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TAPIR SPECIALIST GROUP

Tapir Conservation

The Newsletter of the IUCN/SSC Tapir Specialist Group

www.tapirspecialistgroup.org

Edited by Siân S. Waters and Stefan Seitz

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HOUSTON ZOO NATURALLY WILD

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The large picture on the cover page shows a lowland tapir (*Tapirus terrestris*) at a breeding facility in Araxá, Minas Gerais State, Brazil. Credit: Cláudio Valladares-Pádua.

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Abbreviation: Tapir Cons.

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LETTER FROM THE CHAIR

Much has happened over the past six months. First of all, I would like to tell you that the TSG has a new logo – you can see it below and on the cover page of this newsletter! Gilia Angell, an experienced web/graphics designer who works for Amazon.com in Seattle, United States, supported by Kelly Russo, communications specialist of the Houston Zoo, worked together to create the logo. The development of the logo involved an exhausting process of working on many

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different designs based on the feedback from TSG members until we reached a final design that seemed to appeal to everyone. For that, I am extremely thankful to both Gilia and Kelly! After we were done with the logo, Gilia volunteered to help us with the design of the new TSG web site and she is once again relying on the group's feedback and support to create the site. The domain (www.tapirspecialistgroup.org) has already been purchased and the site is up, although only a few links are currently working. We still need a few months to have all the information available on the site. Any suggestions, comments, criticisms etc. will always be more than welcome! We strongly believe that this new site will be an excellent tool to promote the work of the TSG, to publicise tapir conservation initiatives and projects and to raise funds for tapir conservation. On another note, Kelly Russo and Alberto Mendoza, Community Programmes Coordinator of the Houston Zoo, continue to work on the development of tapir and TSG brochures! Thank you, Gilia, Kelly and Alberto!!!

The TSG Conservation Fund (TSGCF) finally became reality and we conducted our first funding cycle in July. Most of the funds were raised through the "Friends of TSG" campaign conducted in partnership with the Tapir Preservation Fund (TPF), and consisted of personal donations from tapir researchers, supporters and enthusiasts worldwide. Once again, I would like to thank those of you who made donations for the campaign! The TSGCF only accepted applications from TSG members for the 2003 funding cycle and seven proposals were received. A TSGCF committee reviewed each application and selected projects based on the merits of each proposal and its significance for tapir conservation. Three tapir researchers – Iván Lira Torres from Mexico, Adrián Naveda from Venezuela, and Emilio Constantino from Colombia – were awarded small grants (for further details see "TSG Conservation Fund 2003" in this issue). We are really happy about this, and about the fact that after so many years we are finally moving in the direction of being able to support some projects financially. I will do my best to make sure that our contributions are wisely used, always for the benefit of tapirs in the wild and in captivity. Hopefully, we will be able to raise a larger amount of funds in 2004 and fund even more projects. Right now, TSG members and supporters have been discussing some marketing ideas to better promote the fund and some fundraising strategies to get more donations for next year's cycle.

In August, we held the Malay Tapir Conservation Workshop at Krau Wildlife Reserve, Malaysia, which was a very successful event. The workshop was organised by the TSG, the EAZA Tapir Taxon Advisory Group (TAG), and the Department of Wildlife and National Parks (DWNP), Malaysia. It was facilitated by Dr. Phillip Miller and Amy Camacho, who are members of the IUCN/SSC Conservation Breeding Specialist Group (CBSG). We had 35 participants from Malaysia, Indonesia and Thailand, and also TSG representatives from several other countries. The final outcome of the meeting

The Honorable Minister of Science, Technology and Environment for Malaysia, Datuk Law Heing Ding, who spoke during the opening ceremony of the Malay Tapir Conservation Workshop, held at Krau Wildlife Reserve, Malaysia, in August 2003. Photo by Charles R. Foerster.

The Malay Tapir (Tapirus indicus) was the focus of a conservation workshop held in Malaysia, in August 2003. The main outcome of the meeting was an updated action plan for the conservation of the species. Photo by Charles R. Foerster.

was a revised and updated action plan, listing and prioritising strategies and actions for the conservation of Malay tapirs. The CBSG team is reviewing the first draft of the action plan, and as soon as we have the final version of the document we will print and distribute copies to all interested parties in Southeast Asia. This document will also be incorporated into the next version of the IUCN/SSC *Tapir Status Survey and Conservation Action Plan* (1997), currently under revision. The TSG would like to thank all those people and organisations directly or indirectly involved in the workshop, especially

the staff of the DWNP in Malaysia, who organised the most tiring and complicated part of any event, the logistics! Also, we are extremely grateful to the Copenhagen Zoo, Denmark, the major funding source for the workshop. For further details about the workshop see the article "Malay Tapir Conservation Workshop: A Major Success" in this issue.

Speaking of TSG events, we keep working on the organisation of the Second International Tapir Symposium, which will be held in Panama City, Republic of Panama, from January 10 to 16, 2004. Currently, the planning committee is working tirelessly to raise the necessary funds for the conference. As one of the fundraising strategies, the TSG, in partnership with the AZA and the EAZA Tapir TAGs, is approaching all zoos and other institutions holding any of the four species of tapirs worldwide to request contributions for the symposium. Zoos are contributing and we are moving forward with the organisation. The Second International Tapir Symposium website (http://www.caligo.com/tapir/) is set up for registration, and the planning committee has been receiving and reviewing abstracts. The first part of the Symposium will consist of talks by keynote speakers and paper and poster sessions addressing tapir biology, research and conservation. Some of the speakers already confirmed are Joe Fragoso, who has worked on tapirs in Belize and Brazil for most of his professional life, and will give a keynote speech; Rick Barongi and Lewis Greene, respectively former and present chair of the AZA Tapir TAG, will make a presentation about the recently developed Tapir TAG Action Plan; Bengt Holst, chair of the EAZA Tapir TAG, will tell us about the activities of the group and let us know about their plans for captive tapirs in Europe; and Alan Shoemaker, will make a presentation about two important documents recently published, the AZA Tapir TAG Regional Collection Plan for Tapirs, and the Tapir Husbandry Standards. Wally van Sickle with Idea Wild, Gilia Angell with Amazon.com, and Kelly Russo with Houston Zoo, will conduct workshops focusing on fundraising and marketing ideas for the TSG. Anders Gonçalves da Silva, a Brazilian researcher who is doing his Ph.D. at Columbia University, and Javier Sarria from Colombia, will conduct a workshop on tapir genetics. Phillip Miller with the IUCN/SSC CBSG will conduct a workshop about Population and Habitat Viability Analysis (PHVA) and action planning for tapirs. Susie Ellis with Conservation International will once again help us with the facilitation of the TSG planning workshop. We are all very excited about this upcoming symposium and we are expecting more than 100 participants from over 25 countries.

During the past months, we have added five new members to the Tapir Specialist Group. Ms. Siti Khadijah Abd Ghani and Mr. Carl Traeholt from Malaysia, field coordinators of the Malay Tapir Project recently established in Krau Wildlife Reserve, Malaysia. Siti and Carl are doing an amazing job in Krau, and I am certain that they will be able to contribute a lot to our activities regarding the conservation of Malay tapirs in Southeast Asia. Mr. Anders Gonçalves da Silva from Brazil, who, as I mentioned before, is currently doing his Ph.D. at Columbia University working on landscape genetics. Anders is planning to develop a major genetic study for Latin American tapir species all over their range and will present his initial ideas during the upcoming symposium in Panama. Don Goff, Director of Animal Programmes for the Beardsley Zoological Gardens, and AZA Studbook Keeper for lowland tapirs. Joe Roman, Curator of the Virginia Zoo, and AZA Studbook Keeper for Baird's tapirs. Both Don and Joe have been keeping the studbooks for many years and have constantly supported the work of the AZA Tapir TAG and the TSG.

On another note, it is with regret we had to accept Dr. Nico van Strien's wish to step down from the position as the TSG Malay Tapir Coordinator. Nico has done a tremendous job for the TSG during the past three years and his constant contribution will be missed. Nico will continue as a member of the group and will certainly keep helping us in Southeast Asia. In view of this we had to look for another person to take over this important role. During the Malay Tapir Conservation Workshop in Krau Wildlife Reserve, Malaysia, we held a small TSG meeting in order to discuss potential candidates for the position and there was a general consensus that our next Malay Tapir Coordinator should be a person from a Malay tapir range country. The process of identifying the right person for the position will take some time. In the meantime Mr. Carl Traeholt has kindly agreed to take over the job on a temporary basis. I would like to thank Nico for all his hard work over the past years and to welcome Carl to the TSG and to the Malay Tapir Coordinator position.

A few months ago, Dr. Mariano Gimenez Dixon, Programme Officer of the IUCN Species Survival Commission (SSC), informed us about recent progress regarding the IUCN Global Mammal Assessment (GMA). The GMA will be a collaborative effort of all the SSC Specialist Groups concerned with mammals. For the collection of data, IUCN will provide each Specialist Group with the "Data Entry Module" of the Species Information Service (SIS) software, which will be a way to jump-start data acquisition capabilities for the mammal Specialist Groups. The data incorporated in this project will not only serve the GMA, but will also go back to the Specialist Groups to be maintained, managed, and continually updated as part of the SIS. There are various advantages in using the data entry module as it will allow the collection of information on species in an electronic format making it easily available for future use; data will be entered using a standard format and standardised authority files, which will facilitate data entry and allow comparisons between different taxa. Copies of the module can then be sent to different Specialist Group members to enter information. This method

will allow the workload to be distributed between various people and allow experts to enter information on their particular species, while maintaining consistency in the overall process. The information coming from different colleagues will then be merged "centrally". It is envisioned that the GMA will take two years to reach completion. In April 2004, IUCN plans to conduct a comparative analysis of the conservation status of mammals, birds, and amphibians. By this date, the conservation status of all the known species of these three major taxonomic groups will have been evaluated (or re-evaluated) according to the IUCN Red List Categories, allowing a comparative analysis. The TSG will be actively involved in the GMA project.

Finally, I would like to tell you that I have just returned from the American Zoo and Aquarium Association (AZA) Annual Conference that was held in Columbus, Ohio, United States. This was a very productive event for the TSG. Gilia Angell prepared basic, simple TSG brochures that were widely distributed during the conference along with copies of previous issues of the *Tapir Conservation* newsletter. During the conference, members of the AZA Tapir TAG and myself made sure to promote the upcoming Tapir Symposium and work on funding possibilities for the TSG Conservation Fund.

Once again, I would like to thank Rick Barongi and the Houston Zoo for sponsorship of printing and distributing the TSG *Tapir Conservation* Newsletter!

The next months will be very busy, as always, and will certainly bring lots more positive results and good news about TSG. I will make sure to keep you posted!

Best wishes from Brazil,

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TSG NEWS

TSG Conservation Fund 2003

By Patrícia Medici

The Tapir Specialist Group Conservation Fund (TSGCF) was recently established as a vehicle to raise and contribute funds towards tapir conservation initiatives. The organisations involved in the management of the TSGCF are the IUCN/SSC Tapir Specialist Group (TSG), the Houston Zoological Gardens, the Tapir Preservation Fund (TPF), the American Zoo and Aquarium Association (AZA) Tapir Taxon Advisory Group (TAG), and the European Association of Zoos and Aquaria (EAZA) Tapir Taxon Advisory Group (TAG), which are today the key groups working on coordinating and implementing tapir research, conservation and management programmes. The money in this Fund consists of personal donations from tapir researchers, supporters and enthusiasts worldwide, as well as contributions from conservation organizations and tapir holding institutions and zoos.

A TSGCF committee reviews each application submitted and decides to fund projects based on the merits of each proposal, significance for tapir conservation, and several other criteria. Grants are given to projects targeted at research with wild and/or captive tapirs; projects targeted at restoration, protection and conservation of tapir habitat in South and Central America and Southeast Asia; education and capacity-building programs for local communities within the tapirs' range in South and Central America, and Southeast Asia; and implementation of the recommendations of the IUCN/SSC *Tapir Status Survey and Conservation Action Plan*. The proposals must be cooperative in nature and have matching funds. The fund does not support salary, tuition fees, scholarships, conferences, courses and meetings, or operational/overhead costs for institutions or established projects and/or programmes. The proposal must be scientifically significant and sound, logistically feasible, must have a high probability of success and clearly contribute to the conservation of tapirs and their remaining habitats.

