Suiform Soundings

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IUCN
The World Conservation Union

SSC
Species Survival Commission

Photo front page: A pygmy hog sow *Porcula salvania* and her litter at the PHCP Breeding and Research Centre at Basistha, Guwahati, Assam. Photo courtesy of Goutam Narayan

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Editorial: Reintroductions

On page 16 of this newsletter, William Oliver, Goutam Narayan and Parag Deka write about the reintroduction of 16 captive bred pygmy hogs into Sonai-Rupai Wildlife Sanctuary, a protected area in north west Assam, India. This reintroduction comes some 12 years after the initial capture of six wild pygmy hogs, which formed the original breeding nucleus for the captive population.

There is no question that reintroductions are an important conservation tool, especially when it comes to endangered species existing in unsuitable areas (for example, where habitat degradation and human impacts make their survival unlikely) or where vacant areas are identified as suitable for the release of captive individuals. Reintroductions have proved successful with numerous large carnivore and herbivore species, and have the potential to ensure the persistence of a species that would otherwise face an unlikely future.

The captive breeding of the pygmy hogs, a species once thought to be extinct in the wild, and their subsequent release into the sanctuary, is a success story to be proud of. However, reintroductions are often misused as a 'quick fix' solution to a specific problem. As the IUCN Re-introduction Specialist Group emphasizes, reintroduction is a very lengthy, complex and expensive process. Often projects don't meet with success, one of the reasons being that the underlying factors that led to the reintroduction in the first place are not addressed. In such cases, a reintroduction serves merely to delay the inevitable. In the case of problem animals, the reason for the conflict needs to be addressed instead of simply moving the targeted species to a new area. Where habitat degradation is the issue at stake, attempts need to be made to rectify the situation, be it through improved farming methods, more sustainable land use or the creation of buffer zones between human settlements and wildlife areas. This is where conservation efforts need to be focused, so that wildlife populations have a chance of persisting in areas where they naturally occur. Available areas that meet the necessary criteria for reintroducing species that have either been captive-raised or removed from an unsuitable area are few and far between. And such areas will continue to decrease as the human population expands and puts pressure on wildlife habitats and natural resources.

Another point mentioned by the IUCN Re-introduction Specialist group is the need for post-release monitoring of all, or at least a representative sample of individuals to better understand their demography and behaviour, and to determine ultimately whether the project has been a success or not. Please heed William Oliver's call for suggestions on possible monitoring techniques for the pygmy hogs, keeping in mind that direct observations are almost impossible in their natural habitat. Perhaps camera-trapping along travel routes might be an option, while the hogs are still shaved for identification purposes?

This project is a real success for the PPHSG, and as a group we should be aiming to increase the implementation of practical conservation initiatives across the distribution range of our species.

I want to thank everyone that sent in contributions for this issue. As you can see, it really is a rather large edition of the newsletter. Staying with captive breeding, we have an update on the *Sus verrucosus* breeding programme in Indonesia and a short description of the recently launched Oxóssi project in Brazil.

Also included amongst the many articles in this newsletter are a short communication on a peccary conservation action plan for Paraná State, Brazil, and an article on the distribution and conservation of white-lipped peccaries in Costa Rica.

I shall be placing a 'Guidelines for Authors' document on the website for future contributions to the newsletter. Please take note of the instructions for all submissions.

Happy reading!

Anne-Marie Stewart, Otjiwarongo, Namibia

A short progress report on the *Sus verrucosus* (SV) captive breeding project in Indonesia from January to June 2008.

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1. The *Sus verrucosus* project is lead by two institutions: the Cikananga Animal Rescue Centre for the management of the breeding facility; and Research Centre for Biology (LIPI) for the scientific aspects, under the banner of *Consortium of Conservation Breeding Program for Javan Warty Pig (*Sus verrucosus*)*
2. The construction of breeding facilities using the available funding (LA Zoo, USA & ZGAP München, Germany) has reached 95%; a 1.3 ha area has been subdivided into four sections, however the proposed smaller partitioning is still in the planning phase due to funding limitations.
3. Founders that are already present in our facility include one old male SV (Ragunan Zoo loan), one mature wild male SV and one young wild female SV.
4. Additional breeding stock will comprise one pure old male SV, one pair adult hybrid SV x Bali domestic pig and one pair young hybrid SV x Bali domestic pig, coming from a private owner in Gresik (900 km from Bogor). The Gresik party has agreed on the breeding loan document and the animals are going to be collected on the 16th of June 2008. We have also negotiated on two or possibly three pairs of SV from Surabaya Zoo on the 22nd of May 2008, and are now awaiting the approval from the Board of Trustees of the Surabaya Zoo.
5. One paper in Indonesian on the sperm morphometry, blood parameters and some morphological aspects of captive SV, has been submitted to a local journal.
6. One international paper on *Sus* evolution, as part of the international joint collaboration work (Univesity of Illinois, Illinois, USA, and Wageningen Univesity, Netherlands), will be presented at the 7th International Symposium on Wild Boar and Suborder Suiformes, in Hungary.
7. Collection of tissue sample of any wild *Sus* will still be conducted.
8. We are still searching for additional founders. The target is to obtain at least six pairs of pure SV, preferably of wild origin.
9. The University of Illinois, USA, has agreed to provide chemicals and materials for molecular analysis in Indonesia, and we are also consolidating on the possibility of sending an Indonesian scientist to the USA to conduct this analysis.
10. Thus far, the available (limited) funding is still concentrated on the construction and management of the animals, although some funding for laboratory and research related expenses (e.g surveys) is still

needed (proposal in preparation).

11. Tasks to be completed in the next 6 months (if funding is available):
    Survey for *Sus verrucosus* tissue for molecular profile of SV in Java
    Survey prospective areas to collect wild SV founders in East and West Java
    Transporting the 6 SV from Gresik to Sukabumi (900 km)
    Transporting the 4-6 SV from Surabaya Zoo to Sukabumi (870 km)
    Negotiating with Yogyakarta Zoo for a breeding loan of their SV (one old male)
    Collecting samples of the available animals for molecular study and analysis

Abstracts of recent papers

Gambaran Awal Mengenai Biologi Babi Kutil *Sus verrucosus* Di Penangkaran (Some biological aspects of captive Javan warty pig, *Sus verrucosus*)

Gono Semiadi & R. Taufiq Purna Nugraha

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The Javan warty pig (*Sus verrucosus*) is an endemic pig for the Java and Bawean Islands, with the population on Madura Island thought to be extinct. One problem in establishing ex-situ captive breeding is a lack of information on biology and physiology aspects. Studies on these aspects were conducted in Surabaya Zoo. Data showed that blood parameters were not different among the age groups (young and adult) or sexes, or from that of *Sus scrofa*. Extreme values were only obtained from the palette indicator, with the female reaching 14.5 103/mm3, while adult male and young pigs were 58-75 x 103/mm3. The testicle diameter with skin intake was 56.42 mm, while the length of testicles without skin was 83.29 mm on the left and 78.88 mm on the right. Sperm of the Javan warty pig had longer head and tail lengths. Number of litters born was between two to four, with an average of 2.75 litters (SD 0.98). Low numbers of litters from this species is a concern, and a program of captive breeding for release purposes needs to be considered.

