 weeks. The sex pheromone excreted by oestrus female elephants in the urine was the chemical foundation in which bulls were interested (Schulte 2000). Through studying the variation in urinary oestrogen of 3 female Asian elephants at Beijing zoo it was hypothesized that inactive ovaries might be the cause of low oestrogen levels and lack of obvious periodic fluctuation in captive elephants. The lack of oestrus influences the birth rate of the captive population. In addition, the nutrition components of food for Asian elephants in wild and in captivity were analyzed, and it was observed that they had a relatively high need for calcium.

Table 1. Estimated population number and distribution of elephants in China (Zhang *et al.* 2006).

Year / County	1976	1983	1997	2003	2005	2006
Mengla	37	23	0	14-17	12-24	30
Mengyang	26	130	115-137	80-100	80-100	46-69
Shangyong	38	60	50-60	90-100	40-80	60-80
Simao	7	0	18	5-18	11-21	11
Linchang	22	12	18	18	18-23	18-23
Yingjiang	16	0	0	0	0	0
Total	146	225	201-233	207-253	161-266	165-213

Social structure crucially influences the development and evolution of diversified elephant's social behaviour. Cooperative and helping behaviour always occur when they search for food and water, dodge hunters and nurse offspring. Some studies were carried out on the foraging behaviour of Asian elephants in Sanchahe area, Wild Elephant Valley, Mengyang Nature Reserve, Xishuangbanna. Female elephants and their offspring foraged in groups, whereas bulls foraged alone. There was no significant difference on the foraging behaviour of elephants between daytime and nighttime and they foraged crops mainly at night. Asian elephants foraged in a circuitous pattern in the forests, which not only greatly improved the quality of the food in their wild habitat, but also benefited the development of the tropical rain forest ecosystem.

Meanwhile, via the individual morphological characteristics technique, the social relationship and behaviour of elephant populations was studied in Mengyang Nature Reserve. In total, 46 different elephants were successfully identified from the 524 direct observations of wild elephants, of which 38 belonged to 7 family groups, and the other 8 males were bull tuskers. It was also found that elephant groups and bulls appeared seasonally in the Wild Elephant Valley, and there were significant differences among the appearance frequencies of the 7 groups, which were positively correlated to the group size.

Research on conservation genetics of Asian elephants

Owing to the depredated environment and increased sustainence of human activities for a long time, Asian elephant habitats have been badly destroyed, which induced fragmentation of habitats, isolated populations, and intermittent gene flow. Poaching by humans and fragmented habitats are the main threats to Asian elephant survival. So, it is imperative to protect Asian elephants under such situations. Although some measures have been taken to establish several nature resersves in Xishuangbanna, Simao, and Nangunhe in Yunnan province, and we gained primary progress, there is not a credible system to describe the status of Asian elephant populations in China. We could never achieve our conservation aims if we just protect the areas where wild elephants exist.

There are some differences between various molecular methods in the application domains and capacity of solving problems when we cope with questions in different conservation levels or research objects (Li *et al*. 2001). Our group selected a fragment of mitochondrial DNA (mtDNA) as a molecular marker, including the hypervariable left domain of the d-loop (Fernando *et al.* 2000; Vidya *et al*. 2005), to assess the genetic diversity of the Asian elephant in Yunnan province, southwest China. If we fully understand the population structure and the genetic diversity in this area, we can provide some more feasible conservation suggestions and strategies to protect this endangered species.

Our results demonstrated that the genetic diversity was very low ($h = 0.150$, $\eth = 0.00044$) in Xishuangbanna, Yunnan province, and there were few differences among those four geographic populations in Xishuangbanna. Analysis of Molecular Variance (AMOVA) suggested that there is no significant genetic divergence ($Fct = -0.09013$) within Xishuangbanna local populations. Most

individuals in the four local populations shared the same haplotype with no genetic divergence, and there was high gene flow between the two local populations: MY-SM and ML-SY. These data warrant the identification of Xishuangbanna elephants as an evolutionarily significant unit (ESU) on the mtDNA level.

Since 1960, much original forest has been reclaimed to plant rubber trees in Mengla County, and after 1980 the area kept growing bigger. As a result of the price of rubber rising in the international market in recent years, original forests were cut massively for planting rubber trees in Xishuangbanna, thus it formed ecological isolation of Mengxing-Xiangming-Yiwu, including the big and small Kongming hills and Yao areas, and formed a geographic obstruction between Shangyong-Mengla (SY-ML) and Simao-Mengyang (SM-MY), which drove elephants to withdraw to current ecology spots. There has been no intercommunion of elephant populations between the two areas in the past several decades, and the populations just move in small ranges. However, the nucleotide substitution rate of elephant mitochondrial DNA D-loop is 3.5% per million years; therefore mutantations observed in individuals in these two areas, are generated by a history of belonging to different family groups, rather than geographic isolation.

Figure 2. Feeding elephant.

The evolutionary course of wild Asian elephant populations is very slow because it is a large mammal with a big appetite, wide territory, long reproductive cycle (the reproductive age of females is normally 18-20 years old, while the youngest age is 14-15 years), and low birth rate (they give birth to a infant per 2.5-8 years on average). In recent decades, on account of the massive cutting of forests and reclaiming of farmland, the habitats of elephants were fragmented, converting the original forests to rubber woods and farmlands, and no genetic flow occured between the two isolated populations. But this just occurred in recent years, so there is no significant genetic difference and no obvious genetic divergence.

The best solution to this problem is to establish ecological corridors to enhance intercommunication among the geographically isolated populations. The feasibility and necessity of building ecological corridors among Mengyang nature reserve (MY), Shangyong nature reserve (SY), and Mengla nature reserve (ML) was discussed, and one corridor was marked out to connect the three nature reserves according to practical conditions, formeing a protection and management unit in Xishuangbanna (Fig. 3). Combined with our study result, we believe a corridor programme among the isolated populations is critical and important to the survival of Asian elephants in China. So we suggest that the Reserve Management Department should establish the corridor as soon as possible, to reduce the fragmentation of the habitats and the pressure of human activities, improve the intercommunication and then to promote the genetic stability and diversity of Asian elephant populations in China.

There were no shared haplotypes between the populations of Xishuangbanna and Nangunhe. The Nangunhe population could diffuse into Burma in the 1980s, but because of the severe destruction of vegetation, there is no diffusion since 1997, so the Nangunhe population has become an isolated population composed of 13-18 individuals. This matches the low nucleotide diversity of mitochondrial DNA ($h = 0.350$) and haplotype diversity ($ð = 0.0034$). There is significant difference between the Nangunhe population and the 4 geographic populations in Xishuangbanna based on the F_{ST} test on the haplotype frequencies (Table 2). The results of AMOVA analysis indicate that there is distinct genetic divergence between the Nangunhe

population and the Xishuangbanna one, which respectively belong to two distinct assemblages, β and α, according to the phylogenetic tree. In summary, we suggest that when the Reserve Management Department make up the policy to protect the elephants in Xishuangbanna and Nangunhe districts, they should consider them two separate populations.

Corridor designing and habitat restoration

Lin *et al.* (2007) analyzed a series of GIS, RS and GPS information on elephant range areas, ecological factors including altitude, landform, relief, villages and roads which affected the distribution and movement of Asian elephants, and suggested the possibility of designing and establishing corridors in Xishuangbanna National Nature Reserve. One important aim of planning and designing ecological corridors was to build a passage for elephants in Mengyang to migrate outside to communicate with those in Mengla and Shangyong and even those in Laos. Mangao sub-reserve was located far away from the others and no elephants lived there, so planning corridors linking it to the others was beyond consideration. Menglun sub-reserve was located between Mengyang and Mengla sub-reserves. It would be ideal if corridors could be established to link it with Mengyang and Mengla. But the large number of villages, farmlands and plantations as well as busy roads made it almost impossible to build corridors along this route because moving of lots of villages, redistribution of collectivistic forests and large amounts of compensation would be impossible. So it was suggested that corridors be established to link Mengyang, Mengla and Shangyong (Fig. 3).