During the 2003 funding cycle, the TSG Conservation Fund received seven proposals and three of those were selected for funding. On the following page, you can see the titles and coordinators of each project, as well as brief abstracts from each one. I would like to congratulate Iván, Adrián and Emilio for the excellent job they have been doing in Mexico, Venezuela and Colombia respectively.

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The Grantees of the TSGCF 2003

Field Verification of Baird's Tapir Distribution in Oaxaca, Mexico: An Important Step Towards a National Conservation Action Plan

Iván Lira Torres, Mexico

Iván Lira Torres
from Mexico.
Photo by Steve Divers.

Abstract: Baird's tapir is listed as an endangered species in all Mesoamerican countries. This species had a continuous distribution from southeastern Mexico to northwestern Colombia, ranging from coastal forests and wetlands at sea level to cloud forests and paramos above 3,000 m. However, high rates of deforestation, habitat fragmentation and over hunting have restricted current tapir distribution to protected and/or remote areas. Given the fast human population growth in southeastern Mexico, it seems essential to maintain large preserves for the survival of viable tapir populations. It is also very important to identify large forest fragments where tapirs remain in order to promote habitat management, hunting regulation, and other conservation practices in the surrounding human communities. Within the country, it is suspected that tapirs survive in some forested areas of southeastern Mexico. Nonetheless, the presence of these mammals has not been verified in most of the potential distribution areas, especially those without protection. This project aims to: (1) obtain field data to create an updated map of tapir distribution in Oaxaca, Mexico; (2) identify non-protected areas in the state where tapir populations still survive; and (3) to assess the isolation of forest fragments large enough to shelter viable tapir populations. These objectives are all included in the Action Plan's list of priorities for Baird's tapir conservation (Matola *et al.* 1997).

Ethnozoology of Lowland Tapir in Venezuela

Adrián Naveda-Rodriguez, Venezuela

Adrián Naveda
from Venezuela.
Photo by
Sonia Hernandez-Divers.

Abstract: This project will study the different uses and management of *Tapirus terretris* and its products (meat, skin, bones) by local people in two states of Venezuela. We will interview hunters and their families in order to gather information on the relationship that they have with tapirs and other wildlife species. With these interviews we also hope to gather information on the biology and local distribution of tapirs. The information gathered will let us know the biomass extracted and measure the local level of threat which tapirs are under in Venezuela, at the same time the information may be used for the design of management plans.

Identification of Forest Fragments with Populations of the Colombian Tapir *Tapirus terrestris colombianus* and Strategies for its Conservation

Emilio Constantino, Colombia

Emilio Constantino
from Colombia.
Photo by Diego Lizcano.

Abstract: The Colombian tapir *Tapirus terrestris colombianus* is one of the most endangered tapir species in the world, due to its small range, the destruction of its habitat and to over hunting. Identification of the remnant populations needs to be done urgently if remaining populations are to be conserved for the future. Its habitat in central Colombia is becoming highly fragmented due to forest destruction and cattle ranching. Most of the area is today in private hands, so the localisation of remnant populations could lead to the establishment of private nature reserves and regional strategies for tapir conservation. The best fragments will be located by means of satellite imagery and aerial photography and also by interviews with local hunters, biologists and conservationists. Visits to several of those places will be useful to confirm the presence of the tapirs, to assess their local conservation status, to determine threats to them and to propose actions for their conservation. Some of these actions could be to acquire land for the establishment of new reserves, development of an educational strategy for the local communities or other activities identified in the Action Plan for Tapir Conservation in Colombia.

TSG Committee Reports

Update from the TSG Veterinary Committee

By Sonia M. Hernandez-Divers and Donald Janssen

Note: The information on this document overlaps with tasks accomplished as AZA Tapir TAG Veterinary Advisor.

The following tasks have been accomplished in the last two years:

1.) Responded to 71 emails in regard to health issues. The majority of these questions came from abroad, with the largest majority originating from Latin America. The most commonly requested information dealt with the following topics: reproduction/contraception, nutrition, vaccination, immobilisation and questions about specific clinical signs.

2.) Summarised tapir mortalities in the North American captive population from 1996-2002.

3.) Preshipment/Quarantine Guidelines for tapirs for the Veterinary Advisory Group.

4.) Formulated a document, which outlines the rationale for including a veterinarian in field projects.

5.) Formulated a list of health-related priorities for research as a way to aid the IUCN/SSC Tapir Specialist Group Chair in prioritising research needs.

6.) Created a document to guide field researchers who do not have continuous veterinary assistance in the area of biological sample collection.

7.) Summarised previously reported immobilisation protocols in one document.

8.) Revised the updated version of the *AZA Husbandry Manual for Tapirs*.

Acknowledgements: We would like to thank Karin Schwartz, ISIS Registrar, without whom we could not have compiled the mortality survey.

NB: Copies of the documents not contained within this manuscript can be obtained by contacting the TSG Veterinary Committee Coordinator (shernz@aol.com)

Update from the TSG Zoo Committee

By Siân S. Waters

I was appointed the new coordinator of the TSG Zoo Committee last December. The Zoo Committee has a membership of 16 people world-wide. New members include Bengt Holst from Copenhagen Zoo, Denmark who is the European Taxon Advisory Group Chair for Tapirs, Aude Desmoulins, the EEP studbook keeper for lowland tapirs based at Lille Zoo in France, Angela Glatston, Curator of Hoofstock, Rotterdam Zoo, Netherlands and Sheryl Todd who needs no introduction! Kerry Crosbie of Perth Zoo is the ARAZPA regional studbook keeper for the Malay tapir and the member for Australasia.

The tasks for the zoo committee are various but we have made some headway this year. Earlier in the year, Patrícia Medici finished and circulated a list of zoos that support conservation projects *in situ*. This was a major piece of work and will be an extremely useful resource for TSG members.

A register for people who have expertise in keeping tapirs in captivity has now been initiated and there are now 20 keepers, vets and scientists registered from nine countries on the database. If anyone is interested in registering then please contact me by email with your name, position, address and details of your experience with tapirs.

The most important task at present is to cooperate with interested zoos on the development of educational signage for tapir exhibits that will also include information about the work of the TSG. A small sub-committee has been appointed which consists of animal, educational and graphics staff from various zoos to deal with this task. A number of zoos have expressed interest in collaborating in this project and we hope to have this off the ground by the end of the year.

Please don't hesitate to contact me if you have any ideas, suggestions or would like to help with the work of the Zoo Committee.

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CONSERVATION

The Malay Tapir Conservation Workshop: A Major Success

By Patrícia Medici and Bengt Holst

During the First International Tapir Symposium held in Costa Rica, in November 2001, it became clear that one of the biggest concerns among tapir experts was the limited attention that has been given to the conservation of Malay tapirs and that TSG should give this species priority. As a consequence, the TSG decided to organise and hold a Malay Tapir Conservation Workshop in Asia. The European Association of Zoos and Aquaria (EAZA) Tapir Taxon Advisory Group (TAG), the IUCN/SSC Conservation Breeding Specialist Group (CBSG), and the Malaysian Department of Wildlife and National Parks (DWNP) kindly agreed to support this initiative and the first steps towards the organisation of this important meeting were taken about two years ago.

Habitat Threats Working Group. Photo by Charles R. Foerster.

The workshop was held in Krau Wildlife Reserve, Malaysia, August 12-16, 2003, and was a major success. The group was formed by 35 participants from Malaysia, Indonesia, and Thailand, with TSG representatives from several other countries also participating. Unfortunately, we did not have any participants from Myanmar. Dr. Phil Miller and Amy Camacho from the IUCN/SSC CBSG facilitated the workshop using a *Population and Habitat Viability Analysis* (PHVA) format. The PHVA is a very efficient and systematic working process that gets all relevant stakeholders together, identifying status and problems, and based on that generating research and establishing conservation priorities for specific species. It combines a quantitative risk assessment tool with intensive discussions and deliberations of the biological and social issues relevant to the species conservation across its range. Taken together, the risk assessment modelling and focused, stakeholder-driven deliberations are designed to directly address the issues affecting the species so that alternative strategies can be analysed rationally and systematically. When this occurs, better conservation decisions and specific action steps with targeted responsibility will result.

The first step of the workshop was to put together all the available information and data about Malay tapirs. Participants contributed scientific articles, data and knowledge of the species and its habitat, and listed the major issues related to Malay tapir conservation. Based on this, participants were divided into four different working groups:

1.) **Distribution and Habitat**
2.) **Population Biology and Simulation Modelling**
3.) **Habitat Threats**
4.) **Species Management**

Each group had a series of tasks: (1) Identifying and defining problems and ranking them in order of priority; (2) Developing goals to achieve the change in the conditions identified in the problem statement, specifying minimum and maximum goals to achieve in the next five years, developing goals for each problem and ranking the goals in order of priority; (3) Developing actions to accomplish the goals identified under the problems or issues, taking into account the scientific information on the species, its habitat, and the threats identified.

Major issues addressed by the **Distribution and Habitat Group** were related to collection, management, sharing and storage of data in Southeast Asia. There is a lack of uniformity and quality in data collection methods, coverage and human resources (including officials and the general public). There is insufficient unified management and weak international coordination and collaboration. In addition, there is limited access to land use data and rivalry between stakeholders. There is a fear of unauthorised use, misuse and loss of control over data. And, finally, there is lack of centralised, coordinated and secure data storage.

The group listed several goals to deal with the problems identified and three of them were considered to be major priorities:

- To build the capacity of field staff to meet the minimum requirements of the ASEAN

occupational standards;
- To build the capacity of personnel in data analysis and interpretation;
- To ensure sufficient data quality control at all staff levels.

Priority actions listed by this group were:

- Approach regional agencies and request they incorporate/promote tapir conservation into their planned training programmes for nationals to meet ASEAN PA (Protected Areas) occupational standards.
- Widely distribute workshop outputs to relevant agencies/institutions and field personnel.
- Recommend to those agencies/institutions under whose jurisdiction wildlife research and management fall, that they ensure that each tapir research project includes a training component for local people (staff/community/students).
- Develop/build capacity on data collection.
- Develop a tailor made system reflecting the national needs and capacity that can ensure collected data are double-checked, crosschecked and deficiencies addressed.
- Strive to obtain independent review of information intended for public disclosure/publishing.

Major problems identified by the **Population Biology and Simulation Modelling Group** were:

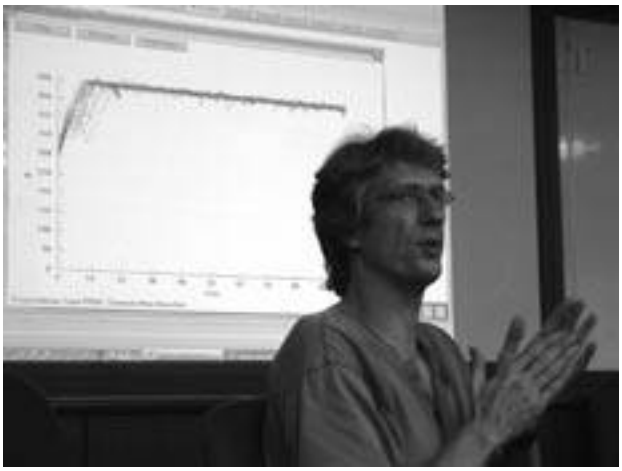
1.) A lack of understanding of basic tapir biology and how threats impact on them.
2.) The need for alternative management scenarios.

The group listed the following goals:

- Develop a greater understanding of basic tapir biology and how human activities impact those processes.
- Evaluate alternative management scenarios.