Submitted to: Jurnal Biota, Indonesia

Towards a Genomic Platform for Analysis of Wild Boar and Suiforme Diversity and Evolution

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The pig (*Sus scrofa domesticus*) was domesticated from *Sus scrofa*, the wild boar, 9,000 years ago and studies utilizing mitochrondrial DNA analysis indicate that this occurred through multiple independent events around the world (Central Europe, Italy, Northern India, South East Asia, and Island Southeast Asia). Our efforts are focusing on the use of genomic DNA polymophisms (single nucleotide polymorphisms, SNPs) to assess nuclear contributions to global wild boar and domestic populations. Our goals are to provide a genomics platform that can be used to: 1) define wild boar and domestic populations; 2)

define the evolution of *Sus scrofa* and suiformes; and 3) provide a tool to assist in captive breeding and management projects. The pig genome sequencing project provides a reference sequence to support SNP discovery and next generation re-sequencing projects. This International Suiforme Genomics Consortium (ISGC) is thus focusing on SNP discovery using global wild boar germplasms (35 samples from Europe and Asia) and ten European, North American and Asian domesticated breeds. Reduced representation libraries (RRL) have been constructed from this diverse germplasm. These RRL were sequenced using Solexa and 454 platforms and SNPs were incorporated into a bioinformatics platform for identification of SNPs with >0.10 minor allele frequencies covering the complete pig genome. These SNPs were subsequently used by the ISGC to design a high density Illumina iSelect pig DNA chip (60,000 SNPs). This pig SNP chip will be used to define wild boar and domesticated populations and to determine its utility in captive breeding and management programs. The ISGC welcomes new members to provide broader access to germplasm and to assist in further defining the wild origins and related suiformes.
Presented at: 7th International Symposium on Wild Boar and on Suborder Suiformes (Hungary 25-30 August 2008).

Adult wild *Sus verrucosus* (pure?) collected from Semarang (Central Java, 600 km from Bogor) at our facility, tagged as no. 363.

Captive breeding construction of the SV facility in Sukabumi. A subdividing fence between pen 1 and 2.

An old pure (?) *Sus verrucosus* from Gresik to be transported to Sukabumi in mid June 2008. In the background is the first offspring, hybridized with the Bali domestic pig

The Oxóssi Project

Sérgio Nogueira-Filho and Selene Nogueira

The Oxóssi project was recently approved by the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), a governmental Brazilian agency. The project goal is to promote integrative action between wildlife management and the landless families recently settled in an agrarian reform project in the southeast of Bahia state, Brazil (D. Helder, Luanda and Rosa Luxemburgo communities). At these settlements we identified that the collared peccary and two other mammalian species (capybara and spotted paca) are considered "vertebrate pests" by these rural producers, as they cause damage to coconut, banana, cassava and cocoa plantations. These animals are frequently pursued to keep them away from the farms, resulting in a state of permanent human-wildlife conflict. As Brazilian law does not allow commercial hunting, these recently settled families need alternatives to improve their living conditions and alleviate poverty.

The aims of the Oxóssi project are to capture and breed peccaries and capybaras in semi-confinement, and pacas under full confinement, producing meat and other by-products, such as valuable leather from the peccary and capybara. It is hoped this will decrease human-wildlife conflict by converting "plague animals", as farmers call them, into an income source. Behavioral, nutritional, financial and management studies will be done to refine husbandry techniques and evaluate this action plan to solve the "problem" caused by peccary and other mammalian species in this region. In addition, the proposal will promote an environmental education program with children in these communities to demonstrate the ecological value of these wild mammals. The Oxóssi project is coordinated by Sérgio Nogueira-Filho and Selene Nogueira, full professors of the Universidade Estadual de Santa Cruz, Ilhéus, Bahia, Brazil.
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Preparation of a peccary conservation action plan for Paraná state, Brasil

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The Paraná State Environmental Agency (IAP) invited and has been working with local researchers to establish a Local Action Plan for *Tayassu pecari* and *Tayassu tajacu*. The Paraná State, Brasil, shows a high diversity of mammals, representing approximately 180 species. *Tayassu pecari* was categorized as "critically endangered" and *Tayassu tajacu* as "vulnerable" according to the Paraná Red List (Mikich & Bérnils, 2004). Locally the main obstacles to mammal species conservation are habitat reduction and destruction, predatory and illegal hunting and trade, ecosystem pollution by agricultural defensives, exotic invasive species, and a reduction in food availability (Mikich & Bernils, 2004). Originally, Paraná State was characterized by large areas of Paraná Pine Forests (*Araucaria angustifolia*), which provided large amounts of nuts during several months. Reduction and fragmentation of Paraná Pine Forests for more than 50 years has increased the threat to ungulate populations in the region.

The State Action Plan for Peccaries is included inside a bigger plan to improve the conservation status of

several species. This plan is called "Paraná Biodiversity", whose objectives are carried out by community, scientific and government personal. This is a large-scale landscape restoration program that intends to establish three biodiversity corridors in the state. Besides this program, full landscape connectivity covering the original Paraná Pine Forest, to the benefit of large and medium ungulates, is not a real possibility in the short or medium term. In order to expand the Action Plan for Peccaries, the Governmental Environmental Agency invites the academic and scientific community, non-governmental organizations and captive breeding establishments to establish guidelines, priorities and deadlines for local conservation actions aimed at the local conservation of these species. The Action Plan for peccaries will include, amongst other themes, general information on the species at a local level; specific threats; status in the wild, as well as in captive and conservation areas; pre-existing local conservation efforts; the need for public polices and habitat protection; ecological research; and management in the wild and in captivity. The Paraná State intends to publish this Action Plan. The research community recognizes this Governmental action as being environmentally responsible, providing public administration with a more focused approach to biodiversity conservation, even for the "uncharismatic" species. Additionally, the publication of these plans could help to support a long-term partnership between conservationist researchers and governmental agencies.

TNC y sus socios desarrollan primer plan de acción para la conservación del chancho de monte (*Tayassu pecarí*) en Costa Rica

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A raíz de un estudio que se realizó en la Reserva de la Biosfera La Amistad en Costa Rica, desarrollado en conjunto con TNC y como parte de su estrategia de conservación en la región, sobre la distribución, cacería y situación de conservación del chancho de monte, se determinó la necesidad de diseñar un plan de conservación participativo para esta especie. La Reserva de la Biosfera La Amistad se ubica en la Cordillera de Talamanca, y representa el territorio de mayor riqueza y potencial de recursos naturales y culturales de Costa Rica. Dentro de esta reserva se encuentra el Parque Internacional La Amistad (PILA), el cual es el área natural protegida más grande de Costa Rica, abarcando aproximadamente 200.000 ha. La Reserva de la Biosfera dentro de Costa Rica incluye, además del PILA, otras 12 áreas protegidas y 11 reservas indígenas con una extensión total en bosques superior a 450.000 ha.

En esta región, como en muchas otras donde existe una relación estrecha entre la gente local y la biodiversidad, el desafío es encontrar un balance entre las necesidades de la gente local y la conservación. Los animales silvestres son una fuente importante de alimento para los habitantes de Talamanca. Un estudio reciente (Altrichter & Carbonell 2007) confirmó que la cacería de subsistencia actual practicada por los indígenas Cabecares y Bribris no es sostenible. Varias especies de fauna, entre ellas el chancho de monte (*Tayassu pecari*), demuestran tendencias poblacionales en declinación, lo que es preocupante desde el punto de vista de la integridad ecológica y de la salud nutricional de los indígenas que dependen en gran medida de la cacería para su obtención de proteína.

Una de las formas de concretar una estrategia de conservación del chancho de monte es a través de un plan de acción que contemple, entre sus aspectos principales: a) problemas, b) metas generales y

particulares, y c) acciones prioritarias a desarrollar. Un plan de estas características requiere de un compromiso político y esfuerzos inter-institucionales e inter-jurisdiccionales para lograr un cambio significativo en la conservación de la especie. A raíz de esta necesidad, TNC organizó un taller para incluir las opiniones y visiones de los sectores involucrados en la conservación de la fauna en la región de Talamanca. Los resultados de este taller se integraron con la información obtenida durante la investigación previa realizada por Altrichter y Carbonell (2007) en la que se estimó la situación de conservación del chancho de monte y el contexto socio-económico dentro del cual se realiza la cacería. El objetivo del taller fue socializar la información obtenida durante la investigación, previamente mencionada, con los diferentes sectores involucrados en la conservación y la gestión de las áreas protegidas y territorios indígenas de la Reserva de la Biosfera La Amistad. Al taller asistieron 22 personas provenientes de nueve instituciones: representantes de tres reservas Indígenas (Talamanca Bribri, Cabecar y Tayní), administradores del PILA de Costa Rica y de Panama, representantes de ONGs, investigadores y estudiantes.