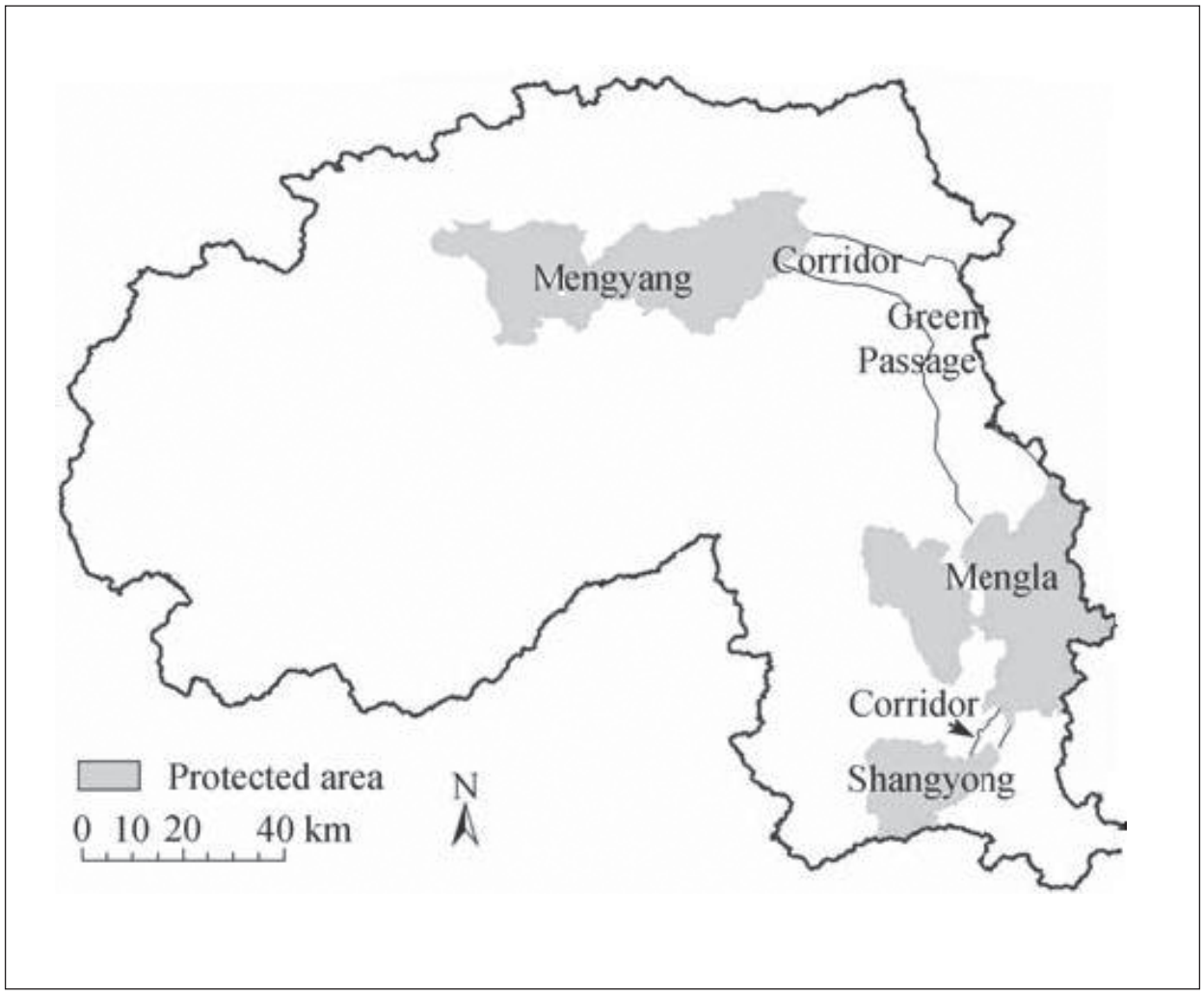

Figure 3. Panorama of designed corridors in Xishuangbanna (Lin *et al.* 2007).

Table 2. Analysis of molecular variance based on mitochondrial haplotypes (AMOVA).

Level of analysis	Variance components	Percentage variation	F-statistics	P-value
Among regions (MY-SM, SY-ML)	-0.01150 Va	-9.01	F_{CT}=-0.09013	0.780
Among populations within regions	0.01464 Vb	11.48	F_{SC}=0.10528	0
Within populations	0.12445 Vc	97.54	F_{ST}=0.02464	<0.001
Between regions (Xishuangbanna, NGH)	7.21347 Va	97.29	F_{CT}=0.97293	0
Among populations within regions	0.00322 Vb	0.04	F_{SC}=0.01605	<0.001
Within populations	0.19746 Vc	2.66	F_{ST}=0.97337	0

Details of the corridor routes should be determined based on comprehensive consideration. To link Mengyang and Mengla, a linear corridor would not be adopted because it would traverse a large number of villages and farmlands. A suitable corridor should traverse areas with less villages and more natural forests. Figure 3 showed that the long and narrow area which was located north to Mengla sub-reserve and west to the national boundary was occupied by continuous natural forests with few villages and many rivers in it. Earlier studies had indicated that a linear natural forest zone between isolated habitats had good potential and obvious advantages for corridor building (de Lima & Gascon 1999; Laurance & Laurance 1999). So this area was called a "Green Passage". And more inspiringly, there had been a few records of elephant activities in this area. So the "Green Passage" would be ideal for corridors linking Mengyang and Mengla.

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References

Feng, L. & Zhang, L. (2005) Habitat selection by Asian elephant (*Elephas maximus*) in Xishuangbanna, Yunnan, China. *Acta Theriologica Sinica* **25:** 229-236. [in Chinese with English summary]

Fernando, P., Pfrender, M.E., Encalada, S.E. & Lande, R. (2000) Mitochondrial DNA variation, phylogeography and population structure of the Asian elephant. *Heredity* **84:** 362-372.

Guo, Y., Zhang, L., Dong, Y. (2006) Foraging behavior of Asian elephants in Xishuangbanna, Yunnan, China. *Acta Theriologica Sinica* **26:** 54-58. [in Chinese with English summary]

Li, M., Wei, F., Rao, G., Fang, S. & Feng, Z. (2001) Application of noninvasive sampling in conservation genetics. *Acta Zoologica Sinica* **47:** 338-342. [in Chinese with English summary]

Li, Z., Li, H. & Lu, F. (1996) Evaluation of Asian elephant's habitat. *Remote Sensing of Environment China* **11:** 108-116. [in Chinese with English summary]

Lin, L., Zhang, L., Feng, L., Guo, X., Zhao, J. & Dao, J. (2007) A preliminary study on designing ecological corridors in Xishuangbanna National Nature Reserve with 3S techniques. *Front. Biol. China* **2(4):** 1–5.

de Lima, M.G. & Gascon, C. (1999) The conservation value of linear forest remnants in central Amazonia. *Biological Conservation* **91:** 241–247.

Sukumar, R. (2003) *The Living Elephants: Evolutionary Ecology, Behavior, and Conservation*. Oxford University Press, New York.

Sun, G., Xu, Q., Jin, K., Wang, Z. & Lang, Y. (1998) The historical withdrawal of wild *Elephas maximus* in China and its relationship with human population pressure. *Journal of Northeast Forestry University* **26(4):** 47-50. [in Chinese with English summary]

Laurance, S.G. & Laurance, W.F. (1999) Tropical wildlife corridors: Use of linear rainforest remnants by arboreal mammals. *Biological Conservation* **91:** 231–239.

Wang, L., Zhang, L., He, Q. & Zhang, J. (2006) Nutrition components analysis of food for Asian elephant in wild and in captivity. *Journal of Beijing Normal University (Nature Science)* **42:** 184-188. [in Chinese with English summary]

Zhang, L. & Wang, N. (2003) An initial study on habitat conservation of Asian elephant (*Elephas maximus*), with a focus on human elephant conflict in Simao, China. *Biological Conservation* **112:** 453-459.

Zhang, L., Wang, N., Wang, Y. & Ma, L. (2003) A preliminary study on the habitat and behaviors of Asian elephant (*Elephas maximus*) in Simao, Yunnan, China. *Acta Theriologica Sinica* **23:** 182-195. [in Chinese with English summary]

Zhang, L., Ma, L. & Feng, L. (2006) New challenges facing traditional nature reserves: Asian elephant (*Elephas maximus*) conservation in China. *Integrative Zoology* **1:** 179–187.

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Elephants in Xishuangbanna, China
Photo by Li Zhang

Gajah 27 (2007) 48-51

A Preliminary Study of Dung Decay in the Yala National Park, Sri Lanka

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Introduction

Assessing seasonal and geographic variation in dung densities can provide information on the temporal and spatial patterns of habitat use by elephants. Enumeration of dung densities also allows the calculation of elephant densities, provided the dung decay rate and the defecation rate can be estimated, and is one of the recommended techniques for elephant census (Dawson & Dekker 1992; Kangwana 1996). Dung decay rates may vary widely between seasons and habitats, and are required to be estimated concurrent with such studies. A study in Cameroon in which 870 dung piles were monitored *in situ* found that dung lasted 75 to 147 days on average depen-ding on the month the dung was produced (Nchanji & Plumptre 2001). Similar studies monitoring 1282 dung piles in Gabon (White 1995) and 426 dung piles in Ghana (Barnes *et al.* 1997) also found that rainfall, humidity and diet had major impacts on dung decay.