Demographic parameters for Malay tapirs were discussed and estimated, a basic model was developed, and several simulations were conducted. Some of the most important results from the simulations were:

1.) *Probability of Extinction*: The Malay tapir populations simulated during the workshop, with all the assumptions made, were able to maintain moderate or no extinction risk in the absence of extraction (*e.g.* hunting) only if their numbers were moderate to large (50 or more). If the population is under extraction pressure, the numbers needed to maintain low extinction risk are much larger, as much as 10 times more (500 animals). Furthermore, in small populations a small increase in extraction levels (of only 5%) can double the chances of the population going extinct. Because both accidental and intentional extractions occur throughout the Malay tapir's range, and because population numbers are low at any given place, it is very likely that current populations are at high risk of extinction within the next 100 years if no further conservation actions are taken.



Dr. Phil Miller, IUCN/SSC Conservation Breeding Specialist Group (CBSG) presenting the first results of the Population Biology and Simulation Modelling Group. Photo by Charles R. Foerster.

2.) *Growth Rate*: The simulations conducted during the workshop also provided insights into the average growth of the populations over 100 years given the combination of population sizes and extraction rates. Under the "no hunting" scenario, only populations with 50 or more individuals showed a positive average growth during the entire interval. Because the demographic stochasticity represented in the exercise was conservative, it is likely that a larger number will be needed to ensure positive growth. A 10% extraction rate will require 100 individuals or more; 20% extraction levels will require more than 1,000 individuals. A population of 2,000 tapirs was insufficient to maintain a positive growth under 25% extraction.

3.) *Genetic Diversity*: Loss of genetic diversity behaved similarly across all hunting scenarios, and was largely determined by the size of the initial population. Populations of 20 to 50 tapirs were able to retain only 60% or less of the original heterozygocity levels after 100 years. At least 500 individuals were needed to ensure no loss. These results suggest that current population levels are at high risk of genetic erosion over the next 100 years.

Overall, the group concluded that despite conservative values of demographic stochasticity and low extraction levels, tapir populations must be maintained at high numbers to ensure their long-term survival, growth and genetic health. Because such high numbers are unlikely to be found throughout their range, the Malay tapir is under considerable threat.

Priority actions listed by this group were:

- The design and implementation of two detailed field studies (Sumatra and Peninsular Malaysia) to generate more precise estimates of selected demographic parameters, such as density and survival rates (primarily of adults).
- Improvement/additions to our database on the distribution of Malay tapirs throughout their range.
- Design and implementation of a study to evaluate the genetic diversity of Malay tapirs throughout their range.
- Assessment of the level of extraction of Malay tapirs (hunting, by-catch, road mortality, etc).
- Periodic addition of results from long-term studies into a Malay tapir central database.

The **Habitat Threats Group** identified the following issues:

1.) Reduction in available habitat for tapirs due to various legal and illegal processes including concessions in protected areas, open or illegal logging and expanding cultivated areas.
2.) Fragmentation of tapir habitat due to roads, power lines, other human infrastructure, creation of protected areas with or without buffer zones.
3.) Damage or destruction to habitat due to shifting cultivation or vandalism.
4.) Deliberate killing for sport hunting or pest control, or by live capture for pet trade, or incidental take from snaring, ignoring restrictions on licenses.
5.) Mass tourism causing disturbance of normal reproduction/behaviour leading to reduction in available habitat.

The goals identified to change the conditions were:

- No net loss of tapir habitat in core areas;
- To minimise fragmentation of existing tapir habitats and to reduce exposure of habitats to edge effects.
- To minimise the negative effects of fires on tapir habitats.
- To minimise the number of tapirs killed or captured by humans.
- To minimise the negative effects of mass tourism on tapir habitats.

Priority actions listed by this group were:

- To conduct awareness campaigns on the need for conservation of tapir habitats
- To create incentives and support for people on the ground to enforce the law.
- To include conservation concerns in land use planning.

The **Species Management Group** identified the main issues related to tapir conservation as being a lack of appropriate policies, research, and public awareness.

Priority actions recommended by this group were:

- Revision of policy regarding wildlife management in Southeast Asia.
- Conducting national level studies on resource management, land use, development, biological diversity, policies, and identification of sectors that support tapir habitat conservation.
- Fundraising for tapir research.
- Training on *in-situ* and *ex-situ* tapir conservation (*e.g.* population dynamics, species biology, reproduction, behaviour).
- Establishment of a global tapir forum.
- Organise a NGO meeting on tapir conservation;
- Establishment of an awareness campaign (local people, hunters);
- Organisation of a rural participatory workshop;
- Creation of opportunities in tourism-related jobs.

Species Management Working Group. Photo by Charles R. Foerster.

Recommendations coming from all four groups were put together and prioritised. The final outcome of the meeting will be a very detailed and updated action plan, listing and prioritising strategies and actions for the conservation of Malay tapirs. The CBSG editorial team is reviewing the first draft of the action plan, and as soon as we have the final version of the document we will print and distribute copies to all interested parties in Southeast Asia. Also, this document will be incorporated as the Malay Tapir Chapter in the next, revised edition of the IUCN/SSC *Tapir Status Survey and Conservation Action Plan* (1997).

The TSG would like to thank all people and organisations directly or indirectly involved in this workshop. First of all, we would like to thank Nico van Strien, former TSG Malay

Plenary session. Photo by Charles R. Foerster.

Dr. Ardinis Arbain, Andalas University, Indonesia, presenting the final results of the Species Management Group. Photo by Charles R. Foerster.

tapir coordinator, for all his help and useful advice during the organisation of the meeting. Also, we thank the CBSG staff, especially Dr. Phil Miller and Amy Camacho, for helping us to design the most appropriate format for the meeting. The organisation of this workshop would never have been possible without the support from the Malaysian Department of Wildlife and National Parks. We would like to extend our gratitude to the Director for Research, Siti Hawa Yatim, Dr. Kae Kawanishi and Ms. Ramlah Abdul Majid for all their hard work organising the logistics of this meeting. Financial support for the meeting was kindly offered by the Copenhagen Zoo in Denmark, our largest donor, and from the Wildlife Conservation Society Thailand, the Department of Wildlife and National Parks of Malaysia, and several other funding agencies that supported partial or total expenses for some of our participants.

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CURRENT PROJECT UPDATES

Colombia

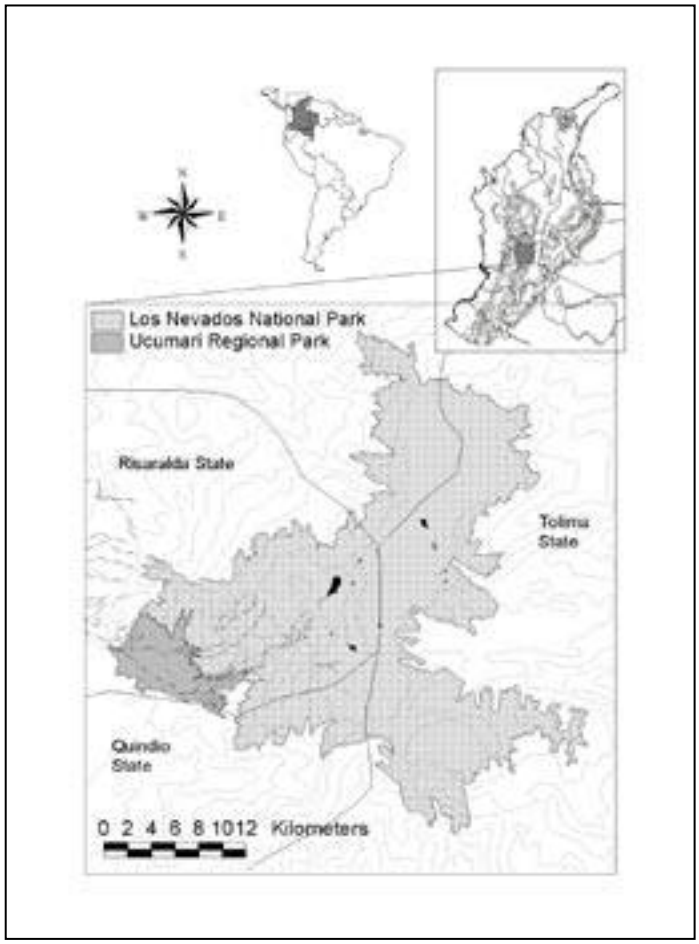
Ecology and Conservation of the Mountain Tapir in the Central Andes of Colombia

By Diego J. Lizcano

In the tropical Andes, the mountain tapir (*Tapirus pinchaque*) is the largest mammal, eating a variety of plants, fruit and seedlings, along tapir trails and in tree fall gaps (Acosta *et al*. 1996; Downer 1996). Studies in Bolivia's lowlands suggest that herbivory by large mammals affects plant community dynamics by reducing the competitive ability of faster growing herbaceous species, which would out compete less competitive species (Painter 1998). But to date we do not have similar data for the tropical Andes region. This research will provide information regarding the importance of mountain tapirs as herbivores.

Hunting in the Neotropics is important to the livelihood of natives and colonist peoples of South America (Redford & Robinson 1987). The growing human population and more

efficient hunting technology increase the pressure on prey species often to the point of local extinction (Bodmer *et al*. 1994). Usually the preferred game species are large herbivores, like tapir, which have a greater predisposition for overharvesting because of their low reproductive rate (Bodmer *et al*. 1997). Thus, the disappearance of large herbivores may alter the structure and species composition of a forest. For this reason it is important to understand why people hunt in the tropical Andes and what the consequences are of this hunting for the animal populations and for the forest.



Study area in the Central Andes of Colombia.

This project is studying the ecological importance of the mountain tapir in structuring the understory and canopy plant communities of tropical montane forest. It is also looking at how hunting of large mammal populations affects the ecological role of these herbivores. In the proposed research, I am studying the plant-animal interactions of mountain tapir in the tropical Andean forest ecosystem and the causes and effects of hunting on the large mammal populations in Los Nevados National Park, Ucumari Regional Park and surrounding areas in Risaralda state, in the Central Andes of Colombia.

A combination of observations and manipulative experiments are being carried out. Twenty-five exclosures (3 x 6 m) using mesh wire and wooden poles and 25 control plots in a nested design were located between 2500 and 3600 m. This experiment will allow us to evaluate the impact of mountain tapirs as herbivores on Andean forest. Specifically I am evaluating the effect on biomass availability, structure and diversity. The diet of mountain tapirs is being studied using microhistological techniques (Alipayo *et al.* 1992; McInnis *et al.* 1983) and habitat use by sign counts. Hunting is being studied using simple data forms, which are completed by hunters, using methods of participatory research. The culmination of this study will help us understand what happens if hunting eliminates the mountain tapir population in the tropical Andes region. The results obtained will provide additional insights into the ecological functions of these herbivores, which will enhance existing and future management plans for tapirs and other large mammals in Colombia.

Data on mountain tapir habitat use will be useful to CARDER (Corporación Autônoma Regional de Risaralda), the regional environmental authority, who plan to increase their protected areas system with the creation of a new protected area adjacent to Ucumari Regional Park and Los Nevados National Park, the areas in which this study is being undertaken. In addition, the information on hunting will be useful to CARDER and the National Parks Office of the Ministry of the Environment, to enable the improvement of protection in their protected areas and to design strategies for the conservation of the most hunted mammals. New data on plant-animal interactions underline the importance of mountain tapirs not just as a species but also as a crucial component of the tropical Andean forest and Páramos.

This study received financial support from a Rufford Small Grants for Nature Conservation, UK, Instituto Alexander von Humboldt, Colombia, and an equipment grant from IdeaWild, USA.

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Tolima Jimba Kush

By Franz Kastón Flórez

Jimba Kush or mountain horse is what the Nasa Wesh community (indigenous Paez people of the Central Colombian Cordillera), call the mountain tapir (*Tapirus pinchaque*). This indigenous group migrated to the Tolima department from the Cauca Department in the south of Colombia about a century ago. The Nasa Wesh community has lived closely with this species, now endangered due to natural resource exploitation.