Como resultado de la investigación y el taller se elaboró el primer plan de acción para el chancho cariblanco en Costa Rica. **La visión del plan de acción es**: Asegurar la **conservación** a largo plazo de las poblaciones del chancho de monte con sus procesos naturales, flujos genéticos, ecológicos y evolutivos, considerando su **importancia** como parte del **ecosistema** y su importancia **cultural** para los pueblos de la Reserva de la Biosfera La Amistad.

La **meta general** del plan es *Implementar una serie de acciones de conservación prioritarias e inmediatas para frenar la disminución de las poblaciones de chancho de monte en Talamanca durante la próxima década, como punto de partida para iniciar la recuperación de la especie en Costa Rica.*

Las metas específicas identificadas en el plan son:

Detener la tendencia de diminución de las poblaciones de chancho de monte.
Mantener o aumentar la disponibilidad de hábitat adecuado para la especie.
Apoderar las comunidades indígenas para que puedan determinar sus propias reglas de cacería y controlar la caza furtiva.
Incrementar el conocimiento sobre especies y ecosistemas amenazados y sobre la importancia de la conservación en la población indígena en general, las escuelas, los funcionarios, y otros tomadores de decisiones.
Promover el reconocimiento de los valores, identidad y conocimiento indígena en las organizaciones, base territorial y organizaciones locales indígenas y no indígenas, líderes y jóvenes de las comunidades.
Impulsar el orgullo de ser indígena y aumentar el respeto al conocimiento indígena, naturaleza, vida silvestre y conservación.
Completar la información existente sobre la distribución y patrones migratorios del chancho de monte dentro de la RBA, situación poblacional y amenazas que enfrenta la especie, y la disponibilidad de alimento para el mismo por encima de los 1.200 msnm.
Investigar el efecto de las enfermedades del ganado doméstico (especialmente cerdos) en las poblaciones de chanchos de monte.
Desarrollar de metodologías simples, económicas y estándares por medio del consenso entre investigadores, organizaciones y comunidades.
Elaborar propuestas de investigación a partir de las necesidades locales.
Capacitar, entrenar e incentivar las comunidades locales para el desarrollo de investigación biológica

y social, así como su participación en investigaciones científicas.

Generar mecanismos para mantener e incentivar la investigación local y lograr que las comunidades sean gestoras de la conservación e investigación.

Realizar investigaciones de base sobre la cacería, hábitats y problemática social en el sector Telire y Tayni.

Implementar estrategias de trabajo intersectorial entre las instituciones gubernamentales como el SINAC, y las locales como las asociaciones de desarrollo.

Aumentar la colaboración entre FONAFIFO, MINAE y las ADIRIs para Incorporar la protección de la especie dentro de los contratos de las áreas sometidas a pagos por servicios ambientales (PSA).

Fortalecer a las comunidades para su mejor organización y capacidad de gestión ambiental.

Implementar en un corto plazo la conformación de comités locales asociados a áreas protegidas que se encuentren ubicadas dentro del área de distribución actual del chancho de monte.

Incorporar personal que proceda de territorios indígenas en las instituciones relacionadas al tema ambiental, tal como SINAC.

Entrenar al personal de áreas protegidas colindantes con territorios indígenas en temas de gestión, manejo conflictivo, cultura y tradiciones, además del manejo de vida silvestre.

Incentivar actividades productivas tendientes a disminuir la dependencia en la fauna como fuente de alimento.

Implementar una normativa local para determinar criterios ambientales y culturales para el desarrollo urbano y rural.

Organizar las comunidades para buscar una mejor remuneración de la producción compatible con la conservación.

Recuperar el conocimiento y las prácticas tradicionales que han regulado las relaciones entre seres humanos y la naturaleza, apoyando la seguridad alimentaria.

Las metas propuestas demuestran una visión integral de la conservación, que solo se logra al respetar y promover la participación de todos los que están involucrados de alguna manera con la conservación de la especie en cuestión. El plan demuestra la integración de los diferentes intereses relacionados con la conservación de la biodiversidad y la cultura indígena en Talamanca, así como la necesidad de reconocer la estrecha interacción entre el desarrollo sostenible de las comunidades locales y la conservación. También se observa una voluntad de aumentar la conexión y los esfuerzos colaborativos entre las diferentes instituciones.

El plan de acción además reconoce responsabilidades para llevar a cabo el plan, identifica las medidas prioritarias a corto, mediano y largo plazo, y presenta una forma de evaluar la efectividad del plan y de su ejecución. El primer paso ha sido completado; ahora debemos impulsar el seguimiento y la aplicación del plan y esperamos que los compromisos adquiridos por los diferentes sectores para la exitosa conservación de esta especie sean respetados.

Literatura citada

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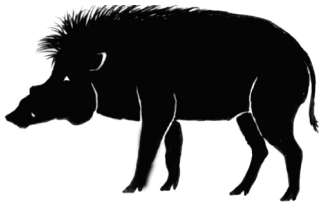

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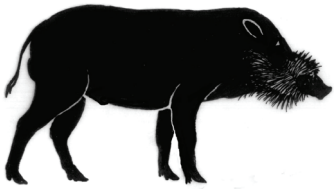

Responses to olfactory cues to increase trapping success for feral pig (*Sus scrofa*) control: a preliminary study.

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Abstract

Feral pigs cause negative impacts on native biota and urban areas on the Hawaiian Islands. The aim of this study was to investigate the natural odor of pigs as a technical bait to increase the capture success of feral pigs. We conducted olfactory tests on 20 reproductively intact adult domestic and feral pigs on Oahu, Hawai'i. We recorded behavioral responses of sexual (vagina and semen) and saliva secretions from unfamiliar male and female pigs. Subsequently we tested the domestic pig secretions in areas where we previously detected free-ranging pig occurrences. The olfactory test with domestic pigs showed that the animals reacted differently to the secretions. Saliva was more attractive to males than females. Despite domestic animals responses to saliva, the field test did not reveal feral pig visits. The unsuccessful sign of feral pigs could be related to human smell, which repels feral pigs as observed by hunters. The results obtained in the present study showed that saliva secretion can work to mark territory.
Keywords: behavior; scent; vertebrate pest control; odor.

Introduction

Feral pigs are considered pests that negatively impact the native Hawaiian Island biota, and several authors have documented the detrimental effects of this animal in forest communities (Spatz and Mueller-Dumbois, 1975; Jacobi, 1976; Cooray and Mueller-Dumbois, 1981; Diong, 1982). Due to these detrimental effects several management plans were devised in the attempted to control the ecological damage caused by pigs (Tomich, 1986; Jenkins et al., 1994). However, feral pigs can smell traps and actively avoid them, making trapping and control difficult. The feral pig problem persists, and what was before almost strictly a rural and ecological concern has now become an urban problem as well.

Nogueira et al. (2007) proposed that the solution to human-wildlife conflicts should consider aspects of pigs' behavior such as reactions to natural odors, which could help improve capture techniques and keep feral pigs away from urban areas. The sense of smell in pigs is an important cue for foraging, communi-

cation, social interaction and mating (Giffin, 1978; McGlone et al., 1987; Pearce and Hughes, 1987; Jensen, 2002; Croney et al., 2003; Morven et al., 2005). Pigs are attracted to odors associated with familiar animals and food (Parfet and Gonyou, 1991; McLaughlin et al., 1983), but as far as we know it has not yet been evaluated whether sexual or salivary secretions can attract or repel free-ranging pigs. In this context the aim of this study was to investigate the reaction of domestic and feral pigs exposed to sexual and salivary secretions in order to improve capture techniques for feral pig control.