During a dung density study in the Yala National Park, we found wide variation in dung densities in different habitats and seasons. Therefore, we conducted a pilot dung decay rate study to assess the variation involved, in order to evaluate the need for and to design a detailed dung decay rate experiment to be conducted subsequently.

Methods

The Yala National Park is located in south-eastern Sri Lanka. The mean annual rainfall in the area is 750-1000 mm with a distinct wet and dry season (Survey Department 1988). Most rainfall occurs from October to January during the Northeast monsoon (>100 mm/month), and a few inter monsoonal showers occur from February to April (50-100 mm/month). The drought is intense from May to September. The study sites chosen were along the coastal strip of Yala and were approximately within 500 m of the sea. The vegetation in that area consisted of coastal scrub forest, dominated by thorny shrubs and interspersed with trees about 10 m high.

We collected a total of 144 individual dung boli estimated to be less than 12 hours old, from the vicinity of water holes and placed them at four different locations. At each location, 12 dung boli were placed on day zero (10th July 2006) and another 12 boli each added on days 2 and 4, making a total of 36 boli per location. Two locations (B and D) were inundated by the December 2004 tsu-nami and the other two (A and C) were not.

Boli (Fig. 1) were placed 5 m apart from each other on a line running from West to East (A, B and C) or South to North (D). Each bolus position was marked with a ribbon attached to the closest tree branch. The GPS position, cover (sun or shade), substrate type (earth, leaves, and/or plants), substrate moisture (wet or dry) and microhabitat (tree, shrub or open area) was recorded for each bolus at placement.

The experimental boli were visited at six day intervals, noting the amount of bolus remaining; if it was entire or broken up; presence of termites and if any part of the bolus was turned into earth by them; the presence and number of plants, mushrooms, and insects other than termites. A bolus was deemed to have 'disappeared' when it could not be clearly discerned from a standing position two meters away. From 24th January 2007 on, when only 11 boli were left (aged 194 to 198 days) the visit frequency was reduced to every 12 days. The study was terminated on 13th March 2007 when the remaining boli were 242 to 246 days old.

Table 1. Details of surroundings of the 144 boli.

Location		A	B	C	D	Total
Cover	Sun	18	29	29	32	108
	Shade	18	7	7	4	36
Substrate*	Earth	25	24	24	13	86
	Leaves	19	11	16	8	54
	Plants	0	9	2	25	36
Micro-habitat	Tree	15	7	7	3	32
	Shrub	19	6	13	7	45
	Open	2	23	16	26	67

* more than one can apply for a bolus

ANOVA and t-tests were conducted to assess the presence of significant variation in decay rate between locations and other environmental variables.

Results

Environmental parameters

Most (75%) boli were in the sun and location A had the highest proportion (50%) of boli in shade (Table 1). The microhabitat for 22% of boli was 'tree', 31% 'bush' and the remaining 46% 'open area'. Locations B and D had mostly 'open area', C had 'shrub' and 'open area', and D 'tree' and 'shrub'. The substrate of 60% of the boli was earth, 38% leaves and 25% plants (grass and herbs). The most common substrate in locations A, B and C was earth, and in location D plants (Table 1).

Most boli (85%) broke up and decayed gradually. Only 8 boli decayed very rapidly, ie. recorded as 'entire' on one visit and 'disappeared' the next. A total of 26 boli (18%) were covered by growth of surrounding plants and were recorded as 'disappeared'. Two boli were washed away by rain and one submerged.

Most boli (94%) had insects other than termites on them at some stage. Ants were observed on 43% and termites on 40% of the boli. Even if termites were not directly observed, most boli (84%) had signs of termite activity such as being turned into earth. On average the first termite activity was noted after 15 ± 29 days.

Figure 1. One of the study boli.

Mushrooms grew on 41% of boli and it took on average 112 ± 20 days for their first appearance. Germination of seedlings was noted on 22% of boli and it took on average 122 ± 21 days before the first seedling was observed. Wood apple (*Limonia acidissima*) was the commonest plant observed and was noted sprouting on 15 boli.

Time of disappearance

On average a bolus disappeared after 112 ± 51 days (Fig. 2). However, 8 boli were still present when the study ended after 246 days. As the time of disappearance for these 8 boli was not known they were excluded from the analysis. A gradual decay and disappearance of dung was noted over the first 100 days and a more rapid phase of decay over the next 50 days (Fig. 3).

Disappearance time varied significantly between locations (Table 2). Boli lying in the sun were found to last significantly longer than those in the shade (Table 2). Significant differences were observed between the 3 microhabitat types; tree, shrub and open area (Table 2). No significant difference in dung decay rate was found between areas affected and not-affected by the tsunami (Table 2) and termites were not a significant cause of decay (Table 2).

On average it took 122 and 112 days for the first plants and mushrooms respectively to sprout on a bolus. Boli with plants or mushrooms disappeared significantly later than those on which nothing grew (Table 2).

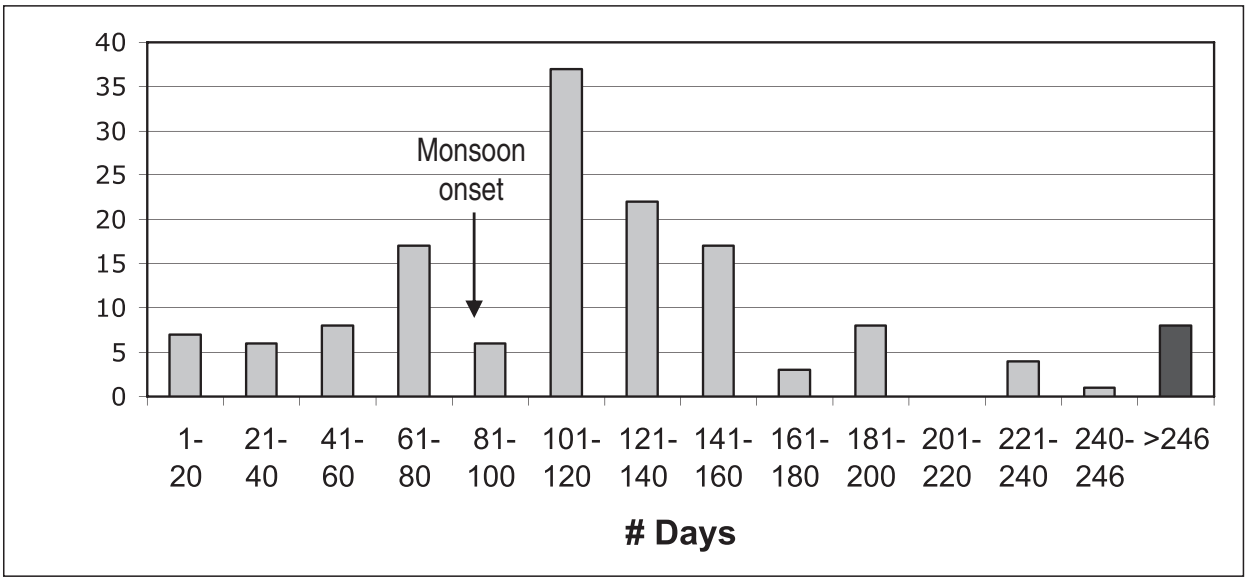

Figure 2. Histogram of the number of days it took for the 144 boli to disappear.

Discussion

The significant differences in decay rates observed between locations can be attributed to environmental factors. Exposure to sun was the most important determinant of decay rate, most likely due to the drying and hardening of the dung, leading to decreased bacterial activity and greater resistance to decay by physical factors.

Although most boli were colonized by termites, no significant difference in decay was observed due to them. In many cases, dung boli were converted to earth casts by termites, which tended to persist. Therefore, establishing a strict definition of what a termite cast is, and when a bolus so affected is deemed to no longer represent a dung bolus but 'disappeared' is important in dung decay rate and density studies.

A significant corelation between the age of dung and the presence of plants and mushrooms was noted. However, here the age of dung is the cause rather than the effect as both plants and mushrooms appeared after a period of a few months.

This study was set up in July, in the middle of the dry season, with brief rains occurring once in August and twice in September. The monsoon rains started on 13th October, at which time the dung in the study was 91 to 95 days old. The highest number of boli disappeared between 101 to 120 days (Fig. 2), likely related to the onset of rain.

Table 2. Average dung decay time and tests for significance of different variables.