In 2000, an application to export a pair of wild caught mountain tapirs out of Colombia to Asia failed. Colombia conservationists proposed a plan that would lead to advancement in the knowledge and preservation of this endangered mammal in Colombia itself. In addition, the preservation of this species must also have a positive impact on the quality of life of the people that currently share their environment with the mountain tapir. Today there is the opportunity to invite the Nasa Wesh to share in the planning process.

The department of Tolima has three National Parks (the parks of Hermosas, Nevados and Nevado del Huila) within its boundaries. All these parks have tapirs and some degree of protection is afforded to the species. However, there are also mountain tapirs outside national parks that do not have any legal protection. For this reason, the location of the Nasa Wesh indigenous community in the Tolima Department between the Nevado del Huila Park and the Hermosas Park, directly links them with the future of this species and its habitat.

The current situation of the Tolima Department that has such influence over the future of the mountain tapir, is that it has many farmers with various socio-economic needs; the original landscape has been transformed into agriculture including cattle ranching, potato, poppy and pasture cultivation. Furtive hunting of tapirs occurs and the opening of a new highway to cross the Central Cordillera has also had an impact. There have been armed insurgents in the area in the past, but since a regional peace pact in 1995 with the Nasa Wesh communities these problems have improved.

Internationally, it has become more and more evident that people, organisations and zoos have become increasingly interested and concerned about helping to conserve this endangered species. With this in mind, a long-term strategy has been in place since 2002 that will help overcome problems in the community and thus guarantee the preservation of *T. pinchaque* and its habitat in this region of the Tolima Department.

The first step of this strategy is to ascertain the population status of the species inside the indigenous territory. This is presently being undertaken in collaboration with the Tolima Government.

The biological and health research program will then be followed by the controlled breeding of this species within the indigenous territory and natural habitat of the tapir. This will be *in situ* management, stimulated by the success obtained with reproduction of this species in zoos.

Once the young tapirs are obtained, there will be two lines of action:

1. The establishment of a core of individuals born in the Central Cordillera that can be used as support to interact demographically and genetically with captive and wild populations;
2. Agreements developed with zoos exhibiting these captive born animals outside Colombia could channel important economic resources back into the country to benefit local tapir conservation initiatives.

These actions will help indigenous peoples and farmers understand that the value of the mountain tapir goes beyond food. It can become a positive resource to the community involved in a world-wide effort to conserve the Andean bio-system. It can represent jobs for members of the local communities.

In the educational context, workshops have been and will be conducted to inform the indigenous community about the biology and conservation of the species and its habitat and enable coordinated efforts.

It has been suggested that the mountain tapir be named the Colombian national animal. This will help inform the Colombian people about the species, establish it as an emblem and thus emphasise the value of the tapir and the importance of preserving biodiversity in the Colombian Andes.

We are all aware of how difficult this job will be but we are enthusiastic about the fact that the region still has something very important – mountain tapirs in their natural habitat. We hope that, as the designated objectives are achieved, the efforts of the local peoples will not permit this species to disappear from Colombia.

Additionally, DNA samples of different tapirs of the area have been obtained and these will be used to measure the genetic diversity of the population. This, together with health evaluations, will allow for detailed knowledge regarding the health and biological characteristics of these *T. pinchaque*

individuals from the Tolima locality and thus support the conservation strategy.

Up until now, the tasks have been difficult because it is not easy to obtain financial resources in Colombia to develop these activities. However, we hope that by using strategies such as the development of a poster showing images, articles and providing information about mountain tapirs and international contributions, we can overcome these obstacles.

I want to thank Ovidio Paya (indigenous Nasa Wesh Governor of Gaitania-Tolima) and Juan Carlos Escobar (naturalist) and the other people who made the development of this project possible. I am also grateful to Sheryl Todd and Patrícia Medici for comments on an earlier version of this manuscript.

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The Nasa Wesh indigenous community plays a role in conservation of mountain tapirs in Colombia. Photo by Franz Kaston Flórez.

Ecuador

Attitudes to Tapirs, Wilderness, and Wildlife Conservation in and around Sangay National Park, Ecuador

By Craig C. Downer

Introduction

A questionnaire survey of 15 settlements around Sangay National Park between October 2001 and March 2002 attempted to reveal the current status of the knowledge, attitudes and lifestyles of inhabitants living in and around the Park that could have an impact on both the park, its tapirs and other wildlife and the forest and paramo habitat. The survey was undertaken using a standard questionnaire and the results are expressed as percentages either of all adults responding or of the total communities surveyed which had each reached a consensus regarding the question asked. This is a part of the original report.

Results

Sixty percent, or 303 individuals indicated they hunted and fished. All 15 communities surveyed contained fishermen. Seven of the 15 communities (47%) had members who hunted the common red brocket deer (*Mazama americana*) and/or the little red brocket deer (*Mazama rufina*), which is of Near Threatened status. Six of the communities (40%) hunted many bird species. Three communities (20%) hunted the Andean Guan (*Penelope montagnii*) and other species of guan (Cracidae spp.). Five communities (33%) each hunted the agouti (*Dasyprocta punctata, D. fuliginosa*) and the white-tailed deer (*Odocoileus virginianus*) of the paramos. Four communities (27%) hunted mountain tapirs (*Tapirus pinchaque*) and wild guinea pigs (*Cavia aperea, Cavia* spp.). In two communities each (13%), Andean bear (*Tremarctos ornatus*), parrots, collared peccaries (*Tayassu tajacu)* and white-lipped peccaries *(T. pecari*), toucans, macaws, monkeys, and various doves were hunted, including the black-winged ground dove (*Metriopelia melanoptera*). Two communities (13%) also hunted the lowland tapir (*Tapirus terrestris*). One community (7%) hunted the northern pudu (*Pudu mephistophiles*).

Of 569 adults surveyed, 358, or 63%, knew of the mountain tapir, while 296, or 52%, knew of the lowland tapir. However, the two species were often confused. Of the 15 communities interviewed, nine communities, or 60%, had members who had observed tapirs in and along rivers; eight communities had observed them at salt licks; seven in cloud forests; six in paramos; while five communities knew of them through visits to local zoos, such as the one in Baños, or another, called "Fatima", near Puyo. One community had observed tapirs at the community's well.

Six communities, 40%, indicated a shift in altitude by mountain tapirs between the lower forests during the rainy season and the higher forests and still higher open paramos during the dry season. The Shuars of Wapu said the lowland tapir is rapidly disappearing from the lower elevations of the Park along the eastern *pie de monte* Andean flank. This ancient tribe, a.k.a. *Jivaro* (Sp.), indicated that lowland tapirs shifted down in altitude during rainier seasons in parallel

fashion to the downward shift of the mountain tapirs.

Foods indicated by respondents as being eaten by tapirs included: *Ñagran* (*Neurolepis aristata*), various species of grass (Poaceae spp), the umbrella plant (*Gunnera brephogea*), plantain, bananas, herbs, ferns, potatoes, dittany (stonemint, or *dictamo real* (Sp.)), *Arquitecta* (Sp.) (*Culcitium reflexum*, fam. Asteraceae, by mountain tapir in paramo), *Pogre* (Sp.), Nasturtium (*Tropaeolum tuberosum*), and mushrooms. Some of these observations concur with those made in previous studies of mountain tapirs (Downer 1996; Downer 2001).

Season of pairing and breeding: December-January was indicated for the mountain tapir, as has been confirmed in Downer (1996). "All year long" also was indicated for both species.

When asked if the tapir hunts other animals, the great majority recognised that tapirs were not carnivores. Communities identified the following species as preying on tapirs: puma (*Felis concolor*: six communities; Andean bears: five communities; jaguars (*Panthera onca)*: four communities; humans: 11 communities; "Pumajaire" (Shuar), a mythical, large, light-colored cat believed to hunt tapirs by the Shuars of Wapu: one community.

Tapirs have religious significance to the Shuars, the Puruhaes, and other indigenous groups around the park, who believe they possess magical, including healing, powers.

Tapir parts of both species have been and remain for sale in the cities and towns around the Park including Baños, Ambato, Riobamba, Macas, Rio Palora, and Puyo. There they are sold both as medicines (especially hooves and snout) and for food and/or pelts.

The survey found that 93%, or 14 communities, noted the recent disappearance of both species of tapir. The townspeople recognise that both the destruction of forest/paramo habitat and hunting coincide with an augmented human population (Cincotta *et al.* 2000). Respondents noted that many other species were decreasing due to over-hunting, habitat destruction, pesticides, and other causes.

Those respondents who were unaware of the law that protects mountain tapirs amounted to 52%, or 350 participants and 72% of respondents were unaware of the boundaries of the Park. 77%, or 489 participants were unaware that the mountain tapir was in imminent danger of extinction. However, 71%, or 450 of respondents were aware that it was illegal to kill any animals in the Park. Interestingly, four communities, or 27%, had members who were aware that either one or both species of tapirs were seed dispersers, or helped to enrich soils through their droppings or, in general, contributed positively to the tropical ecosystems they inhabited.

Conclusion

This survey has served to reveal a gap in conservation education and law enforcement among communities surrounding and intimately associated with Sangay National Park. This Park has been designated as a "World Heritage Site" by UNESCO, but has been placed on its "In Danger" list due to the serious problems this Park continues to experience. A more consistent and far-reaching education programme coupled with sustainable development is essential if the Park, its endangered and threatened tapirs, and other wildlife species are to continue. The Andean Tapir Fund's future focus of endeavour will follow considered outlines presented in the Tapir Specialist Group's action plans (Downer 1997; Bodmer & Brooks 1997) and incorporate new ideas from the group as well as from local stakeholders, conservation officials, and other NGOs. Please contact the Andean Tapir Fund to obtain the full results of this enquiry.

Acknowledgments

The Andean Tapir Fund is grateful to ZGAP, of Munich, Germany, and to the Zurich Animal Protection Society for their financial support for this project. The spirited participation of Xiomara Navas-Carbo of the *Fundación Mana* proved indispensable for the success of this project. The Andean Tapir Fund is also grateful to the numerous national, state, and local government officials, park superintendents /rangers, and local mestizo and indigenous guides whose permission and practical knowledge and help proved essential in the realisation of this project. We also express our appreciation to the educators and spiritual guides of the schools and churches who collaborated in an essential way. A significant "gracias" also goes to media workers and town and canton leaders who helped to organize the timely public inquiries and presentations of this project.

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NEWS FROM CAPTIVITY

Publication Announcement for the Revised AZA Husbandry Guidelines for Tapirs

After much work, the AZA Tapir TAG has completed its task of compiling husbandry standards for keeping tapirs in captivity. This assignment was given over three years ago by the AZA Animal Welfare Committee and directed all the TAGs to oversee the compilation of rigorous documents that could be used by AZA inspectors visiting zoos during accreditation inspections. These standards are much more in-depth than the early husbandry guidelines that were written 5-6 years ago, and are at the request of USDA and to be used by federal inspectors, animal welfare agencies etc.

Alan Shoemaker is happy to supply electronic copies. Please contact him on sshoe@mindspring.com

Status, Origin, and Diet of Captive Tapirs (*Tapirus terrestris*) in the State of Santa Catarina, Southern Brazil

By Alexey Bevilacqua Tormin Borges & Marcos Adriano Tortato

In the State of Santa Catarina in the southern region of Brazil, there are a relatively small number of zoos, few of which exhibit tapirs. These facilities are poorly structured, with little investment in infra-structure or research on the animals. A brief survey indicated four establishments with a total of 15 lowland tapir (*Tapirus terrestris)* individuals. The survey also collected information on the origin, gender, diet, exhibit, reproduction and handling of the animals.

Surveys

In all, four facilities with captive tapirs were identified (see below). Three of these facilities were zoos, and the fourth was a Visitor Centre in the Serra do Tabuleiro State Park. All of these facilities were open to the public. They were:

- Fundação Ecológica Zoobotânica de Brusque (FEZB), Brusque.
- Parque Cyro Gevaerd (PCG), Balneário Camboriú.
- Zoológico Pomerode (ZP), Pomerode.
- Visitor Centre at the Serra do Tabuleiro State Park (STSP), Palhoça.