Materials and methods

Animals and study areas

We conducted two olfactory tests with domestic and feral pigs. The first part of the study was at Jay's Pig farm, on Waianae, Oahu, Hawai'i. At this farm the males were housed in individual pens while the females were kept in groups that ranged from three to five within each pen. We observed the behavioral responses of twenty reproductively mature domestic pigs to secretions obtained from unfamiliar boars and sows. The experimental animals were 10 non-pregnant crossbreed sows (Landrace/Large White/ Duroc) with average weight of 198.2 (± 14.8) kg and 10 boars (four Landrace, four Large White and two Duroc) with average weight of 182.9 (± 8.8) kg.

Subsequently, we used the domestic pigs' secretions, collected at the pig farm, to test their effects on feral pigs at the Harold L. Lyon Arboretum, a Research Unit of the University of Hawaii at Manoa, Honolulu, Hawaii. The Lyon Arboretum has an extensive plant collection comprised of native Hawaiian species planted in different sections and has also suffered from feral pig damage.

Olfactory test with domestic pigs

We collected sexual secretion samples from the penned males – semen and saliva – and females in estrus – vaginal secretions. The saliva and vaginal secretions were collected with cotton cloth (0.1 m x 0.1 m) directly from their mouth and genitalia when animals were in their home pen, while the semen was collect during natural mount when receptive females were introduced into boar pens. After collection, we stored the samples for later tests on domestic animals and free-ranging feral pigs at -20^0C.

We conducted the test in 20 neutral pens (non-used pens, 6.0 m x 8.0 m) that had never been used before for animals. We used 10 domestic pigs as experimental individuals (five females and five males) and 10 as controls (five males and five females), each one being introduced to the pens individually. The experimental animals had never had previous visual or olfactory contact with the secretions' donors. We divided the pens into different areas: the smell zone, the neutral zone, and door. The smell zone was comprised of three areas with 2.0 m x 3.0 m blocks demarcated with floor markings. In the early morning, immediately before the experimental animal introduction, each sample was placed in the center of these areas by rubbing the cotton cloth with one of the previous collected samples (S1: vagina secretion; S2: male saliva and S3: semen). We demarcated the control pens in the same way but rubbing the cotton cloth without secretion. We observed both experimental and control animals immediately after their introduction to the pens and we recorded their behavior for 30 minutes by video camcorder (Sony® Handy cam DCR-HC21 NTSC). We performed the observations from 0900 to 1200, three times a week for two months.

Field olfactory test with feral pigs

The same secretion samples used in the olfactory study with domestic pigs described above (S1, S2 and S3), were taken to places where feral pigs sign, such as tracks or rooting, observed at the Harold L. Lyon Arboretum.

We made three 1.0 m x 1.0 m track traps, 2.0 m apart from each other. In the middle of these traps we left on the forest floor a small piece (0.01 m x 0.01 m) of cotton cloth impregnated with one of the sampled secretions. Additionally, we made three control traps in the same way but leaving cotton cloths without secretion. The control traps were located 500 m far from the experimental ones in similar habitats. Then we recorded all movement around the sample and control locations using two video camcorders equipped with a movement sensor (M.A.D. Wildlife Eye®, Koupin Outdoors Inc.). We placed the samples on Friday mornings and checked feral pig visits after 24 hours. The field data collection was comprised of six twenty-four hour observations, totaling 144 hours of observation.

Behavioral measurements and data analyses

For the olfactory test with domestic pigs we compared the time that experimental and control animals spent in each of the different pens' zones by the Mann-Whitney *U* test. We also compared the time spent by experimental male and female animals exploring the three secretion areas tested: saliva secretion area, semen secretion area, and vagina secretion area by the G independence test; followed by the Mann-Whitney *U* tests to compare, between males and females, the time spent sniffing each one of the secretion areas. Field data were analyzed based on feral pig's visits.

Results

Olfactory test with domestic pigs

The presence of the secretions affected the behavioral patterns expressed by the experimental animals when compared to control individuals. The data showed that the control males spent more time exploring the whole pen than the experimental males ($U = 3$, $N_1 = N_2 = 5$, $P = 0.02$), while experimental males ($U = 2$, $N_1 = N_2 = 5$, $P = 0.01$) and experimental females ($U = 5$, $N_1 = N_2 = 5$, $P = 0.05$) spent more time exploring smell area than control males and control females respectively.

Our results also showed differences in the time spent by experimental male and female animals among the three secretion areas ($G_{test} = 1011.8629$, DF = 20, $P < 0.0001$). Males spent more time than females exploring the saliva secretion area ($U = 4$, $N_1 = N_2 = 5$, $P = 0.04$). However, we did not find a difference in the time spent between experimental males and females in the semen secretion area ($U = 10$, $N_1 = N_2 = 5$, $P = 0.30$) and in the vaginal secretion area ($U = 7$, $N_1 = N_2 = 5$, $P = 0.12$).

Field olfactory test with feral pigs

We registered that none of the secretions tested – semen, vaginal or saliva – attracted feral pigs at the Lyon Arboretum, since we did not obtain images on the automatic camcorders or register tracks around the secretions placed in the field.

Discussion

Our data showed that the presence of secretions obtained from other pigs can lead to changes in behavior, which may differ according to the type of secretion. The control males spent more time exploring the entire pen than the experimental males. This can be explained by the fact that control animals did not have any particular odor to attract or repel them to or from specific areas of the pen.

Pond and Houpt (1978) suggested that the pheromones present in boars' saliva serves to regulate group behavior, attracting sows in estrus and mediating boar's social ranking within a group. In our observations, however, we verified that the males' saliva proved more attractive to other males than females.

Diong (1982) described two behavioral patterns for boars in Hawai‘i when in groups with a sow in estrus: the boar slashed the base of tree trunks with his canines, marking them with foamy saliva, or the boar held its snout directly upward, sniffing the air and repeatedly snapped its jaws. Therefore, our data suggest that the male's saliva is used more to mark territories than to attract females.

Although we were unable to confirm the effects of domestic pig secretions in the field study, we do believe that the reaction to saliva by domestic pigs may contribute to pig damage control programs, aiding in the development of pig attractiveness in urban and non urban areas where feral pigs occur and need to be trapped. A more long-term study of behavior than the present can lead to the development of control methods such as those obtained by Baker et al. (2005); Littin and Mellor, (2005); Sato (2001) and Singh and Kaumanns (2005).

It must be pointed out that the absence of pig images or tracks in the field could be related to human smell contamination that could warn wary animals. Pigs have been observed to smell humans from nearly one kilometer away (Diong, 1982). This acute sense of smell may also be used to detect leg snares on Oahu, even when hunters use gloves. Therefore, further studies need to be performed to test pigs' reactions to male saliva secretion so that their efficacy in attracting male feral pigs can be evaluated. To this end adequate technology to mask human scent must be developed.

In summary, the results obtained in the present study suggest that the use of natural secretions to attract feral pigs must take into account sex differences and should use chemical technology to mask human scent in the field.

Acknowledgements

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First captive bred pygmy hogs (*Porcula salvania*) reintroduced to Sonai Rupai Wildlife Sanctuary, Assam, India

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Summary

Twelve years after six (2♂♂4♀♀) pygmy hogs were captured for conservation breeding purposes from the last surviving wild population in Manas National Park, 16 (7♂♂9♀♀) captive bred hogs were released in Sonai Rupai Wildlife Sanctuary in north-west Assam between 4th and 9th May 2008. This event not only constituted the first such reintroduction attempt, but the first of a proposed series of releases in this sanctuary; hopefully to be followed by similar series of releases into 'vacant' habitats in two other protected areas within the known or presumed former range of this species in this region.

This project is being conducted by Pygmy Hog Conservation Programme (PHCP), a collaborative venture between PPHSG, Durrell Wildlife Conservation Trust and local government authorities. This agreement, the first of its kind in India, was first signed in 1995, and was intended to facilitate implementation of a wide-ranging conservation action for this species originally drafted and approved by both the Union Ministry and Assam State Forest Department in 1981! Both the PPHSG and Durrell have played instrumental roles in the development of the Action Plan and in subsequent evolution of this Programme, for which purposes Durrell also kindly provided or sourced the majority of funding support and provided diverse other assistance for the past 30 or more years.