Type	Group	N	Mean [days]	P
Location	A	34	67.3	0.0000 [A]
	B	34	129.6	
	C	32	147.9	
	D	36	106.0	
Tsunami	No	66	106.4	0.2090 [t]
	Yes	70	117.5	
Cover	Sun	102	119.6	0.0024 [t]
	Shade	34	89.5	
Micro-habitat	Tree	30	94.3	0.0092 [A]
	Shrub	42	104.4	
	Open	64	125.5	
Termites	Yes	117	111.6	0.7941 [t]
	No	19	114.9	
Plants	Yes	27	165.1	0.0000 [t]
	No	109	99.0	
Mush-rooms	Yes	51	153.1	0.0000 [t]
	No	85	87.5	

[A] = ANOVA; [t] = t-Test

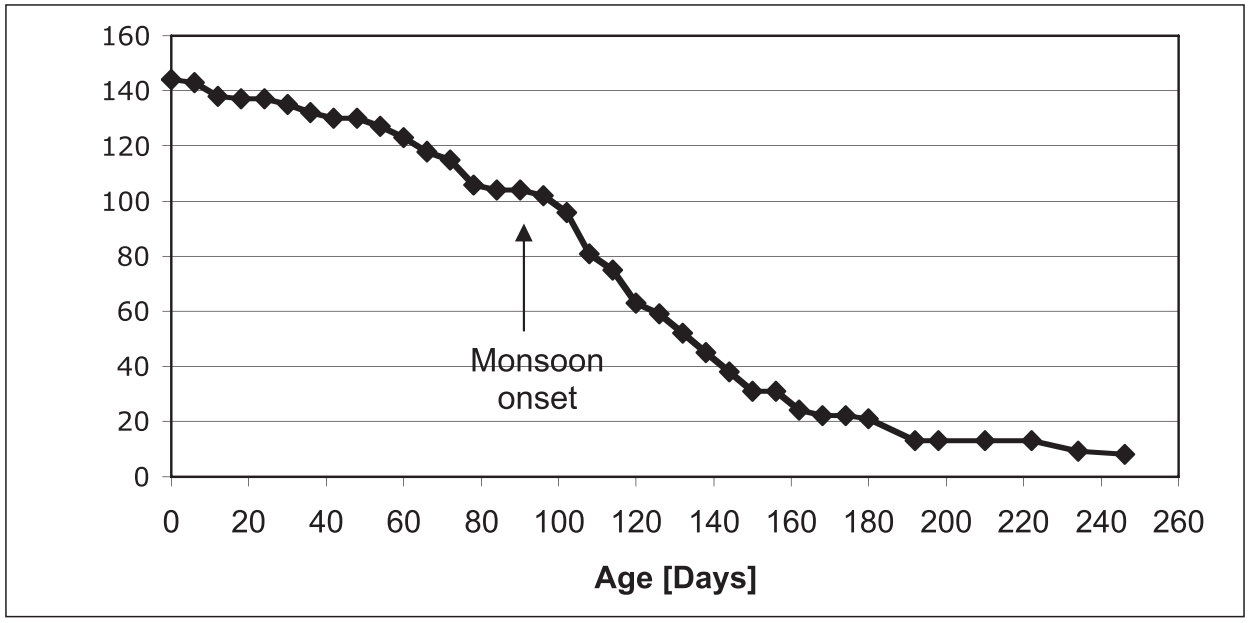

Figure 3. Graph showing the survival for the 144 dung boli over time.

Dung may be directly affected by rain, but more importantly, moisture may increase the activity of microbes, insects and other causative factors of decay. As the age of dung in our experiment was only 6 days apart, we could not discriminate between the affect of rain and age related factors of decay. However, our results suggest that rain is a major determinant of decay rates as observed in African studies (White 1995; Barnes *et al.* 1997; Nchanji & Plumptre 2001). Since the mean time of sprouting for plants and mushrooms were 122 and 112 days respectively, environmental changes consequent to rainfall are likely to have been the main cause of their appearance.

Our pilot study suggests that environmental variables have a significant influence on decay rates and that there maybe considerable variation in decay rates even within a particular habitat. Therefore, the need for a comprehensive dung decay study with replicates within and between habitats and seasons is supported.

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References

Barnes, R.F.W., Asamoah-Boateng, B., Naada Majam, J. & Agyei-Ohemeng, J. (1997) Rainfall and the population dynamics of elephant dung-piles in the forests of southern Ghana. *African Journal of Ecology* **35:** 39-52.

Dawson, S. & Dekker, A.J.F.M. (1992) *Counting Asian Elephants in Forests. A Techniques Manual.* RAPA Publication 1992/11. RAPA and FAO, Bangkok.

Kangwana, K. (1996) *Studying Elephants*. AWF Technical Handbook Series 7. African Wildlife Foundation.

Nchanji, A.C. & Plumptre, A. (2001) Seasonality in elephant dung decay and implications for censusing and population monitoring in south-western Cameroon. *African Journal of Ecology* **39:** 24-32.

White, L.J.T. (1995) Factors affecting the duration of elephant dung piles in rain forest in the Lopé Reserve, Gabon. *African Journal of Ecology* **33:** 142-150.

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Asian Elephants in the Seima Biodiversity Conservation Area, Mondulkiri, Cambodia

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Introduction

The Seima Biodiversity Conservation Area (SBCA) was established in 2002 by decree of the Ministry of Agriculture, Forestry and Fisheries of the Royal Government of Cambodia. The total area of the Conservation Area is 3034 km^2 (303,400 ha). The conservation area is located in eastern Cambodia in Mondulkiri and Kratie provinces. The site remains almost entirely forested and contains an unusually high diversity of forest types (Walston *et al*. 2001, WCS/FA 2006a, Zimmerman & Clements 2002), from Annamitic evergreen forest, through mixed deciduous formations to deciduous dipterocarp forest on the Cambodian Eastern Plains.

Southern Mondulkiri, the area which now forms the SBCA, was first surveyed for wildlife in 2000. Waltson *et al.* (2001), obtained camera-trap photos and found tracks and fresh dung from several elephants in what was then a Samling International logging concession. They concluded that:

"Assessing the population of elephant in the area is impossible without more intensive surveys in both the dry and wet season. However, it is clear that, although the species still exists in small numbers, the overall population has been reduced dramatically over the last few decades."

The Cambodian government's Forestry Administration (FA) began intensive conservation efforts with technical support from the Wildlife Conservation Society (WCS) in the SBCA in 2002. Since that time increasing efforts have been made to understand the status of Asian Elephants in southern Mondulkiri. Several mineral licks that are used regularly by elephants have been the location of dry season camera-trapping work since 2002. These results have helped the project identify key sites for elephants, and have led to the identification of several distinctive individuals, such as a bull with only one tusk. Since 2003, anecdotal observations and the data collection along standardised recce transects has revealed more information about the distribution of elephants in the landscape. These results have also identified dung and tracks from very young animals indicating that the population is breeding. The population size is small, however, and at low density. A faecal DNA based survey using capture-recapture methodology was carried out in 2006. When analysis is complete this survey will provide the first accurate assessment of the size of an elephant population in Cambodia. More generally, the survey tested the utility of the method for monitoring low-density Asian elephant populations.

The FA currently uses two main interventions to help protect Asian elephants and other species of conservation concern in the SBCA: (1) active law enforcement and (2) land-use planning. In addition, a range of other programs support and enhance these on-going field activities (WCS/FA 2006b). Political support is garnered at the local, provincial, and national level to help address issues ranging from large-scale economic land concessions, to localised disputes over resource access. Education and awareness of environmental issues are carried out by all components of the project, and through partnerships with other organisations. These and other activities help provide a suitable enabling environment. The core conservation strategies however remain law enforcement, together with land-use planning and community engagement.

Law enforcement

Law enforcement in the SBCA has to date managed to balance successful application of the law with support from local residents. This has been achieved without significant conflict. The

law enforcement strategy for the SBCA was designed in 2004 (Lynam & Soriyun 2004). It addresses the main threats to the site and elephants. The basis for all activities is the active enforcement of existing laws, specifically clauses within the Forest Law, and the Land Law. There are no laws, and regulations specific to the management of the SBCA. The strategy is to simply enforce existing, national level laws.

At present, protection of the elephant population is carried out using two main methods: (1) regular foot and vehicle patrols and (2) permanently-manned guard posts. These programs have been effective in controlling the principal threats of hunting, and habitat loss due to conversion to agriculture. The FA have hired and trained 32 staff from the FA, police, military and local communities to undertake patrolling activities with support from WCS. These staff have been equipped and trained to carry out

Figure 1. Single elephant passes a mineral lick in the semi-evergreen forest.

wildlife enforcement activities and record and collate elephant and other wildlife information. Training takes place annually for both new and seasoned patrol staff.