Status, Origin, Enclosure, Diet and Handling

Most tapirs located in these facilities were bred from founder specimens at the Visitor Centre at the Serra do Tabuleiro State Park (STSP). None of these specimens are native to the State of Santa Catarina.

Visitor Centre at Serra do Tabuleiro State Park:

- **STATUS** – seven tapirs comprising 4 adults (2.2) and 3 young (0.2.1). Reproduction takes place without any genetic management due to the extensive enclosure inhabited by the animals. In two decades of captivity, only one pair has bred.
- **ORIGIN** – both founders are originally from the state of Rondônia, northern Brazil, and all others were born in captivity. These founders were brought here through the implementation of an Extinct Fauna Restoration Project of the 1980´s located in a coastal region of the STSP (Baixada do Massiambu). This project was eventually abandoned due to lack of technical/scientific criteria.
- **ENCLOSURE** – An enclosure of 150 ha composed of a mosaic of Restinga vegetation, flooded areas, and temporary lagoons, typical of Coastal Atlantic Forest ecosystems. The animals are managed so that they are available for exhibition to the public and for the Park's Environmental Education Programme.
- **DIET** – composed of natural vegetation found in the exhibit and supplemented with pumpkin, manioc, cabbage, lettuce, banana, papaya and equine feed.
- **HANDLING** – over the course of two decades in captivity, some offspring have been transferred to other facilities as follows:
  - 1.0 to the Fundação Ecológica Zoobotânica de Brusque (FEZB)
  - 2.0 to the Parque Cyro Gervaerd (PCG), Balneário Camboriú

This facility currently has a need for decisions about managing the population and for training in handling the animals. The enclosure has proven to be inadequate for containing tapirs, and the potential for contact with resident populations of wild tapir along the foothills of the Serra do Tabuleiro is high.

Fundação Ecológica Zoobotânica de Brusque:

- **STATUS** – 4 tapirs, 3 adults (2.1) and 0.0.1 young. Reproduction is managed.
- **ORIGIN** – both founders are originally from the State of Mato Grosso in the Central-Western region of Brazil, and were brought into captivity in the 1990´s. One male was born in captivity from these two founders, and the other juvenile was transferred from the Visitor Centre at the STSP.
- **ENCLOSURE** – 1,800 m^2 (0.18 ha) containing a lake and forested areas.
- **DIET** – Composed of equine feed, cabbage, broccoli, lettuce, hay and tomatoes.
- **HANDLING** – There are no records concerning births, acquisitions or transfers of specimens to or from other zoos.

Parque Cyro Gevaerd:

- **STATUS** – 2 adults.
- **ORIGIN** – Visitor Centre at the STSP, Santa Catarina, southern Brazil;
- **ENCLOSURE** – 1,500 m^2 (0.15 ha), includes a lake. Shaded areas are currently being provided.
- **DIET** – Composed of equine feed, banana, apple, melon, papaya, cabbage, sweet potato, manioc, tomato, green beans, corn, hay, sugar cane (during winter) and mineral salts.
- **HANDLING** – There are no records concerning births or transfers from the STSP.

Zoológico Pomerode:

- **STATUS** – 1 male.
- **ORIGIN** – Fontana Farm, State of Paraná in southern Brazil, arrived in the 1970´s.
- **ENCLOSURE** – 700 m^2 (0.07 ha), includes a lake. Shaded areas are currently being provided;
- **DIET** – Composed of equine feed, pumpkin, apple, banana, sweet potato, carrots, hay, and mineral salts.
- **HANDLING** – There are no records concerning age or date of acquisition.

Final Considerations

The captive conditions of tapirs in the State of Santa Catarina, southern Brazil, are very precarious, given that the facilities lack technical and scientific guidance in their maintenance and welfare. At the Visitor Centre at Serra do Tabuleiro State Park, the situation is both interesting and critical at the same time, with animals coming into close contact with natural environments and making regular use of the natural resources available. The area of over 150 ha, while being the largest encountered in this survey, is insufficient for maintaining seven individuals and the impact caused by foraging and trampling is visible. This condition is worsened by the fact that the fencing does not adequately contain the animals, potentially allowing disease transmission and inter-breeding with tapir populations that are native to the Park. On the other hand, the tapirs have a strong appeal as a flagship species for the Environmental Education Programme of the park. There is great potential for future work directed at the conservation of the species in the STSP and improvements in living conditions and research in captivity. Although critical, the captive situation in Santa Catarina offers great potential for the development of several research initiatives involving genetic diversity, inbreeding, diet, epidemiological studies, and the use of naturalistic habitats.

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Recent Births of Mountain Tapirs

Two births of mountain tapirs (*Tapirus pinchaque*) have been reported from zoos in the United States this year.

Five days old mountain tapir at the Los Angeles Zoo. Photo by Roxane Losey.

The Cheyenne Mountain Zoo in Colorado Springs, Colorado, and the Los Angeles Zoo, California, each achieved a recent success in breeding this highly endangered species. The offspring, both males, were born on May 29th and October 10th, 2003. Altogether, eight individuals are currently represented in three North American facilities.

CONTRIBUTED PAPERS

The Age Structure of Tapirs (*Tapirus terrestris*) in the Chaco

By Leonardo Maffei

Introduction

The lowland tapir (*Tapirus terrestris*) is one of the most important sources of meat in the Bolivian Chaco. For example, it provides 14.3% of the wild meat harvested by indigenous hunters in the area (Noss 1998). Interviews with local people indicate that hunters must travel increasing distances from communities in order to hunt this species. This suggests that the species is over hunted and that management measures may be required to ensure that its hunting be sustainable. To confirm interview evidence we collected additional biological information to evaluate the status of the tapir population, namely the proportion of juveniles and adults. There are different ways to estimate the age of an animal, including changes in the coat colour or size of the animal to differentiate between young, juveniles or sub adults and adults. More accurate age estimates can be achieved applying more sophisticated techniques such as the analysis of dental wear (Dimmyck & Pelton 1996). This article describes the process for estimating the age of tapirs from dental wear, assigning age classes based on dental annuli analysis conducted in a laboratory.

Study area

The sampling area is covered by Chaco alluvial plain forest, with an annual precipitation of 500 mm and an average temperature of 26 ºC (Navarro & Fuentes 1999). The Chaco forest is a dry tropical forest with a canopy of 4 to 6 m, numerous species of Cactaceae, and a dry season that lasts for 6 to 8 months. Twenty-four indigenous communities are distributed along the Parapetí river, including roughly 10,000 Isoseño inhabitants who depend, in part, on hunting for their subsistence needs.

Methods

As a part of a hunting monitoring program between 1997 and 1999, hunters of the Isoso area (Gran Chaco) collected the skulls of 40 tapirs hunted for subsistence purposes. It is assumed that young and old animals have the same probability of being hunted. As hunters hunt with dogs, the dogs do not discriminate between young and adults. For example, capturing tapirs using dogs as the Isoseño do in Cerro Cortado Investigation Camp (a area near Isoso where there is no hunting pressure) one juvenile and four adults were captured. This indicates that all animals have the same probability of being captured (Noss *et al.* 2003).

In order to determine the age of each animal, incisors were taken from the skulls and the roots were decalcified with 30% formic acid, then analysed in a laboratory by counting the dental annuli in the cementum of the root (the procedure is described in Maffei & Becerra (2001). Given the seasonality of precipitation and resource availability in the Chaco, with a single long dry season, it is assumed that each ring represents a year. In addition, based on dental wear, and relating this feature with the age obtained by counting the annuli, a key was developed to identify age classes (Appendix 1). Between 1999 and 2001, 27 new skulls were added to this study. The first 40 were aged according to the results of the annuli count, and the 27 new ones were aged using the key of dental wear detailed in Appendix 1.

Results and Discussion

Annuli could be seen in all samples, most of them showing clearly the age annuli, but several were so diffuse that they did not reflect the real age of the tapirs. In some cases the root of the tooth was so thick that it took between one week and 10 days to decalcify, and the annuli may have been lost in this long process. Analysis of the 67 samples shows that juveniles (ages between 0 and 1 year old) represent 63% of the hunted population (Fig. 1), and accordingly are being over-hunted.

Tapirs reach reproductive maturity at two years of age (Parera 2002). Padilla and Dowler (1994) reported first conception between 23 and 27 months, and gestation lasts for one year. Based on these figures, less than 72% of the live-born individuals die before reproducing in the Isoso tapir population. This means that only 28% of individuals can be considered as reproductively active. At two years old, the curve of age structures falls and stays stable. A further indication that the population is being over hunted is that the oldest reported individual from the Isoso was 12 years, against 30 years reported from captivity (Parera 2002).

The population structure of an over hunted population is similar to that observed with brocket deer (*Mazama gouazoubira), (*Maffei 2001), which is also a solitary species, where the only groups found are a female with her offspring. Tapirs are suffering intense hunting pressure in Isoso. Noss (2000), using different data applied to a sustainability model also reported that in the hunting area, the population of tapirs and white-

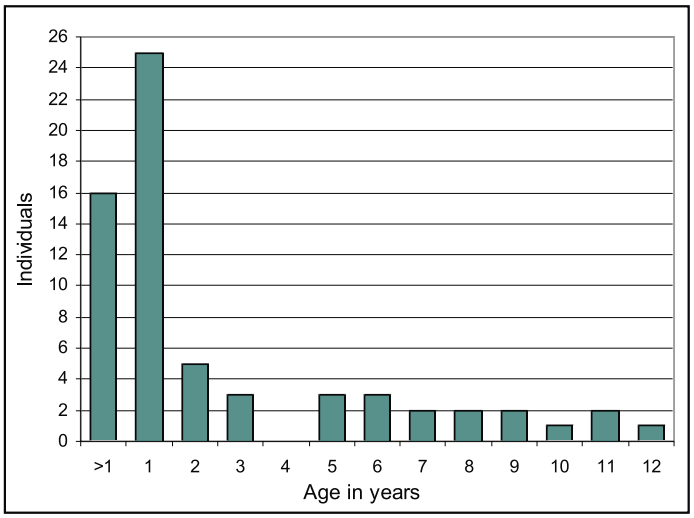

Fig. I. Age structure of tapirs (Tapirus terrestris) from 1997 to 2000 in Isoso (n=67).

lipped peccaries (*Tayassu peccary*) are over hunted. The fact that less than 30% of tapirs reproduce at least once is a warning that the situation for tapirs in Isoso is critical. If this species is to survive in the Isoso indigenous territory, hunting should be controlled, for example by instituting no-hunting zones, a temporary ban on tapir hunting, and/or a ban on hunting young tapirs.

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Appendix I

Key to determining tapir age (*Tapirus terrestris*) according to dental wear. **Note:** This key applies to the right inferior mandible, for dry forest tapirs. A skull where the last molar has not yet erupted is from an individual less than two years old.

2 years: All teeth have completely erupted, the first molar has the points slightly worn.

4 years: The crowns of all the teeth are slightly worn except for the last molar.

6 years: The first molar is very worn and concave, the first and second premolars are almost worn smooth. The last molar may or may not show wear.

8 years: The first and second molars are concave. The crown of the last molar shows wear.

12 years or more: Almost all the teeth are concave. The last molar shows variable wear.

The Lowland Tapir in the Caraça Reserve, Minas Gerais State, Brazil: Preliminary Results

By Edsel A. Moraes Junior, Joaquim A. Silva & Rafael L.A. Freitas

Abstract

Due to hunting and habitat destruction, the lowland tapir, *Tapirus terrestris*, is now endangered over much of its range. This paper presents the preliminary results of a study of the distribution and relative abundance of tapirs, using track surveys and camera traps, in the Private Natural Heritage Reserve, Serra do Caraça. By monitoring footprints it was observed that *T. terrestris* apparently occupies all habitat types in the study area. Five photographic records of tapirs were obtained from camera traps, thus representing a capture success of 6.5% and Relative Abundance Index (RAI) = 2.71. No photographic records were obtained during the day and most were during the period from 20:00 to 24:00 hours. Some photographic records were damaged by the dense mist, an effect usually observed in the coldest, driest months of the year. Despite the short monitoring period, the results presented here reinforce the importance of the reserve as a refuge for wild tapir stocks.