These animals were bred at the PHCP research and breeding centre at Basistha, near Guwahati, before being transferred to a specially constructed 'pre-release' facility in Potasali, on the outskirts of Nameri National Park, east of Sonai Rupai Wildlife Sactuary; both of which areas had been identified as likely future reintroduction sites. Whilst at Potasali, every effort was made to 'pre-condition' the animals for eventual release by maintaining them in integrated social groups, in simulated natural habitats intended to encourage natural foraging, nest-building and other behaviours; whilst also minimising human contact to mitigate tameness and other behavioural characteristics consequent upon their captive management. Whilst in Potasali radio-harnesses designed for post-release monitoring studies were field-tested during trial attachments to two individuals in each group, thereby unexpectedly exposing serious problems in the use of these harnesses, which the animals were either able to escape from or which caused unacceptable injuries. Possible alternative means of monitoring were devised and initiated, including training the animals to visit random bait sites and screening for field 'sign'.

After 5 months tenure in the 'pre-release' enclosures at Potasali, these hogs were transferred in early May to temporary 'soft-release' enclosures constructed for this purposes in a relatively secluded, but easily accessible area of natural habitat in the far interior of the Sonai-Rupai Sanctuary. These enclosures were also rigged with two lines of electric fencing and kept under continual surveillance as a precaution against potential predators and to deter incursion by wild elephants. The animals were maintained for a

further two to three weeks in these enclosures before being released, by the simple expedient of removing sections of fence in each of the three enclosures and allowing the animals to find their own way out.

Introduction

The pygmy hog (*Porcula salvania*) is the smallest, one of the most specialised and almost certainly the most endangered of the world's wild suids. It was formerly known or presumed to occur in early successional tall grasslands at intervals along the southern Himalayan foothills, extending from N.E. Uttar Pradesh and S.W. Nepal in the west, to northern West Bengal and N.W. Assam in the east. However, all confirmed reports and most anecdotal accounts dating back to its description in 1847 refer only to the latter areas; and, most recently, only to N.W. Assam, where the species was famously 'rediscovered' in 1971. This event prompted great interest in its conservation management needs, including a series of captive breeding attempts on local tea estates, and in Assam State Zoo and Zurich Zoo, during the 1970's to early 1980's, and in Manas National Park in the late 1980's; though all of these were ultimately unsuccessful (Mallinson, 1977; Oliver, 1980; Oliver & Deb Roy, 1993).

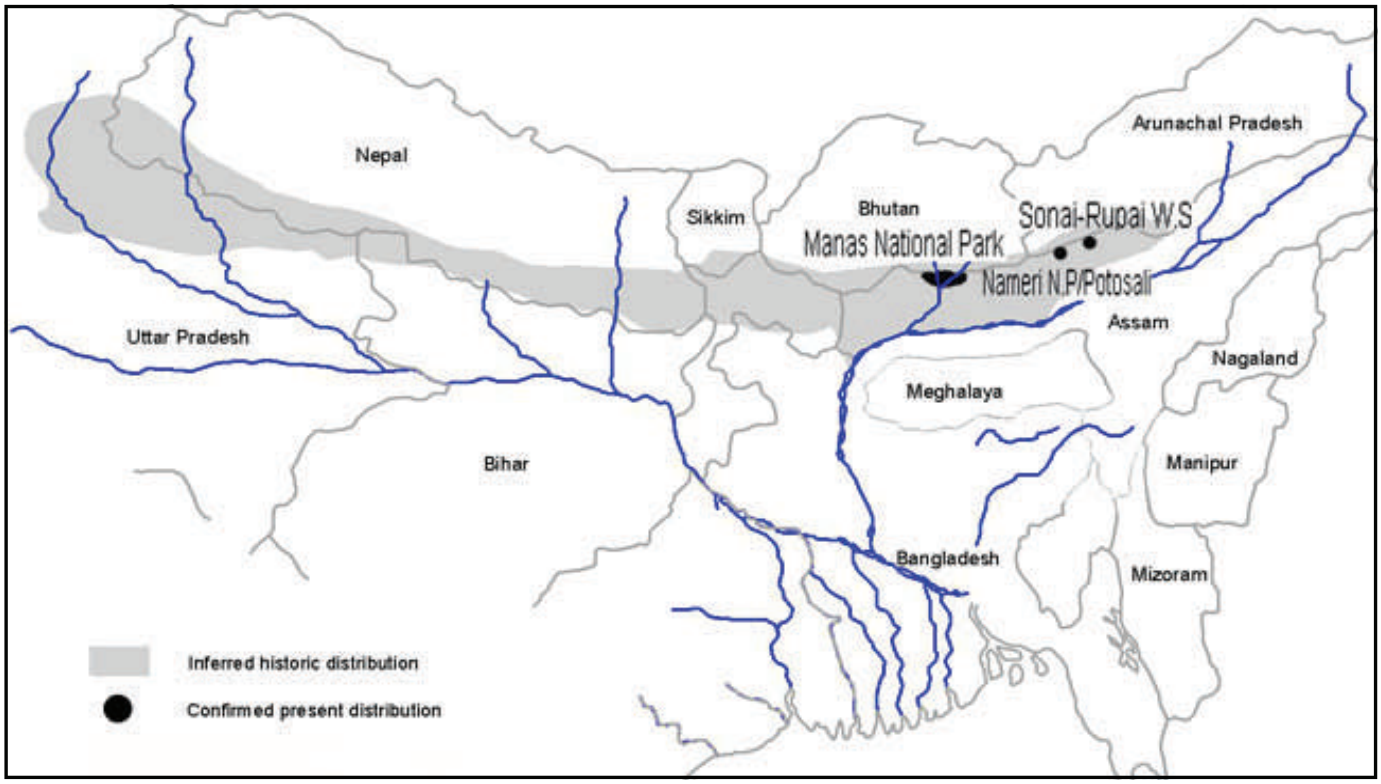

Figure 1: Inferred and current confirmed distribution of pygmy hogs

Wide-ranging distribution and status surveys conducted during this period and in later years also confirmed the continuing occurrence of this species in the Manas National Park and its buffer reserve forests, and documented the occurrence of a number of other small, and highly fragmented populations in the reserve forest belt of north-western Assam, east of Manas, but all of these smaller populations were confirmed or feared extinct by the early to mid-1980's. Attempts to trace any other possibly surviving remnant populations elsewhere within their known or presumed former range in southern Nepal and north-eastern India, extending into extreme south Bhutan, south-western Arunachal Pradesh, were also unsuccessful (Griffith, 1978; Oliver, 1980; Oliver & Deb Roy, 1993; Narayan & Oliver, in press). Accordingly,

the only known surviving wild population of pygmy hogs occurs in Manas National Park, though this area is unfortunately also threatened by political instability and other problems and has also been included on the IUCN List of Threatened Protected Areas since the late 1980's (J. Thorsell, pers. comm.)

The main threats to survival of pygmy hogs are loss and degradation of habitat due to the expansion of human settlements, agricultural encroachments, flood control schemes and injudicious grassland management practices, especially extensive and indiscriminate burning of tall grasslands during the dry-season and replacement of these grasslands with commercial tree plantations. Pygmy hogs are clearly dependant on the continuing existence of these grasslands, which are likewise crucial to the survival of a number of endangered species such as the one-horned rhinoceros (*Rhinoceros unicornis*), swamp deer (*Cervus duvauceli*), wild buffalo (*Bubalus bubalis*), hispid hare (*Caprolagus hispidus*) and Bengal florican (*Houbaropsis bengalensis*). However, none of these other species appear to be as crucially dependant on the continued availability of the later successional grasslands most prone to widespread and too-frequent burning and other disturbances, and are thus one of the first species to disappear from such habitats which may continue to support these other species (Bell & Oliver, 1990; Oliver, 1989; Oliver, 1980; Oliver & Deb Roy, 1993; Narayan & Oliver, in press).