Figure 2. A pair of elephants wallowing in a mineral lick.

Patrolling is now continuous, with up to five teams in the field at any one time. Patrols operate out of four stations and regularly visit all critical elephant habitat. The locations of mineral licks and rivers that are of high importance to elephants are known by the patrol team and are the focus of regular patrols. This high level of patrolling is supported by an informant network of local villagers who report illegal activities to the law enforcement team leaders.

A specialised database, MIST (Management Information SysTem) is used to monitor and assess patrol effort and success. Enforcement teams record their location continuously, and the locations of any illegal activities encountered. These data are compiled and are used to track patrol effort and coverage, and the number of illegal activities encountered. These data can be used to show the degree to which critical elephant habitat has been patrolled. In addition this information shows that, since the start of intensive patrolling in 2004, there have been no documented cases of hunting of elephants.

The patrols and political support have also been successful in controlling encroachment and conversion. The whole of the SBCA is still under nearly 98% forest cover. This success in controlling encroachment is made clear through comparison with the neighbouring sections of Snoul Wildlife Sanctuary, which have been almost totally cleared of natural forest in the last five years.

Figure 3. A small group of curious elephants.

Land-use planning

The law enforcement work has been a success in part because of support from important members of the local communities. These communities have been supportive of the activities because law enforcement also protects their resources and traditional lands. However, a process of land-use planning is also required to ensure that the resource-gathering and farming practices that are carried out within the SBCA are compatible with the goals of biodiversity conservation. By stabilising land-use across the landscape the project will ensure that forest habitat is retained for elephants and other species.

The SBCA contains many indigenous villages and is fringed by large recent Khmer settler populations. This situation requires the Project to engage with communities to agree land-use zones and regulations because the laws themselves are sometimes quite vague. The Project works with partners at a local, provincial, and national level. One village in the SBCA is a national pilot site for the application of village level land use planning and the development of communal tenure. If successful these methods will be used across the SBCA in coming years. This work is done under the general heading of PLUP (Participatory Land-use Planning) which includes participatory research, legal extension, mapping, community organisation, and conflict resolution.

Land-use planning which protects vital elephant habitat whilst maintaining local residents' farmland is a critical tool in the prevention of human–elephant conflict (HEC). The project continues to monitor any reports of human–wildlife conflict. There are at present very few problems with HEC in the SBCA (Scally *et al.* 2007). This is surprising considering the close proximity of villages and farmland to elephant habitat, particularly in the dry season. This may be because there are still large areas of undisturbed elephant habitat. The potential remains, however, for further encroachment to lead to a dramatic increase in the level of conflict. This may be especially so along the southwestern border of the SBCA in Keo Seima district, which appears to be an important area for elephants, but has also seen a large amount of in-migration of people from other areas of Cambodia. Furthermore, elephants are encountered regularly only a few hundred metres from the village of O Am, and yet there is very little HEC. Monitoring of the situation and efforts to reduce impacts on elephant habitat will be a major focus of future project activities.

Figure 4. Elephant investigating the camera.

A significant elephant population is also known to the north of the SBCA in the Phnom Prich Wildlife Sanctuary (WWF in litt). There is some evidence of seasonal movement between this population and that in the SBCA. Further work is planned to determine the degree of connectedness between elephant populations in SBCA, Phnom Prich, and other protected areas (Bu Gia Map National Park in

Vietnam and Mondulkiri Protected Forest, Cambodia). To ensure the continued protection of Asian Elephant Habitat WCS and the World Wildlife Fund – Greater Mekong Program are working with the local government in Mondulkiri to develop a conservation plan for the province. This will form part of a multi-stakeholder landscape-scale corridor planning process under the Asian Development Bank's biodiversity corridors initiative.

Acknowledgements

Conservation of Asian Elephants in the SBCA is carried out by the Forestry Administration of the Royal Government of Cambodia. Technical support is provided by the Wildlife Conservation

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References

Lynam, A.J. & Soriyun, M. (2004) *A Conservation Management Strategy for the Seima Biodiversity Conservation Area, Southern Mondulkiri: Guidelines for Law Enforcement and Administrative Structure*. Wildlife Conservation Society - Cambodia Program, Phnom Penh.

Scally, K., Evans, T.D. & Nut Meng Hor (2007) *Human-Wildlife Conflict In and Around Seima Biodiversity Conservation Area, Mondulkiri and Kratie Provinces, Cambodia*. Wildlife Conservation Society Cambodia Program, Phnom Penh.

Walston, J., Davidson, P. & Soriyun, M. (2001) *A Wildlife Survey of Southern Mondulkiri Province, Cambodia*. Wildlife Conservation Society, Phnom Penh.

WCS/FA 2006a. *Threatened Species of the Seima Biodiversity Conservation Area*. Wildlife Conservation Society - Cambodia Program, Phnom Penh.

WCS/FA 2006b. *Vision for the Seima Biodiversity Conservation Area*. Wildlife Conservation Society - Cambodia Program, Phnom Penh.

Zimmerman, J. & Clements, T.J. (2002) *Preliminary Study of the Species Composition of a Gradient of Forest Types in Southern Mondulkiri, Cambodia*. Wildlife Conservation Society - Cambodia Program, Phnom Penh.

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Figure 5. The distinctive bull elephnat with only one tusk, drinking at a mineral lick.

Slippery Bed - An Effective Indigenous Method for Preventing Crop Damage by Elephants in Kerala

Kannan Govindaraj

Asian Elephant Research and Conservation Centre, Bangalore, India

Crop damage by elephants has been a major challenge for elephant conservation in India. Increasing incidences of crop damage has led to innovative mitigating measures to defend crops. There are several mitigating measures that have been tested for their efficacy. Most of the methods are effective in the short term, but have failed against habitual raiding elephants. Normally, selection of the crop protection method would depend on the conflict site and availability of funds. Elephant proof trenches and rubble walls are very expensive and not suitable for high rainfall and loose soil areas (Veeramani *et.al.* 2004). The traditional methods for deterring crop raiding elephants, such as fire and sound making, have generally failed except with animals that are closer to the field (Bell 1984). Slippery bed – an indigenous method made up of tall grass for protecting crops from elephants has been very effective in Anaiyarangal tribal settlement of Devikulam range, Munnar forest division, Kerala.

The Kerala State government had relocated tribals residing inside the forest to the pine plantation around the Anaiyarangal reservoir, a part of the elephant habitat in Munnar forest division. People living in the Anaiyarangal tribal colony have been experiencing human casualty and severe crop raiding by elephants for the past five years. Elephants, moving along the reservoir, used to congregate on the banks of the Anaiyarangal reservoir and finally end up in human habitation and cultivation areas.

To prevent crop damage by elephants, the tribals in the area developed an indigenous technique called slippery beds. Slippery beds were prepared using tall grasses. The cut and dried tall grasses were placed along the slopes of the banks throughout its length without any gap; this made it a very slippery stretch. If anything stepped on the grass, it would make the animal stumble or slip. All along the reservoir banks they have used the slippery beds to prevent elephant entry into human habitation. This indigenous technique has worked effectively and has reduced human elephant conflict considerably in Anaiyarangal. These slippery beds could be used to reduce human elephant conflict in other areas, having similar kind of site and problem.

Acknowledgements

I thank Prof. Raman Sukumar, Chairman, Centre for Ecological Sciences, Indian Institute of Science and Dr. N. Baskaran for the opportunity to work in the elephant project. I also thank my colleague Joshua David for her valuable comments on an earlier version of the notes. I also thank the Kerala Forest Department for permission.

References

Bell, R.H.V. (1984) The man–animal interface: An assessment of crop damage and wildlife control. In: *Conservation and Wildlife Management in Africa*. Bell, R.H.V. & McShane-Calluzi, E. (eds.) US Peace Coprs, Malawi. pp. 387-416.

Veeramani, A., Easa, P.S., & Jayson, E.A. (2004) An Evaluation of crop protection methods in Kerala. *Journal of the Bombay Natural History Society* **101:** 255-260.

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Gajah 27 (2007) 57 - 60

Gobal Elephant Management Program

Harald M. Schwammer

Vienna Zoo, Tiergarten Schönbrunn, Vienna, Austria

The Planning meeting for a global elephant management group took place from 23. - 25. August 2007 in Tiergarten Schönbrunn, Vienna, Austria. This article informs about development, structure, global approach and vision dealing with elephants under human care.