Introduction

The tapir, *Tapirus terrestris*, is the largest terrestrial mammal in Brazil, with a length of around 2 meters and weight of 250 kg (Emmons & Feer 1997). Due to its herbivorous diet, the tapir plays an important role in the maintenance of vegetation, being an important seed disperser in its habitat (Olmos 1997). The tapir is threatened in a large part of its range, with several cases of local extinction caused by hunting and habitat destruction. Habitat destruction is principally responsible for the decline of the populations in the state of Minas Gerais (Costa 1998).

The efficiency of track surveys (Naranjo 1995; Affonso 1998) and camera traps (Holden 2003; Noss *et al*. 2003) in estimating tapir populations has been demonstrated previously. These data, therefore, represent the preliminary results of a study of the distribution pattern of *Tapirus terrestris* in the Private Natural Heritage Reserve, Serra do Caraça.

Study Area

The Private Natural Heritage Reserve, Serra do Caraça (10,187.89 ha), is located in the southern portion of the Espinhaço mountain range (20º05' S; 43º29' W), Minas Gerais State, Brazil. This orographic system is represented by a mountainous complex that delineates a zone of contact between the "Cerrado" (savannas) and the Atlantic Forest, in its southern portion, and transition zones of "Cerrado", Atlantic Forest, and "Caatinga" (tropical deciduous forest), at its central and northern edges (Giulietti & Pirani 1988; Harley 1955; Giulietti *et al.* 1997). The reserve comprises three main types of vegetation represented by seasonal semi-deciduous forests, "campos de altitude" (high altitude grasslands), and "campos rupestres" (rocky grasslands), which occur at elevations of between 850 and 2,072 m. The regional climate is rainy in summer (October-March) and dry in winter (April-September) with mild temperatures throughout the year (18º to 19º C). The maximum temperature rarely surpasses 30º C and the minimum temperature can reach negative values. "Campos rupestres" consist of grasslands surrounded by rocky outcrops, as well as shrubs and small trees (Fig. 1). Vegetation patches in different stages of ecological succession are present in the region as a consequence of timber extraction and the "slash-and-burn" practice used in the past. The reserve represents a rich artistic, cultural and historical heritage resulting from over two centuries of human occupation (Andrade 2000).

Methods

To investigate the distribution of *T. terrestris* in the reserve, footpaths, roads and watercourses were surveyed from April to August 2003 recording footprints indicating tapir presence in the area. Geographic coordinates of tracks were recorded using UTMs (Universal Transverse Mercator), with GPS Garmin II, in the locations where footprints were encountered. Each location in the study area was sampled just once per month, to ensure independence of samples (Swihart & Slade 1985). After collection, all of the footprints were erased to avoid multiple recordings.

The coordinate was then plotted on a map of the study area, scale 1:10,000, with the different vegetation types, topography and hydrology. The data was analysed using the programme Arcview 3.2 (Environmental Systems Research Institute, ESRI, Redlands, California, USA).

Camera trap monitoring was carried out between April and September 2003 with a sampling effort of 184 trap days, using only two camera traps in the two last sampling efforts. The camera-traps were located in a trail near the forest

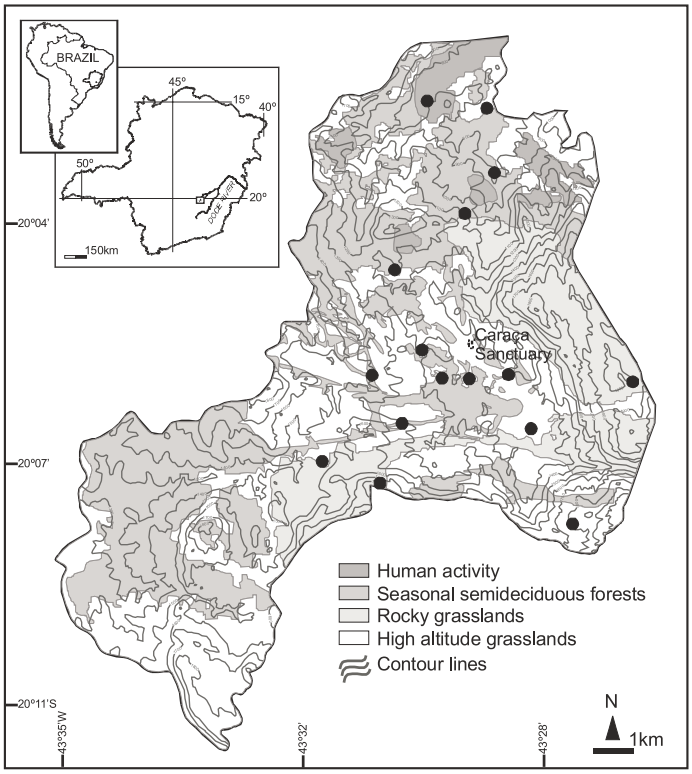

Figure 1. Map of the distribution of Tapirus terrestris tracks in the Private Natural Heritage Reserve Serra do Caraça, Minas Gerais State, Brazil.

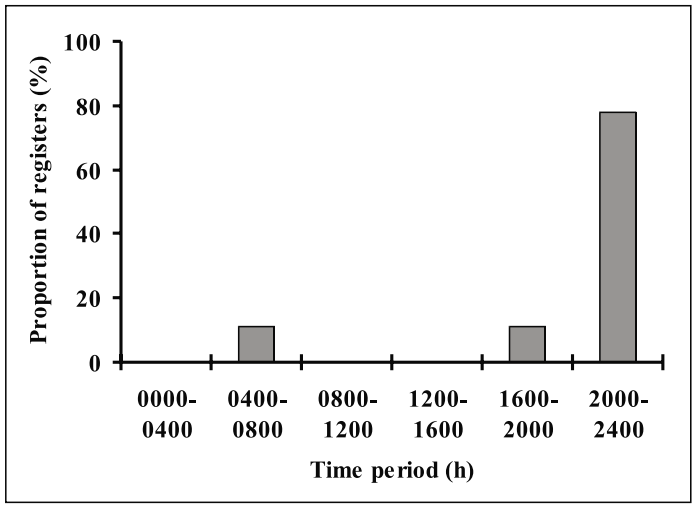

Figure 2. Preliminary results of activity patterns for T. terrestris according to camera-traps in Reserve Serra do Caraça.

edge. To calculate the success rate of capture and Relative Abundance Index (RAI) we considered an effective recording to be a photo of an animal in a camera trap during a 24-hour period. Sequential photographs of the same individual were excluded. RAI was calculated as the total number of tapir photos X 100/total number of cameras/nights (TEAM Protocol; Center for Applied Biodiversity Science, 2002).

Results and Discussion

Track surveys have revealed that *T. terrestris* apparently occupies all of the habitat types in the study area (Fig. 1). The different types of vegetation and, principally, the abrupt variations in relief do not appear to restrict the movement and habitat use of tapirs in the Serra do Caraça Reserve. The use of track surveys to assess the distribution pattern of species can be hindered by various factors such as terrain type, rain intensity and the movements of humans.

Five effective photographic recordings of tapirs were obtained from the camera traps, with a capture success rate of 6.5% and RAI = 2.71. No recording was obtained during the day (06:00-18:00 h) and most were during the period 20:00-24:00 h (Fig. 2). The tapirs appear to have exclusively nocturnal habits – perhaps due to the large number of tourists who visit the area.

Two individuals were recorded (an adult female and a sub-adult) in the same capture station, on different days (Fig. 3a,b). Some photographic records were damaged by dense mist in the locations of capture stations (Fig. 4), an effect usually observed in the coldest, driest months (June - July). Despite the short sampling period, the results presented here reinforce the importance of the reserve as an essential refuge for fauna, particularly as all of the surrounding area is occupied and degraded (principally by mining activities, common in all areas south of the mountain range of Espinhaço). Therefore, studies of long duration, with a larger number of camera traps or using radio-telemetry, should be conducted to generate information on the population status of tapirs in the Serra do Caraça Reserve. This will supply sufficient information to guide management decisions and aid the conservation of species in the mountainous regions of Minas Gerais State.

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Figures 3. (a) Picture of an adult female individual of lowland tapir;

(b) a sub-adult individual captured on film by the same camera-trap.

Figure 4. Picture of a lowland tapir, in dense mist, taken by a camera-trapping system.

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Feeding as a Method of Environmental Enrichment for Malay Tapirs (*Tapirus indicus*) at Nuremberg Zoo, Germany

By Susanne Zenzinger

Abstract

The aim of this study was to examine the effects of environmental enrichment on the feeding and resting behaviour of Malay tapirs at the Nuremberg Zoo. In addition, the enrichment objects used were examined in order to ascertain their suitability as occupational food. For this purpose, three successive experiments were carried out with the Malay tapir group (1.2) at Nuremberg Zoo within an observation period lasting from July 1st to October 2nd 2002. These experiments used suspended food branches and stuffed jute sacks as well as providing spiked hay-bales. The observed individuals were an adult male, an adult female and her female calf. The results pointed to a preference for the suspended food branches followed by the hay-bales and finally the jute sacks.

Introduction

The environmental surroundings of zoo animals differ fundamentally from those of their free ranging relatives. Zoo animals are usually fed at fixed times and so efforts to find and consume food do not take up as much time as in the wild. Therefore, a gap is left in the life of an animal kept in captivity that must be filled (Johann 1992). If this is not achieved, the animals may react with prolonged periods of rest (Dittrich 1986), stereotypic behaviour or increased aggression (Johann 1992).

The term "environmental enrichment" attempts to fill the gap left by the lack of foraging opportunities (Meister 1998). For that purpose, natural as well as artificial objects are used. Natural objects are usually objects or methods of providing food and are favoured by most animals. In most cases, variation can be created in different ways and times of presenting food. To avoid the development of a habit, it is crucial for every kind of enrichment to create continuing variety. The more easily that the offered objects can be manipulated, the longer it will take for them to lose their enriching effect (Berufsverband der Zootierpfleger 1997).

Until recently, tapirs have not received much attention regarding the development of specific enrichment programmes. Presently, there are far less studies of this topic on the Malay tapir (Taylor 2000) than on its American relative, the lowland tapir (Sharpe 1997; Penning 1998; Müller 2001). Therefore, the aim of this study was to examine the consequences of environmental enrichment on the feeding and resting behaviour of Malay tapirs. In addition, the enrichment objects used were examined and their suitability as "feeding enrichment" evaluated.

Materials

During the observation period between July 1st and October 2nd 2002, three successive experiments were carried out with the Malay tapir group at Nuremberg Zoo:

1. Hanging up leafy food branches on a coconut rope (suspended branches).
2. Hanging up slit jute sacks stuffed with fruit, cut grass, hay and small branches on a coconut rope (jute sacks).
3. Bringing in hay-bales spiked with fruit, peanuts and small branches tied together with a coconut rope (hay-bales).

The observations took place exclusively in the outdoor enclosure. The observed individuals were an adult male and female and their female calf (Table 1). For protection of the offspring, the male was kept apart from the two females.

Table 1. Composition of the Tapir Group Investigated at Nuremberg Zoo.

ANIMAL	SEX	DATE OF BIRTH
HENK	1.0	24. 04. 1997
INDAH	0.1	15. 05. 1998
CALF [Nür14]	0.1	09. 05. 2002

Methods

For each experiment, the observation period lasted seven days. Every day, the respective enrichment objects were renewed before observations began. The analysis was based

on two hours of observation in the morning (9 to 11 a.m.) and two hours in the afternoon (2 to 4 p.m.). These represented the periods of highest activity for the animals in the outdoor enclosure. This period had been determined before the start of the study. The duration of time spent eating the different enrichment objects was recorded as accurately as possible (± 5 seconds). The term "eating" has to be taken as occupation with food in general. This does not only include ingestion, but also the acquisition of food that is not easily accessible.