After extensive surveys to locate possible reintroduction sites, a couple of sites in Assam were shortlisted. Sonai Rupai Wildlife Sanctuary, situated about 20 km west of Nameri, has been selected as one of the first release sites. The grasslands at the release site are being managed and protected with the help of sanctuary authorities and staff and we are confident the released hogs would settle down in this restored habitat.

Sixteen pygmy hogs (7 males, 9 females) prepared for independent survival in the wild at the pre-release facility were taken to Sonai Rupai in May 2008 under a soft release procedure. This is the first time that captive bred pygmy hogs are being released in such numbers in the wild and efforts will be taken to monitor them although it is almost impossible to see them in the grasslands.

PHCP continues to work closely with Sonai Rupai authorities to improve protection and management and to control annual dry season burning of grass. Frontline staff of the Sanctuary were trained in wildlife monitoring and habitat management under a Darwin Initiative training course conducted in collaboration with Zoological Society of London. The Assam Forest Department is confident that these training programmes will help in better monitoring and management of state's Parks and Sanctuaries.

The Pygmy Hog Conservation Programme

The Pygmy Hog Conservation Programme (PHCP), a coordinated and broad-based research and conservation project formally initiated in 1995 under the aegis of an 'International Cooperative Management and Research Agreement (ICMRA)', between the Ministry of Environment and Forests (Government of India), the Assam State Forest Department, Durrell Wildlife Conservation Trust (DWCT, Jersey, Channel Islands) and the IUCN/SSC Pigs Peccaries & Hippos Specialist Group (PPHSG).

This agreement, the first of its kind in India, was primarily intended to enable the implementation of a wide-ranging conservation action plan aimed at assisting the enhanced protection and management of grasslands in Manas National Park, whilst also highlighting the need for more applied field research into species' distribution, ecology and behaviour; the development of experimental protocols aimed at assisting the enhanced future management and protection of tall grass grasslands; and the development of a properly structured conservation breeding programme, both as an insurance against the species' possible

early extinction in the wild state and as a source of animals for future reintroductions.

Both the PPHSG and DWCT played instrumental roles in the development of the Action Plan and in subsequent evolution of this Programme, for which purposes the DWCT has also kindly provided or sourced the majority of funding support and provided diverse other assistance for the past 30 or more years. The current project is likewise supported by the UK Government's Darwin Initiative, sourced by the DWCT, and implemented in collaboration with EcoSystems-India, the local partner organisation of DWCT and PPHSG. Both this project and EcoSystems India are also working closely with local communities and other stakeholders, including some NGOs such as Aaranyak and the Centre for Environment Education (CEE), to improve awareness about the species and the management of its grassland habitats.

Conservation Breeding

Following the signing of the ICMRA, initial funding support from the European Union via DWCT, and with the active assistance of the Assam State Forest Department, a new 'Pygmy Hog Research and Breeding Centre' was established at Basistha, on the outskirts of the Assam State Capitol of Dispur, in Guwahati City. Initial constructions comprised outer fencing, a well, a project house/office and meeting room; together with a specially designed range of 10 inner and 8 outer enclosures, the latter being planted with tall grasses imported from known former hog habitats.

In March 1996, six (2♂♂4♀♀) wild hogs were captured under permit from within Manas National Park and transferred to the new breeding enclosures in Basistha. During this process, a further 5 hogs were caught and released at the capture site after fitting three adult males and an adult female with radio harness for radio-telemetry studies; the remaining animal being a juvenile and therefore released without attaching a radio-harness. No losses of any animals occurred during these capture operations.

Since it was known that reproduction in this species was strongly seasonal, with almost all documented births coinciding with the onset of the monsoon in late April and May, the capture operation was also carefully timed to coincide with expected mid-term pregnancy of adult sows, which (following extensive consultations with specialists) was understood to be the period of least risk in these regards. In the event, 3 (of the 4) sows captured in Manas were adults and pregnant, and subsequently produced three healthy litters, comprising a total of 13 (7♂♂6♀♀) young, all but one of which was successfully reared.

Following the initial breeding successes in Basistha, whereby the only captive population of these animals trebled in numbers from 6 (2♂♂4♀♀) to 18 (10♂♂8♀♀) individuals in the first year, another 7 litters were born in 1997, of which 24 (15♂♂9♀♀) young were reared. However, these gains were offset by the loss one of the founder females and 6 sub-adults following an outbreak of a mixed bacterial-fungal infection. This was eventually contained, and although the overall population growth rate in 1997 was reduced to less than 100%, i.e. from 18 to 35 individuals; even if this also constituted a 580% increase during the preceding 21 months period.

In the 1998 breeding season five sows farrowed at Basistha, adding another 22 (11♂♂11♀♀) hogs to this stock; though piglet losses from diarrhoea again curbed reduced population growth rates in 1999, when only 11 (7♂♂4♀♀) young from five litters were reared. Slightly better results were achieved in 2000, when a further 14 (8♂♂6♀♀) individuals were reared, thereby bringing the total captive population up to 65 individuals (Narayan & Deka, 2002).

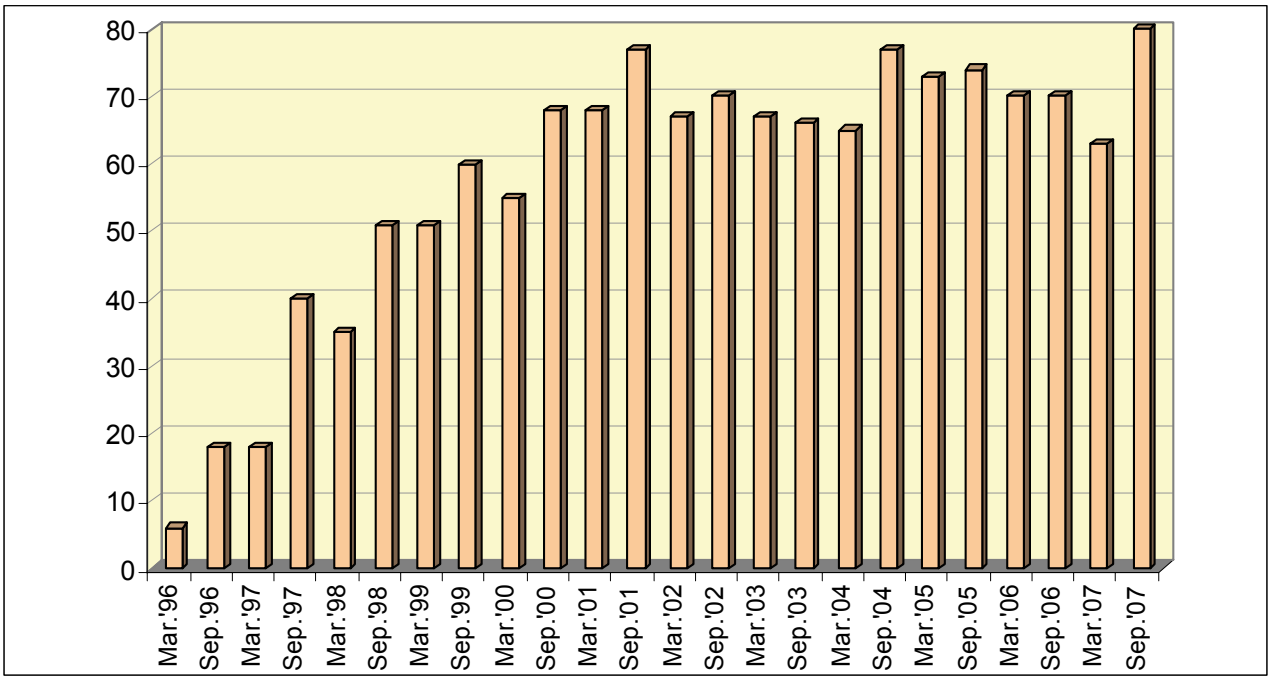

Figure 2: Increase in captive population at Basistha centre

Unfortunately, however, these increases also inevitably resulted in increasing over-crowding problems, which were only temporarily resolved by the construction of additional holding enclosures and a new quarantine facility, kindly sponsored by the Assam Valley Wildlife Society. Nonetheless, increasingly rigorous curbs on the reproduction of these animals had to be imposed, especially owing to other restraints likewise imposed on the proposed dispersal of surplus stocks to other breeding centres consequent upon the expiry of the original ICMRA, and subsequent, protracted delays in the renewal of this agreement. For all of these reasons, the captive population was allowed to rise to only 77 individuals in 2001 (i.e. a 13-fold increase in this stock in 6 years), but generally maintained at a level of around 70 hogs for the following four years.