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Introduction

A group of zoo professionals within the IUCN Conservation Breeding Specialist Group met in 2004 and expressed their concern that none of the regional elephant populations appeared to be sustainable. This group also determined that zoos play an important role in elephant conservation through fundraising and their education programming. The group met again in Syracuse, New York in 2005 and examined the benefits of a global approach to managing regional elephant programs. They identified a list of global challenges, which could hinder zoos from keeping elephants in the future. Challenges were categorized by communication, reproduction, management, cooperation, finances, research and conservation. The group recommended that the World Association of Zoos and Aquariums (WAZA) set up a global group consisting of TAG chairs and studbook keepers from the regional zoological associations. This group, with their experience and expertise in elephant care, management, and conservation, would be responsible for developing a plan to ensure the continuation of *ex situ* elephant populations and enhance their impact on conservation. WAZA's Comittee on

Inter-Regional Conservation Cooperation (CIRCC) agreed, at their mid-year meeting in April 2007, that there was a need for an inter-regional group of elephant experts.

Concurrently, Regional Program coordinators were reaching similar conclusions. A group that included representatives from the European Association of Zoos and Aquaria (EAZA), Australasian Regional Association of Zoological Parks and Aquaria (ARAZPA), Association of Zoos and Aquariums (AZA), and South East Asian Zoos Association (SEAZA) agreed that global management and collaboration would be necessary to maximize the management and reproductive goals for ex situ elephant populations. As a result, they agreed to convene and begin examine the need and feasibility of an inter-regional elephant program.

From 23. – 25. July 2007 elephant experts from ARAZPA, AZA, EAZA, SEAZA attended a meeting hosted by the Vienna Zoo to discuss a global strategy for managing zoo elephants.

Global Elephant Management Program structure

There will be a single program covering all species/subspecies of elephants.

Chair

Harald Schwammer (unanimously elected as Chair by meeting participants)

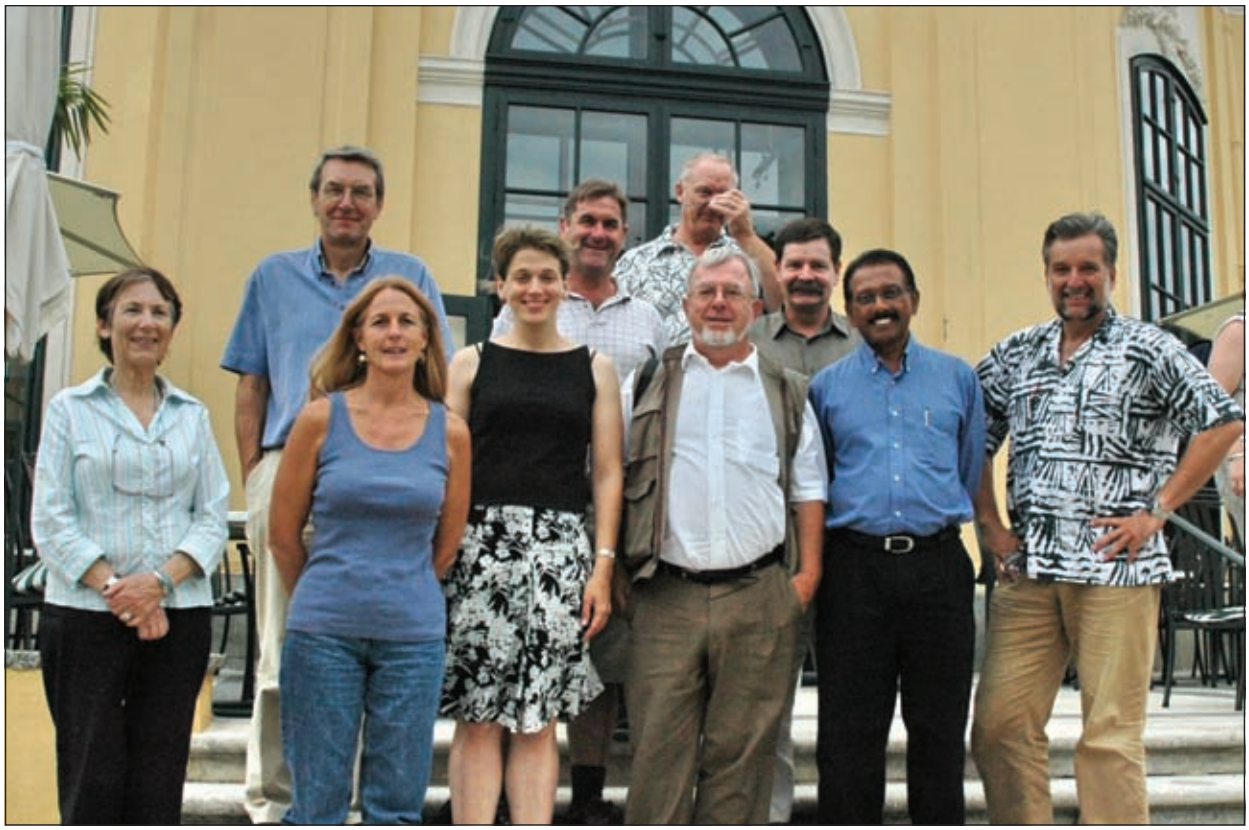
Members

Comprised of elephant program leaders from each of the regional zoological associations. Associations, which have already agreed to participate, include EAZA, ARAZPA, SEAZA, and AZA.

Recently the members of the board are:

Ton Dorresteyn, Rotterdam Zoo, EAZA Elephant TAG Chair, EAZA Asian Elephant Co-Studbook Keeper (directie@ rotterdamzoo.nl)

Mike Keele, Portland Zoo, AZA Elephant TAG/SSP Chair, AZA Asian Elephant Studbook Keeper (mike.kele@oregonzoo.org)



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GEMP has been approved by WASA in August 2007.

Studbook

An international studbook is not recommended at this time. Regional coordinators will work with each other as needed to share data for population management and research.

Advisors

Appointed from each of the regional zoological associations (e.g., Public relations advisors will be Lisa Keen, ARAZPA, and Steve Feldman, AZA)

Vision statement of the Global Elephant Management Program

The Global Elephant Management Program is comprised of inter-regional elephant experts working cooperatively to initiate conservation, education and research programs to ensure that elephants continue to exist in our care and in the wild.

GEMP recommendations for population sustainability

1. Place all potential breeding bulls in a breeding situation.
2. Exchange breeding bulls that have sired an adequate number of viable offspring in one institution.
3. Place all potential breeding females – especially those under 25 years old – in a breeding situation. Monitor reproductive cycles of all individuals in breeding situations.
4. Encourage development of matriarchal family units including female offspring, and keep these units intact. However, to promote additional stable female groups or prevent young cows from breeding with their fathers, it is acceptable in some cases to move groups of sibling or half-sibling females away from their matriarchal unit.
5. Facilities without a bull that are temporarily sending potential breeding females to be inseminated at another zoo should send whole female groups, or relevant units of a group, to the host zoo.
6. Further development of artificial insemination (AI) techniques should be encouraged; however it should never replace the most important method of reproduction: 'natural' reproduction. AI must be carried out only upon recommendation and approval of the regional coordinator, just as with any other breeding recommendation.
7. All zoos that rebuild elephant facilities should design new enclosures that can hold at least one bull and four cows. If a zoo is not able to start keeping a bull within a reasonable period of time, the zoo will be considered a non-breeding facility and recommendations for that institution will be to only obtains/houses non-reproductive females.
8. Development of facilities for bachelor herds of several adult bulls is urgently needed. Bulls should be kept in bachelor herds when they are temporarily not in a breeding situation or before they reach that stage. Bachelor herd facilities should stimulate relevant social behaviour between the surplus bulls, and serve as a genetic reservoir.
9 While it may be desirable, keeping young elephants in their family group until they reach puberty is often not practical for breeding management. Young elephants should preferably not be transferred out of their family units before they are four to five

years of age. A young elephant being transferred should be accompanied by at least one other member of the herd in which it was born.

10. When an animal is transferred, it is recommended that an elephant keeper from the receiving institution spend some time working with the animal at the sending institution first. Additionally, a keeper from the sending institution should accompany the animal to the receiving institution for a suitable period of time when possible.
11. New/renovated enclosures should be constructed to provide flexibility for all management styles in such a way that maximises animal welfare and keeper safety.
12. Close cooperation between regional breeding programs, e.g. exchange of bulls, is vital to the sustainability of elephant populations.
13. Disease has an impact on populations (e.g., TB, EEHV) and further research is needed. Veterinary experts should continue to work on minimizing and managing disease.
14. Dissemination of information (e.g., veterinary, management) is essential for the success of cooperative programmes.
15. All institutions holding elephants should contribute to the conservation of elephants in the wild.