All-occurrence-sampling (Altmann 1974) was used as the recording method. The statistical analysis was carried out according to the Friedman test and using the statistics programme "SsS 1.0 für Windows" by Rubisoft Software GmbH. The results were rated significant if error probability was $p \leq 0.05$. However, p-values between 0.05 and 0.1 can also be of interest and can be accounted for as "not entirely" or "almost" significant (Lamprecht 1999).

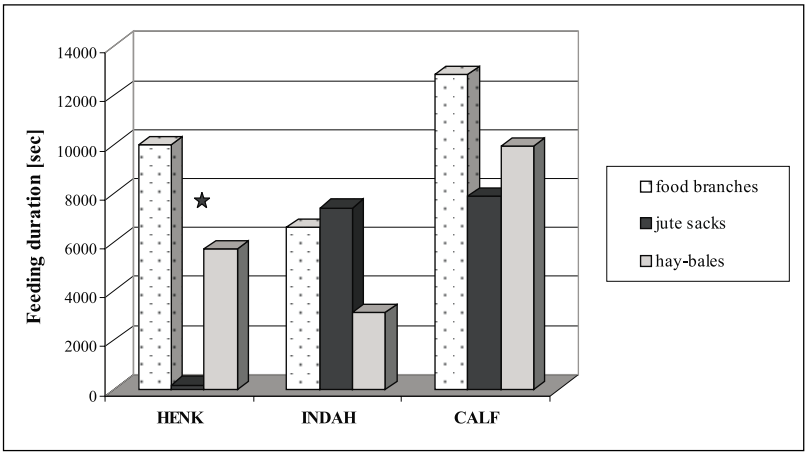

Figure 1. Comparison of the duration of feeding on the different enrichment objects for all observed individuals (overall duration of observation: 28 h for each experiment).

Results

Adult Male Tapir – HENK: As shown in figure 1, the adult male spent almost twice as much time eating the suspended branches as the hay-bales. Clearly, he spent least time eating out of the jute sacks ($p = 0.0027$, Friedman test). Significant differences (*) can be seen between the times spent with the jute sacks and the suspended branches ($Q = 2.940$, Dunn's test) and between the jute sacks and the hay-bales ($Q = 2.0673$, Dunn's test). As can be seen from Figure 2, the adult male tried to eat all parts of the suspended branches that he could reach. Whenever all leaves and side branches were plucked off and the bark of the main branch was removed, the adult male repeatedly used the stones in front of the test construction as "stairs" to reach the higher branches. In contrast, the adult male paid little attention to the jute sacks. Most of the time, he kept a distance of at least one metre from the sack and only occasionally sniffed in its direction (Figure 3). However, if he pulled out pieces of the stuffing, he instantly galloped away with them to eat them in another part of his enclosure. This was only observed on two test days out of seven. The hay-bales aroused the adult male's interest to a greater extent. On the first test day, he took the complete hay-bale to pieces in order to obtain its contents, and consumed a large part of the hay.

Figure 2. The adult male uses stones as "stairs" to reach a suspended branch.

Figure 3. The adult male sniffs in the direction of a jute sack.

Figure 4. The adult female with her nose in the sack. The calf eats fallen hay.

Figure 5. The calf uses a hay-bale for rubbing its head.

Adult Female Tapir – INDAH: Of the three types of feeding enrichment, the adult female spent the least time with the hay-bales. She spent the most amount of time with the jute sacks (Figure 1). There was a "not entirely significant" difference regarding the duration of time spent eating these objects ($p = 0.0854$, Friedman test). Accordingly, the adult female often just plucked off the leaves and the side branches of the suspended branches. The main branch remained almost entirely untouched. In contrast, the jute sacks were shaken and hollowed out with the help of her snout (Figure 4) or were nibbled at the corners. As a result, the contents were partially spread over the ground, where the calf or the adult female herself immediately ate them. The adult female repeatedly tried to push down the sack by using one of her front legs and placing it inside one of the slits. The hay-bales were moved a short distance within the enclosure by using the coconut rope to carry them. The adult female only ate the stuffing, but not the hay itself. In addition, she used the bales for scratching her belly.

Female Calf: The calf spent most of the time eating the suspended branches. It spent the least amount of time with the jute sacks (Figure 1). Thus, an "almost significant" difference could be determined according to the Friedman test ($p = 0.0515$). The calf preferred to remove the bark from the suspended branches. With regard to the jute sacks, the calf's behaviour on the first test day mirrored that of the adult male described above. But by the second day of testing, such behaviour was no longer observed. The calf ate the fruit as well as the hay. A short period of nibbling for longer periods at the corners of the jute sack, which contained the fruit pieces, was observed. The calf exhibited a very wide range of different activities with the hay bales. While trying to hollow the bales with its nose, the calf sometimes climbed on top of the bale. In this position, the calf either spread apart the single hay-ribs or used the hay-bale to sway back and forth. In this experiment, the calf also ate fruit as well as hay. The calf also used the hay-bales for scratching. Due to the calf's height, either only the head (Figure 5) or the complete body could be rubbed.

Discussion

The adult male clearly preferred the suspended branches and the hay-bales to the jute sacks and also showed a preference for the suspended branches rather than the hay-bales (Fig. 1). Of all the animals, the adult female paid the most attention to the jute sacks. She spent far less time with the hay-bales than with the suspended branches. The calf, like the adult male, preferred the suspended branches, followed by the hay-bales and finally the jute sacks. As the results show, no clear preference for any of the enrichment objects could be observed in the case of any individual.

It was also observed that the adult male kept his distance from the jute sacks for most of the time. This behaviour can possibly be attributed to the strong smell of jute. The observations also showed that the adult male was startled whenever he pulled something out of the sack. The reason for that could possibly be the design of the test construction, which caused the jute sacks to swing every time one of the animals touched them. This might be enriching in itself (Berufsverband der Zootierpfleger 1997). However, the adult male seemed to prefer eating the suspended branches, which were mobile. But with the suspended branches and the hay-bales being familiar objects to the tapirs in contrast to the jute sacks, which had not been used with the Nuremberg tapir group before, the adult male's distrust of the sacks could possibly be explained accordingly. For that reason, Hutchins *et al*. (1984) come out in favour of using as much natural material as possible for environmental enrichment. On the first test day, the calf showed a behaviour quite similar to the adult male's towards the jute sacks. However, it lost its fear of them after the adult female had spent some time with them. The popularity of the objects used decreased, beginning with the suspended branches, then the hay-bales and finally the jute sacks, with the exception of the adult female. As mentioned above, this could result from the degree of familiarity or from the naturalness of the respective occupational object. The sequence determined could also be related to the natural foraging preferences of the Malay tapir. It is not surprising that the suspended branches came off best, because tapirs are, to a great extent, browsers. Furthermore, fruit makes up a large part of a tapir's diet and is usually picked up from the forest floor (Williams & Petrides 1980). The hay-bales stuffed with pieces of fruit enabled the animals to practice exactly that kind of foraging behaviour. Unknown objects seemed to attract the adult female the most. The fact that she spent the shortest time with the hay-bales might be attributed to the fact that she was the only one who did not eat the hay but went straight for the contents.

Conclusion

Taking individual differences into consideration, many enrichment objects may be suitable for tapirs. As animal behaviour depends on various external and internal factors (Berufsverband der Zootierpfleger 1997), reactions to just one enrichment object can be very different. Therefore, a study on a larger scale – especially with more test animals – may give more detailed information on this subject.

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ASKING THE EXPERTS: OPINIONS ON TAPIR SCIENCE AND RESEARCH QUESTIONS

How Old is an Old Tapir?

By Leonardo Salas

The survival rate of adult and reproductively active tapirs is probably the most important demographic parameter determining the resilience of a tapir population facing hunting pressure. For an example at hand, see what Leo Maffei has to say in his article in this TSG Newsletter issue. Ageing the animals becomes an inevitable necessity when estimating survival rates, both in unharmed and hunted populations.

We are faced with the same hurdle when addressing questions on heterochrony, and inter- and intraspecific allometries. Or when determining age of first and last reproduction, longevity, age of dispersers (a critical factor due to increased fragmentation of habitats) and mate choice, just to name a few examples. Yet, it seems like ageing tapirs or any other long-lived tropical mammals is a daunting, if not impossible, feat.

Tapirs have several identifiable growth stages. The most basic stages would be: newborn, juvenile (i.e., animals already with adult pelage but still growing), and adult (i.e.,

animals from about 4 to 25+ years old). Several criteria can be applied to age newborn and juvenile tapirs using data from zoos, but ageing adults remains unattainable. At least one author (Dr. Richard Bodmer) used tooth wear and other clues to divide hunted tapirs into broad age categories; but we are still left with no means to assess the accuracy of his classification method unless the animals' ages are determined through unrelated means.

Ageing mammals has been done using several techniques. All of these require building a calibration curve with samples of animals of known age, from which the appropriate measurements are taken. Perhaps the most common method for temperate areas is counting cement annuli in cross-sections of teeth. These rings are formed due to changes in cement deposits in teeth probably caused by changes in diet and/or strongly seasonal climate changes. A calibration curve is constructed showing the relationship between numbers of cement rings in a particular tooth versus age. When an animal of unknown age is found, the same tooth used to build the calibration curve is extracted and cut. The counts of rings can be then used to age the animal. Notably, the method offers estimates of error due to sampling, environmental variability and other factors.

Maffei (in this issue) does a brave attempt at ageing a sample of tapirs from the Bolivian Chaco without the use of a calibration curve, perhaps because none was available for him to use or he could not find a set of known-age skulls to build one. For ageing his sample, he by force, assumes that each cementum ring means one year of age, and that the rings are the product of a marked dry season. But note that he cannot assign confidence intervals to his ageing, despite the fact that he acknowledges possible sources of sampling error (difficulty in visualizing rings, or problems with sample preparations). Another source not mentioned include the heating and cooling of the teeth if the skull was cooked, which also dilutes or destroys rings. Without a calibration curve we cannot verify the accuracy of Maffei's age estimates, and so we do not know if he sorted each skull in the sample into the correct age category (he used six). In his defence, he supports his ageing and sorting with evidence of tooth wear. Also, Mr. Maffei has managed to gather some information on the age of his skulls, at least relative to each other.

It is probably safe to say that tapirs generally live in relatively aseasonal habitats, meaning that there may be no drastic changes in diet and certainly no harsh winters. This could represent a problem if we attempt to use Mr. Maffei's method. Consider also that the known-age samples will come from zoos, where there is little seasonal variability in diet. Another problem with the cementum annuli method is that it requires damaging the samples, which many museum curators will certainly not consent to.

Dr. Matt Colbert, of the University of Texas at Austin, has conducted research on ageing in tapirs. "Establishing metrics by which to evaluate an individual's relative maturity would be an enormous boon to many different types of studies," he commented through e-mail. One of his research interests is that of differences in skull and skeletal ontogenetic changes among the three New World tapir species (i.e., changes as a tapir ages, from foetus to adult). He was interested in "a method for establishing sequences of tooth eruption and cranial suture closure occurring during ontogeny for the four tapir species." He was interested in change patterns unique to each species, but, he explains, "I soon realized that I needed a way to age the samples in order to distinguish static allometry [variation between individuals of the same age cohort] from ontogenetic allometry."

Dr. Colbert encountered the same problem many field biologists have faced when trying to understand population dynamics and other aspects of tapir population biology and ecology. In his particular case, as he put it succinctly, "…age, or maturity stage, has to be established with enough precision" to distinguish if the patterns observed were due to static or ontogenetic allometry.

Skulls are important records of tapirs, but their precise ageing is difficult. In this example (T. terrestris), the missing eruption of the last inferior molar indicates – after Maffei's description – an age below two years. Photo by Stefan Seitz.