However, development of the 'pre-release' facility at Potasali in 2006, not only enabled the first-ever translocations of breeding stocks from Basistha, but also enabled increased reproductive activity in the Basistha Centre; all of which activities were made possible by increased funding support from DWCT via a Darwin Initiative grant, and additional funding support kindly provided by the *Zoologische Gesellschaft fuer Arten- und Populationsschutz e.V*. (Zoological Society for the Conservation of Species and Populations or ZGAP, Germany) and a generous personal donation by Joseph Mayo (also see Oliver, 2006).

In June 2007, the captive population had therefore increased to an all time high of 80 (36♂♂44♀♀) individuals, though it is naturally hoped and expected that much higher levels of reproduction may be both possible and necessary for reintroduction purposes over the next few years.

Reintroduction

After extensive surveys and detailed consultations with the relevant authorities, two sites were finally selected as being potentially most suitable for reintroduction purposes, i.e. Nameri National Park and Sonai Rupai Wildlife Sanctuary. Both of these areas fall within the species known recent range in north-western

Assam, though no evidence could be found of the species continuing occurrence in these areas, despite the presence of suitable - if presumably now 'vacant' – habitats, and that these habitats were discontinuously distributed; thereby reducing the risks of any uncontrolled burnings effectively destroying all available habitat at any one time. Of the two, Sonai Rupai was also selected for the first such releases on the basis that it contained considerably more tall grasslands than Nameri, but that this area had been generally neglected and that any such reintroduction attempt might also generate increased interest and resources to effect the enhanced future protection and management of the entire area. To these ends, the PHCP continues to work with the Sanctuary authorities and staff to improve protection and management and to control annual dry season burning of grass. Sanctuary staff were also trained in wildlife monitoring and habitat management under a Darwin Initiative training course conducted in collaboration with Zoological Society of London.

Conversely, Assam Forest Department property in Potasali, on the outskirts of Nameri National Park, was selected as being the better location for the establishment of the pre-releases facility, based on the availability of vacant land, better on-site security measures (including greater distance from the neighbouring forest areas and therefore less risk of wild elephant damage), ease of access on all weather roads, and closer proximity of village markets for accessing of supplies, etc.

Construction work at the new facility at Potasali was initiated in 2005 with the completion of four new holding enclosures, and completed in 2006, when the first hogs were transferred from Basistha, and four large 'pre-release enclosures' were completed and planted with tall grasses collected in Sonai-Rupai. These enclosures are therefore intended to simulate the hogs natural habitat, whilst also enabling minimal human contact by allowing the hogs to forage naturally. Supplementary feeding of these hogs in these enclosures is therefore carefully controlled to exclude most preferred items, but provide sufficient quantities of less-preferred items in order to both encourage natural foraging and discourage caretaker contacts, whilst also ensuring adequate nutrition. The behaviour and habitat use of hogs in these enclosures is as carefully monitored as possible, though the increasing difficulty in doing this owing to the increasing timidity of these animals was viewed as being at least as encouraging as it was frustrating to the assigned researchers.

All animals targeted for release were marked for identification using microchip transponders as well as through hair clipping. They were also subjected to regular health screening. Blood samples, rectal and nasal swabs were sent for investigation but no abnormalities were found.

Radio telemetry harness problems

A month before the scheduled release dates, six adult hogs, two from each of the 3 groups intended for release, were 'pre-fitted' with radio-harnesses to test for any technical design problems and to hopefully ensure that these did not cause any undue discomfort or hindrance to the movements of these animals through dense ground vegetation. In the event, the harnesses, which contain insulated wire transmitter antenna covered with soft rubber tubing, appeared to work well for the first few days, though a variety of serious problems became apparent within the ensuing two to three weeks. If the harnesses were fitted too loosely the animals eventually managed to wriggle out of them, but if the harnesses were tightened these soon caused irritation and skin abrasions, leading to open wounds if the harnesses were not removed. Since these animals are adapted to moving through coarse grasses and other dense ground vegetation, the harnesses also tended to snag sharp stems and other debris causing further problems. Wounds caused by these means were quickly treated and no losses occurred, though such losses seemed certain if the harnesses were not removed.

These findings constituted a serious set-back to the proposed post-release monitoring studies, especially as radio-telemetry offered the only practical means of monitoring animals of relatively small body size inhabiting dense vegetation habitats, and which were therefore unlikely to be seen except by chance. Whilst the PHCP is now investigating the possibility of utilizing implanted transmitters in future studies, the only other options, all of which are now being deployed, were: a) monitor supplementary feeding stations established within or close to the release site; b) training the hogs to come to alternative bait stations further afield (i.e. by linking the provision of delicacies to the sound of a whistle); and c) searching for field 'sign' (i.e. faeces, footprints, nests and foraging/rootling maks). Of these, the latter method is perhaps the least satisfactory since it is both labour intensive and intrusive, and is unlikely to yield any other data than evidence of one or more individuals recent presence at a given location (though it is also hoped that at least some individuals may be subsequently identified via hairs or cells recovered from faeces or nests that may be matched to DNA samples previously collected from these animals).

Figure 3: An adult sow with newly fitted radio harness; *photo: G. Narayan*

Figure 4: Last of three batches of hogs crated for transport to Sonai-Rupai; now vacant pre-release enclosure on left; *photo: W.L.R. Oliver*

Transport and reintegration of hogs in Sonai-Rupai.

In early May 2008, after 5 months tenure in the pre-release enclosures at Potasali, the first 3 groups of hogs, totalling 16 (7♂♂9♀♀) individuals, were transferred in 3 batches to temporary release enclosures in Sonai-Rupai; a journey of approximately 20 miles (36 km). The animals were relatively easily rounded up in the pre-release by first containing them in a fenced in 'safe area', previously used as a supplementary feeding station, then driving them individually through a narrow shoot into a high walled enclosure located beneath a centrally located observation platform. Once in this enclosure they were caught-up by means of a long-handled square 'hoop' to which a deep capture bag made of black denim is stretched around the edge of the hoop and fixed with 'poppers' Once the poppers are removed the animal is very easily weighed and manipulated whilst still contained in the capture bag, by which means the identity of each animal was confirmed by microchip reading, blood samples taken for possible future DNA comparisons, and each animal given a brief health check, multi-vitamin injection and mild sedative to reduce cap-

ture and transport stress. A small patch of hair was also shaved from the back, sides or rumps of each animal as an aide to later field identification. The animals were then gently 'emptied' into individual transport crates, previously furnished with bundles of dry grasses taken from their former enclosures. All of these capture and subsequent transport arrangements were made without loss or other incident.

Figure 5: Release of hogs into release enclosures at Sonai-Rupai; *photo: W. L. R. Oliver*

Figure 6: Prior to group integrations at Sonai-Rupai; *photo: W. L. R. Oliver*

On arrival at Sonai-Rupai, the animals were placed in their transport crates in the release enclosures, whereupon the slides of each crate were removed and the animals al lowed to find their own way out. This usually happened within a few minutes; indeed most animals were remarkably calm and most individuals located and readily consumed food items scattered around their enclosure as soon as they had left their crates.