The GEMP started its business, and first action is to establish a global information system for professionals. The first digital package has been sent around with topics like basic information about GEMP, new results of herpes-research and recommended future research programs on elephants.

We are now informing and contacting all national zoo-federations and also establish a veterinarian – expert list from all continents. So the whole program now could be started.

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Captive elephants in Sumatra
Photo from the VESSWIC archive

Assam Elephant Foundation – Prelude to a Solution

Kaushik Barua

Assam Elephant Foundation, Guwahati, India

Introduction

Assam is home to one of the largest populations of Asian elephants, both wild and captive. The need for a practical and comprehensive approach to save the elephants of the region led to the formation of the Assam Elephant Foundation (AEF), a trust formalized in early 2007 for in–situ and ex–situ conservation of elephants in Assam, India.

AEF has organized health camps for elephants and their handlers, and conducted around a dozen rescue operations involving elephants both in the wild and in captivity.

The work of the AEF can be considered under two main sections:

Human-elephant conflict

Last year WWF India requested the services of AEF in their North Bank Landscape Project which involved the deployment of koonkies, (domestic elephants trained in elephant capture) to drive out wild herds in high HEC areas. AEF helped plan and implement the programme, and provided trained elephants and logistics. Similar programmes were also carried out jointly with the State Forest Department in Goalpara and Hojai and. AEF has proposed their extension to Rani and Chakrado.

Currently AEF, in conjunction with the State Wildlife Department, is working towards setting up permanent Koonkie Camps in these areas. Eight koonkies that were used for illegal logging and rescued by AEF, will be used for this project. AEF is also working closely with local communities, conducting community development and capacity building as part of this programme. Depending on the success and achievements of the project, AEF plans to adapt it to other areas of Assam.

Elephant Conservation Center

AEF is setting up an Elephant Conservation Center in Sonapur, Assam, which will house a state of the art veterinary facility for elephants.

The Center will:

a) Provide a refuge and rehabilitation center for old, sick and neglected elephants.

b) Provide an orphanage for abandoned or rescued elephant calves. A systematic approach for releasing calves into a semi–controlled environment will also be envisaged.

c) Carry out scientific studies relating to conservation of Asian Elephants both in the wild and in captivity in Assam, including a Captive Breeding Programme.

d) Develop programmes in the field of elephant management, care and health targeting elephant handlers, managers and owners.

e) Set up an Interpretation and Resource Facility, which will act as an information bank and will:

- Educate the public about elephants and create awareness on conservation issues.
- Involve communities in conservation projects and carry out community development and capacity building programmes.
- Work with individuals, local bodies, government agencies and institutions engaged in the conservation of elephants.
- Formulate programmes on Mitigation of HEC keeping in view Assam's age-old traditional and cultural relationship with elephants – under the motto "Man Elephant Co–Existence".

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Request for Information on Elephant Behaviour

Jeheskel Shoshani

Elephant Research Foundation, Bloomfield Hills, USA

My colleagues and I have been compiling the available data, information, and observations (published and unpublished) on elephant behaviours that indicate cognitive thinking processes beyond innate or programmed behaviours. We have collected much information and we are preparing a paper for publication incorporating these observations together with the accumulated knowledge of elephant brain. We are also trying to understand, in an evolutionary perspective, what physical and social attributes are required to make a tool.

Before submitting our paper, we thought that we might have missed some published material and there might be readers who would be willing to share observations to augment our knowledge on elephant behaviour. We ask readers to please send us any observations related to tool using and/or tool making in elephants. Please note that we already have collected many references on these topics (e.g.,Chevalier-Skolnikoff, S. & Liska, J. [1993, Animal Behaviour 46: 209-219]; Hart, B.L. et al. [1994, 2001, 2002, in press, Neuroscience and Biobehavioral Reviews]; Poole, J.H. [1998, Etica & Animali 9: 85-110]), but it would not hurt to send references, just in case we did not see them.

More importantly, we ask you to send us your unpublished observations of elephant tool using and/or tool making (if you have photos, that is even better). Depending on the content of your observations, we can either acknowledge your help, or should you feel that your contribution warrants co-authorship, we will evaluate the content of your contribution and discuss the options. Below are the information/data we request:

Brief description of the observation, location (as accurate as possible, with GPS if available), date, gender (F, M) and age (young, adult, sub-adult) of the elephant, place of observation – captivity (C) or in the wild (W), and source (complete reference) or date, for unpublished observations. I provide below four examples.

1. Asian, ?, ?, Sad, Ad, DESCRIPTION: Uses planks and branches to place under feet to prevent from sinking in the mud. SOURCE: Sanderson (1962).
2. Asian, C, M, Ad, DESCRIPTION: Elephant fails to obey command to lower pillar into a hole until a sleeping dog in the hole is chased away, possibly to avoid hurting the dog. SOURCE: Pillai (1941).
3. Asian, W, F, Yg, Sad, Ad, DESCRIPTION: Modify branches to make leech scrapers, body scratches, and to chase away flies. SOURCE: Peal (1879).
4. Asian & African, W & C, ?, Sad, Ad, DESCRIPTION: Modify branches by shortening them or by removing side branches for a purpose — to drive away flies. SOURCE: Hart & Hart (1994), Hart et al. (2001, 2002); Braden (2003, attributed to I. Douglas-Hamilton and/or J. Poole).

Kindly send information to:
Jeheskel Shoshani at hezy23@gmail.com

Thank you.

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Book Review

"The Asian Elephant in Captivity - A Field Study" by Fred Kurt and Marion E. Garaï
"The Sri Lankan Elephant in Captivity" by Fred Kurt and Marion E. Garaï

Reviewed by Jayantha Jayewardene

In The Sri Lankan Elephant in Captivity, Fred Kurt and Marion E. Garaï have outlined how the lives of captive elephants could be improved. It provides data on ecology and behaviour of captive elephants in relation to their wild counterparts. These stem from a recent research project carried out by the authors and colleagues in Sri Lanka together with a number of their studies on wild and captive elephants in Sri Lanka, South India, Myanmar, South Africa and several European zoos and circuses.

The book starts off dealing with body characteristics like weight, shoulder height, depigmentation, ear forms, length and density of hairs and mastication frequencies which are given according to sex and age to define age criteria and social classes.

Captive elephants engaged in forest and conservation work were observed to spend their 'free' time in nearby jungles, where they find food, meet tame and wild elephants and reproduce on a more or less regular basis. Contrary to these extensively managed elephants those living in temples and urban areas are kept intensively. They are chained when not used and fed. Social contacts are avoided, reproduction is absent or rare.

Wild and captive elephants differ considerably in many respects, e.g. the diversity of daily activity, diet and behaviour. Differences have been found in the use of tools, such as sticks to scratch the skin or stones to be thrown at adversaries. Wild elephants use a variety of different tools but captive ones use certain tools more often.

Feeding time at the Elephant Transit Home in Udawalawe, Sri Lanka (2007)
Photo by Jennifer Pastorini

The authors have found differences in behaviour and body growth, not only between wild and captive elephants, but also between captive elephants growing up under different living conditions. It seems that orphans slept more and performed 'weaving' behaviour more often. The authors consider 'weaving' a ritualised searching (repetitive) behaviour, which evolved from permanent rhythmical fore and backwards steps accompanied by searching trunk movements.

The authors believe that long lasting lack of contacts with other elephants lead to the incomplete development of social behaviour and even infanticide. Social isolation was found to be only one of numerous other defects, due to restraints by inadequate conditions in captivity leading as well to retarded body growth and occasionally obesity, malfunction of feet, teeth and ligaments, or low or even absent successful reproduction.

About the authors

Dr. Fred Kurt, member of the AsESG, has taught at the Pedagogic High School of Zurich, Switzerland, and the University of Veterinary Sciences of Vienna, Austria. For over 40 years Fred Kurt has been engaged in studies of Asian elephants. Between 1967 and 1969 he was field director of the Smithsonian elephant survey in Sri Lanka and between 1997 and 1999 headed a team of 111 students from Sri Lanka and five western countries to study behaviour and ecology of wild and captive Sri Lankan elephants.

Dr. Marion E. Garaï, member of the AfESG, She is the founder of the Elephant Management & Owners Association (EMOA) in South Africa and its chairperson. She is also the chairperson of Space for Elephant Foundation (SEF).