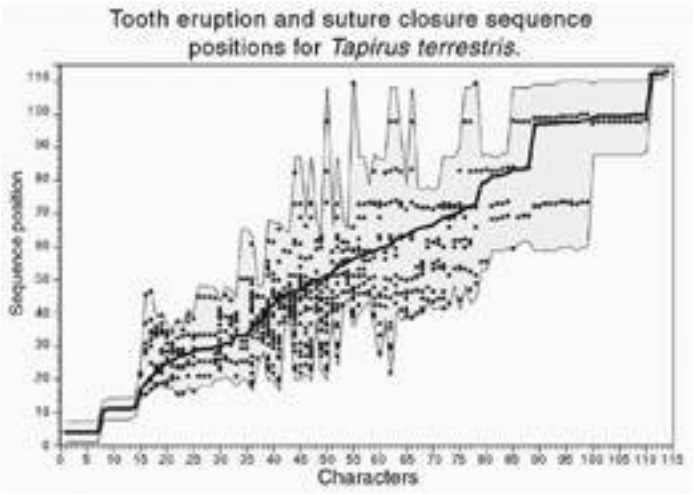
Using techniques typically used in phylogenetic analyses, Dr. Colbert has been able to find predominant sequences of character changes (e.g., eruption of teeth, closing of cranial sutures) for each species of tapir, and levels of variability associated with these sequences. He can also tell which characters produce the least variable sequences. "…The method was used to figure out sequences of character changes based on cross-sectional data (that is, a bunch of skulls sitting in museum drawers that have no information about absolute age)." By cross-sectional data, Dr. Colbert refers to the method of sampling a population by taking individuals of all age cohorts only once, hence resembling a cross-sectional cut; this method is in contrast with longitudinal sampling, which means following a cohort from day one until all the individuals die.

Although intuitively simple, Dr. Colbert's approach is not

exempt from difficulties. He adds: "One of the difficulties in deriving such sequences is that the sequences are inconsistent (for example, in a majority of individuals 'event A' may occur before 'event B', but in a few 'event B' is the first to occur)."

To better understand Matt's work, imagine you are a newborn tapir. As you grow, your "milk" teeth erupt, and then a second set of teeth (except for molars) replace these. Meanwhile, sutures between pairs of bones in your skull close. In theory, this process goes on until some time in your adult life. These are the character changes that make up Dr. Colbert's data, and which he has represented in the figure included here. In the figure, each point represents a skull of a lowland tapir. There are many ways in which all the character changes he recorded (115 in total) could be sorted (indeed, as many as a permutation of the total number of character changes he recorded, or 2.9×10^{188} combinations in the example of the graph!). If the changes happened in perfect sequence, then there would be only one way in which they could be sorted if it is set a priori that a newborn individual has no teeth erupted and no sutures closed, and that a fully adult one shows the diametrically opposite condition.

But life is never so sweet! Dr. Colbert used powerful statistical techniques to develop a sequence order that most closely resembles a perfect sequence. In the case of lowland tapirs in the graph, the species for which he had the most data, there is clearly quite a bit of variability in sequences of character appearance. The black line in the graph represents an "average" solution.



It would be possible to use these sequences of changes to age tapirs. Just as with the cementum annuli, the sequence of changes can act as the "calibration curve", thereby knowing the age or stage of an animal by simply recording what changes have happened to its skull due to aging. This is an oversimplified picture, though, because there are at least two levels of variability in the process; there is variability in the order of changes in the sequence and there is variability in the timing of each. He said, "…although there is great potential to use such data [for generating age calibration curves], these patterns of tooth eruption and suture union have only been partially determined for the different species, and have not been related to the individual's absolute age. As always, sample sizes of tapirs are small. However, there is an opportunity for the community of zookeepers and field researchers to rectify this situation through a collaborative on-line effort. Dental records associated with the tapir's actual age could be kept for zoo animals."

Matt recognizes that the sequences he used would work best for ageing young animals, as both kinds of variability increase substantially with older skulls. "I couldn't determine relative sequences for the many characters that fuse very late in life – which is a consequence of the very few samples of really old tapirs in collections. Many of the latest fusing sutures happen only in the oldest individuals. There is definitely a pattern of increasing plasticity with age, which makes these later characters less informative for establishing maturity and age." The plasticity, or variability of appearance of a change in the sequence can be inferred from the graph, if we assume that the sorting of the sequences correlates with age of the animals. This is not just a trivial assumption, as it happens, it is an assumption implied in the sorting technique. "Perhaps the more important thing is (that) the older closing sutures are less reliable. This is indicated by the increased individual polymorphism in the oldsters, as well as the increased range of sequence position for such features. That is, variability in the span of box axes' values for older individuals in the graph. "I also suspect that many are likely to fuse as a consequence of injury or trauma. As always, bigger samples will allow us to say more about this..."

There are at least two caveats with using Dr. Colbert's method to age tapirs. First, the animal must be dead to be able to inspect its skull and record the character states for ageing. "Dental patterns are obviously advantageous compared to skeletal indicators", Matt acknowledged, "because they can be surveyed in living animals (unless one has access to X-radiographs!)." Although this presents a problem for field researchers dealing with precious living study subjects, it would nevertheless be a most welcome advance from the present state of affairs. It would still allow just about anyone else to age specimens, including samples of dead animals for estimating survival rates.

Second, Dr. Colbert conducted his analyses independent of age of the samples. Because of this, it is possible that all the character changes he used in his analyses appear within the first 10 years of a tapir's life. In that case, we will remain unable to age older tapirs, or will need to use other characters. But he is confident that some of the changes he recorded occur in very old animals: "I would still be quite confident in saying that I have a really old animal if all I had was remains of a [skull showing] fully fused occiput, where the mastoid was fully fused to both supraoccipital and squamosal."

Dr. Colbert needed to generate some scoring system to age the samples in order to address some of his initial questions. "With the highly variable sequences seen in suture

closures, it is difficult to point to any single criterion (or even sets of criteria) that could characterize all the samples at a particular point in maturity." Because of this, he used the sum of character scores to create "maturity scores". This simple approach assumes that each character change provides the same value of information about an animal's age. "Of course, if there was a compelling reason to do so, one could weight characters," and thus assign higher value to certain character changes. There are a few desirable properties inherent to his method. For one, "note that it doesn't matter which characters change, (…) animals having different suites of characters could have the same maturity score. This is to be expected when there are polymorphic sequences [meaning that the sequences vary from individual to individual, thereby creating the variability observed in the graph]. One could create pseudo-stages by lumping together all individuals with a certain range of maturity scores (e.g., bins of 5, or 10, or whatever increment was deemed appropriate). Indeed, it would be reasonable to have the bin size change during maturation, as the character's variability increases with maturity."

Dr. Colbert is now considering a strategy to tackle this obstacle with better statistical tools. He commented that "…it would be a good idea to try to fit the data to some sort of PDF" (probability density function – the reader is likely familiar with the Normal or Gaussean PDF). A probability density function is a statistical distribution function for a parameter, such as maturity scores. His newest idea is to "slice" the graph above into bins, each representing a set of maturity scores (defined as he previously did, or by other algorithms). These scores could be used to develop a PDF that would allow ageing of the animals. Clearly, the maturity scores must be built from data from skulls of known age.

To better understand the idea, imagine that you are standing in front of the street recording the colour of the first 80 cars that pass by. Imagine also that a sort of calibration curve exists relating the number of red cars you count to your age. If you are 25 years old, you will likely record that 16 of the first 80 cars are red; if you are 35, then the count is 20, and so on. Similarly, if a researcher finds a skull and records the state of 80 characters to determine the maturity score, then she should be able to establish, with certain degree of confidence, that the tapir was 10-15 years old because the characters scored 62. But the high levels of variability fog things up. For example, animals in that bin on average score 57, whereas those in the previous bin (say, 7-9) on average score 44, and those in the next (16-25) average 73. Fortunately, statistical techniques come to our aid by showing that a skull scoring 62 fits better in the 10-15 years old category than in any other. How so? For theoretical reasons, the sampling for maturity scores, as defined above, is suitably represented by a Poisson PDF. A Poisson PDF would be developed for each age bin, and this could be used to tell if a score is within the "normal range" of scores for the bin. By comparing among bins it would be, in theory, straightforward to decide which PDF the sample best fits in, thus obtaining an age estimate. In our example above, a score of 62 would have a much smaller likelihood of happening if the animal were in the 7-9 years or in the 16-25 years bins, rather than in the 10-15 years bin. Indeed, simple statistical calculations could tell how much confidence the researcher would have in her assessment. Moreover, a PDF could be built from the combined PDFs for each bin, making the estimate more straightforward. Clear as mud?

But again, to create the PDFs it is necessary to secure many records of known age. The more bins defined, the more PDFs that must be built, and the more data needed. Alternatively, and because data is scarce, the PDFs can be generated using a statistical tool called "bootstrapping." Bootstrapping is simply an artificial means to generate "bootstrap replicates" from a sample of a few individuals by sampling with replacement. Bootstrapping may help by reducing the need for large numbers of skulls of known age for generating the PDF for each bin, but the more samples used, the more the bootstrapped PDF will resemble the real thing. "I doubt bootstrapping will be possible if we need 50 or so samples per 'stage', but this might depend on how the stages (are) defined", commented Dr. Colbert, with a hint of sarcasm due to his knowledge on the dearth of data. Another critical aspect is choosing the right characters to develop the scores, where those showing the least variability in sequence of appearance would be most desirable.

The availability of a *large* collection of samples of known age is critical to scientists' efforts to age tapirs. Ideally, this collection would have several to many individuals of each age class. If such a collection does not exist, at least an electronic database of samples with known age from all museums and zoos could be compiled. Anyone interested in knowing what is available and where to review the specimens would find this database most helpful. Also, it is never too late to begin building such a collection by amassing in one location dead specimens from zoos – where tapirs with known age most likely will come from.

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Structure & Positions

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Notes for Contributors

Scope – This newsletter aims to provide information regarding all aspects of tapir natural history. Items of news, recent events, recent publications, thesis abstracts, workshop proceedings etc concerning tapirs are welcome. Manuscripts should be submitted in MS Word.

Deadlines – There are two deadlines per year. They are 31 March for publication in June and 30 September for publication in December.

Please include the full name and address of the authors underneath the title of the article and specify who is the corresponding author.

Full length articles on any aspect of tapir natural history should not be more than 15 pages in length (including references). An abstract is required and British English spelling is requested.

Figures and Maps. Articles etc can include black and white photographs, high quality figures and high quality maps and tables.

References. Please refer to these examples when listing references:

Journal Article
Herrera, J.C., Taber, A., Wallace, R.B. & Painter, L. 1999. Lowland tapir (*Tapirus terrestris*) behavioural ecology in a southern Amazonian tropical forest. *Vida Silv. Tropicale* 8:31-37.

Chapter in Book
Janssen, D.L., Rideout, B.A. & Edwards, M.S. 1999. Tapir Medicine. In: M.E. Fowler & R. E. Miller (eds.) *Zoo and Wild Animal Medicine*, pp.562-568. W.B. Saunders Co., Philadelphia, USA.

Book
Brooks, D.M., Bodmer, R.E. & Matola, S. 1997. *Tapirs: Status, Survey and Conservation Action Plan.* IUCN, Gland, Switzerland.

Thesis/Dissertation
Foerster. C.R. 1998. *Ambito de Hogar, Patron de Movimentso y Dieta de la Danta Centroamericana (Tapirus bairdii) en el Parque Nacional Corcovado, Costa Rica*. M.S. thesis. Universidad Nacional, Heredia, Costa Rica.

Report
Santiapilli, C. & Ramono, W.S. 1989. *The Status and Conservation of the Malayan tapir (Tapirus indicus) in Sumatra, Indonesia.* Unpublished Report, Worldwide Fund for Nature, Bogor, Indonesia.

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TAPIR CONSERVATION

The Newsletter of the IUCN/SSC Tapir Specialist Group

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