The Asian Elephant in Captivity - A Field Study
Fred Kurt and Marion E. Garaï (2007)
Cambridge University Press India, New Dehli
352 pages, ISBN 81-7596-358-1

The Sri Lankan Elephant in Captivity
Fred Kurt and Marion E. Garaï (2007)
Vijitha Yapa Publications, Sri Lanka
352 pages, ISBN 955-1266-47-1

Elephants bathing in the river at the Pinnawala Elephant Orphanage in Sri Lanka
Photo by Jennifer Pastorini

News Briefs

Gajah 27 (2007) 65 - 67

1. Indian elephants prefer crops to forest fodder

Reuters
April 26. 2007

A government study in India has shown elephants prefer food crops to forest fodder and often travel hundreds of miles to the same farmland every year, even remembering specific months of harvesting.

Elephants in India are having problems with shrinking habitats, usually travel long distances and mostly do it as a routine. With constant encroachment from growing cities and villages, their habitat range has shrunk and they end up searching for food at various places. Instead of searching for food in the forests, the elephants go to nearby farms and start eating the crops planted in the fields. According to Ujjal Bhattacharjee, chief conservator of forests in West Bengal, India, the elephants like the farm crops better, they make it a point to visit again just in time when the foods are ready to be harvested.

This federal government study was done over four years on Asian elephants in West Bengal state. The researches and wild life experts trapped dozens of elephants and installed radio and satellite collars to monitor this behavior.

Elephants are migratory animals and move from one forest to another through corridors which are now fragmented due to villages and farmlands, conservationists say, making the animals change their habits.

The villagers because of limited land are beginning to encroach the forests and start planting farm crops, which makes it easier for these animals to eat the crops. Shakti Ranjan Banerjee of the Wildlife Protection Society of India said the elephants eating habits changed because of the encroaching by farmers.

The Elephant population is dwindling in India, from 50,000 a century ago to 21,300 currently. The loss is also due to illegal hunting of elephants for their ivory tusks. Elephants are also shot by hunters for precious ivory and sometimes killed by villagers to protect their fields.

After this study, the researchers and wild life experts want to help preserve and strengthen the foraging paths of the elephants, so want to relocate the villagers to a safer place.

It is a good step, now the villagers and elephants can live side by side without harming each other.

2. Rampaging elephants force Indonesians to relocate

Antara News
April 26, 2007

Jakarta - Thousands of Indonesians will be relocated on Sumatra island after wild elephants repeatedly attacked their villages killing six people, officials said Wednesday.

The local government will move about 10,000 people living in Bukit Barisan National Park, a protected habitat for the animals whose numbers on the island are fast diminishing.

Villagers in the past have co-existed with the elephants in the 363,000 hectare (896,000 acre) park which has been declared a World Heritage Site.

But new communities were springing up in the park, encroaching on the animals' habitat and causing a series of violent clashes, an official at the Lampung provincial forestry office said. "We need to relocate thousands of people living in the national park zones to prevent the clashes from recurring," official Arinal Junaidi said.

Conversation group WWF said the elephants had trampled six people to death in the park in the past 12 months and destroyed villages and crops. Nurchalis Fadli of WWF added that it appeared the same six female elephants were involved in the clashes, although it was unclear why. "It was not their fault. The incidents have occurred in the elephants' natural habitat," Fadli told AFP.

He added the relocation of the villagers was a huge task, as they had built communities and were farming crops.

WWF is also attempting to track the movement of the animals, by tagging their necks with a device containing a global satellite positioning system, Fadli said. Six elephants had been tagged since November, he added.

The WWF has said that elephants in Sumatra, one of two Indonesian islands where they are found, were dying at an alarming pace with numbers dropping by 75 percent in just 18 years. As of 2003, only about 350 to 430 wild elephants remained on the island in seven provinces, it said. Their natural habitat is being increasingly taken over by resettlement, plantations and industrial estates. (*)

3. Elephant census in State from May 7 (India)

S Prashantha, Deccan Herald
April 28, 2007

The Forest Department is all geared up to conduct the three-day-long elephant census in the State, scheduled to begin from May 7.

Experts from Indian Institute of Science, Bangalore, held a session to train department officials in the methods and procedures for the census, at Bandipur, on Thursday. It was attended by officials of various cadres, including the CCFs, Conservators, ACFs and DFOs from across the State. In turn, they will train the other department personnel and volunteers, who will actually conduct the census. Meanwhile, the department is looking for volunteers physically fit enough to handle the job. It is also planned to rope in research students for the purpose. The elephant census is being held in Kerala and Tamil Nadu on the same days. This will, it is hoped, help in correctly estimating the number of elephants since the three States share the same forest border. This way, there are hardly any chances of "duplication" in enumeration.

Chief Conservator of Forests (Project Tiger) S Rajanna told Deccan Herald that three methods would be adopted: 'Direct counting' on sighting the animal, and the "indirect method of counting their droppings". Counting male, female and baby elephants from herds sighted in a water body would be the third.

The census will be done with the direct method on May 7, with the water-hole method on May 8 and the indirect method on May 9. About 30 to 50 per cent of the forest area will be covered during the counting and the figure thus arrived at would be extrapolated to include the total forest area.

According to the statistics available with the department, Bandipur topped the list in the State with 1217 elephants as per the last census conducted in 2005, while Nagarahole came second with 804.

4. First elephant released into wild under foundation plan (Thailand)

Pasara Puthamat, The Nation
May 20, 2007

After two years of careful training to prepare Pang Kham Mool Yai for life in the wild, the 35-year-old elephant was yesterday released into the Sublangka Wildlife Sanctuary. Kham Mool Yai is the first domesticated elephant to be introduced to the wild under a programme that will see a further 80 released over time by the Elephant Reintroduction Foundation. However, many fear the animals may not be able to adjust.

Kasetsart University's Narit Bhumiphakphan said domestic elephants born and raised in captivity depended on humans for survival. "It will be very hard for them to change their habits and survive," he said. But foundation chairman Sumet Tantivejkul argued Kham Mool Yai had two years to learn to survive. The elephant has been living in Sublangka with her mahout during that time. "She is now ready to live in the forest as a wild animal," he added.

Sumet explained foundation staff would observe Kham Mool Yai for the next five years. The foundation was established several years ago in response to concerns of Her Majesty the Queen. When indigenous logging

was ended in Thailand in the 1980s, thousands of domesticated elephants were out of work. Handlers were forced to roam them in cities, begging for money or food to care for the animals.

5. Elephants could join dodos in Vietnam central highlands

Thanh Nien Daily
May 22, 2007

Deforestation and owners' callousness have taken a toll on elephant populations both in the wild and in captivity in Vietnam's central highlands, sending the giant animals to the brink of extinction. There are only a few hundred elephants left in the area compared with thousands a century ago, the International Union for the Conservation of Nature and Natural Resources reports. Dak Lak province, once a pachyderm haven, now has just 50 elephants, mostly in captivity. Residents point out that the relentless illegal logging has robbed the elephants of their habitat and left them in a permanent state of agitation. Besides, the animals are chained, preventing them from mating, spelling further doom for their numbers. They are not in great health to start with since their owners work them into the ground.

Residents in Gia Lai province's Nhon Hoa village are nostalgic about the elephants' heyday around 40 years ago when people were proud about the number of elephants. The disappearance of the elephants has badly affected elephant-related cultural festivals in the region, they grumble.

The Gia Lai and Dak Lak provincial administrations have begun to act to save the elephants from extinction. They have called for using In Vitro Fertilization (IVF) and offering elephants private spaces to mate. A Gia Lai-based tourism company has bought three elephants for VND50 million (US$ 3100) and uses them to entertain tourists as a last-ditch effort to conserve the pachyderm. But a long-term plan to protect and preserve elephants is yet to be chalked out.

6. Rare Nepal elephants have tuberculosis

Reuters
June 12, 2007

Ten of Nepal's 250 endangered elephants are suffering from tuberculosis in a national park and the disease is threatening to spread to humans and other wildlife, authorities said on Monday.

Chitwan National Park in southern Nepal attracts thousands of tourists every year and has numerous rare wildlife, such as rhinoceroses and tigers. Park authorities said tests had confirmed at least 10 of 100 domesticated Asian elephants in Chitwan had contracted the disease in the past two years. "Tests have confirmed that the elephants have tested positive for TB and we are trying to provide treatment," Kamal Gaire, a senior veterinary official, said by phone from Chitwan, 50 miles south of Kathmandu. "This is serious because it may spread to human beings." Park officials said this is the first time that tuberculosis in elephants had been reported in the Himalayan nation.

Nepal has about 150 elephants in the wild and about 100 domesticated pachyderms, some of which are used in safaris by private hotels and state-run national parks. Elephants are a protected species in Nepal and killing them carries a jail term of up to 15 years.

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