The three release enclosures (each 20 m x 15 m) were fabricated from readily available local materials (i.e. wooden posts and split bamboo fences), but also rigged with two lines of electric fencing as a precaution against potential predators and to deter incursion by wild elephants. The animals were maintained under continual surveillance in these enclosures for a further one-two weeks, during which period they were also able to 're-familiarise' themselves with animals/groups in adjacent enclosures, from which they had been entirely isolated in Potasali.

On 16th May, one to two weeks after the transfer of the first and last groups to Sonai-Rupai, all three groups were allowed to mix freely together by the removing of sections of the dividing fences. It was not originally intended to integrate the animals in this way, but concerns about the security of these animals, coupled with the obvious difficulties of simultaneously monitoring 3 separate groups in 3 separate release enclosures in 3 sepa-

rate locations, had determined that all three groups were placed in adjacent enclosures in one location where they could be most easily monitored and relevant intervention measures instigated in the event of threats from predators or wild elephants. However, this circumstance also raised concerns about the possibility of any one group inhibiting any others from re-visiting the release enclosures and/or supplementary feeding stations after their release in the same location, or even the earlier than expected dispersal of these groups, and the likely added difficulty of relocating these animals in the absence of radio-telemetry. Re-mixing of these groups within the enclosures, whilst still under continual surveillance was therefore considered the likely best option in these current circumstances; but that any future releases might be better accomplished by releasing groups in separate locations consecutively.

In the event, the only serious problem recorded during the reintegration of these animals occurred the first two days when one adult boar repeatedly attacked several other males from other groups, one of which sustained head injuries from which it later died. By contrast, little aggression was observed between any other males, and no obvious agonistic behaviours were recorded between sows or between boars and sows. Conversely, few animals routinely moved around the enclosures together, except when approaching feeding or 'bait' stations.

Supplementary and bait feeding

Whilst in these enclosures, supplementary feeding of fruits and raw tubers was continued twice daily; all such feeds being offered in a single location most easily monitored from a nearby viewing platform following integration of the three groups. The aggressive boar often attempted to monopolise the food, but other indviduals easily avoided this animal by grabbing and removing food items to consume at a safer distance.

'Bait-training' also continued via the offering of such delicacies as chopped dates in small quantities and at occasional and random intervals; the latter being signalled by the sound of a whistle. Although initially frightened by this sound, the animals quickly adusted to it and soon made the association with the provision of such delicacies and moved to the source. Field trials also indicated that the whistle could be perceived by the human from a distance of up to 700m from source.

Release and post-release monitoring

The animals were finally 'released' on the morning of 22nd May by simply removing a section of outer fencing. After opening of the fence the animals quietly moved out of the enclosure together, stood by the exit gate for a few minutes, before moving into the surrounding grasslands.

One PHCP staff member and at least one armed forest guard kept the release site and surrounding areas under continual, dawn to dusk surveillance during the following weeks. Data on all individuals visiting the release site were recorded; these data including identity of individuals (mostly by distinguishing between same-sexed individuals by the shaved body patches), numbers of individuals seen together, their general condition, directions from which each arrived and departed from sight, frequency of visits, and their responses to both supplementary and bait feeding; the supplementary feeding also being gradually reduced to scattering loose corn kernels to help ensure that all individuals visiting the feeding station would find at least some kernels and that most would stay long enough to be accurately identified and inspected for any injuries and general condition.

During the first three days all hogs visited the feeding site at least once a day, though frequency of visits

quickly diminished amongst most animals, and after three weeks the feeding site was being regularly visited by one or two individuals (see below). Nonetheless, diverse other sightings were made, either during more occasional visits to the release/feeding site by other individuals, by chance, during wide-ranging screenings for field sign, or in response to bait-feedings. From these sightings and other evidence, it appears that the hogs had dispersed to four separate location: one is close (150m) to the release site, another at least 500m west of the release site, the third is approximately 700m east of the release site, and the fourth approximately 1,3 km north west of the release site close to Gelgeli forest camp.

In all such sightings the largest/oldest boars were isolated from the female/sub-adult groups. At least two adult sows believed to be in late-term pregnancy at the time of their release are suspected to have farrowed, at least one of these successfully to judge from fresh footprints of a sow and piglet found in early June. Conversely, two of the oldest (8 yrs) sows, both of which had suffered superficial injuries during the radio-harness trials and appeared unable to fully recover their health, together with a younger boar (4 yrs) remained seemingly more dependant on supplementary feeds and regained the tameness they seemed to have lost whilst in the pre-release enclosures at Potasali. Given the generally poor condition of the two sows additional feeds were offered, though one of the two sows was found dead close to the release site five days after the animals' release. The remaining pair also eventually found their way to the main forest guard post 1.3 km from the release site, though the second sow also disappeared a few days later and is presumed dead; whereas the male continued to visit both the original release site and forest camp looking for food for a few days before he stopped coming to the camp.

Figure 7: Released hogs with wild elephants in background; *photo: Parag Deka*

By early July, about six weeks after the hogs were allowed to leave the soft release enclosure, seven nests were found in different directions at distances varying from 150m to 1300m from the enclosure. Fresh pygmy hog footprints are regularly seen on soft ground in these areas. Forage marks are also evident and it appears that the released hogs have broken into a number of termite and ant nests within 1.5km of the release site. Thus, it may be concluded that most of the hogs, particularly the younger individuals, have rapidly and successfully established themselves in the wild as evident from the information, though limited, collected in the two month period after they were taken to Sonai-Rupai release site from Potasali pre-release facility.

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Footnote: updates on the progress of this project and other future releases, including diverse and requisite refinements to the release protocols and post-release monitoring methodologies, will be submitted for possible inclusion in future issues of this newsletter.

In the interim, the authors would also be extremely *grateful for any suggestions re. any other possible monitoring techniques, given that these animals are almost impossible to observe in their normal habitat and they rarely emerge from thick cover.*

Habitat selectivity of Araucaria Forest by White-lipped Peccaries (*Tayassu pecari*) in Paraná, Brasil

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This report presents some preliminary results of a research project investigating the "Spatial analysis of forest remainders with araucaria based on the landscape metric and on ecological requirements of wild ungulates, in Parana, Brazil", presented in Suiform Soundings, volume 7, No. 1 of July, 2007. In order to sample the different habitats present on *Lageado Grande* Farm (control area), parcel grids of 1 ha were applied on the maps of habitat types where the signs of white-lipped peccaries (*Tayassu pecari*) had been made through observations of tracks, scat, routes and other signs that proved the presence of these animals.

Evidence of nut consumption

Forest paths

Scat

Tracks of white-lipped peccaries

The kinds of habitats considered were: Low Land (VZA), Ciliary Vegetation (APP), Forest with Pine Tree predominance (FPP), Forest with Leafy predominance (FPF), Reforestation with *pinus* (REF) and Anthropic Area (AIA). The selectivity calculations of habitat per species were based on Ivlev Index (IS), taking into consideration the percentage of the species sign occurring in each habitat type in relation to the percentage of habitat available in the whole sample area. This index varies from -1 to +1, being 0 when there is no selection evident. Selection (values near +1) occurs when the ratio of habitat use is superior to the ratio of habitat availability.

Considering the frequency of the white-lipped peccary sign occurrence found by habitat types (given by dividing the number of signs found in the habitat by the number of parcels performed in the same habitat) it is possible to check that this peccary selects the Low Land environment (IS 0,8382) in proportion equivalent to 11 times more than its respective availability in the area. The Ciliary Vegetation (IS 0,6216) is used four times more than its availability in the area. FPF and REF are little selected or not selected habitats. AIAs and FPF are rejected habitats.

Habitat	% in the area	% use by white-lipped	IS	Ratio of use in relation to the habitat availability	Level of selection
AIA	4,9	0,0	-1,0000	0	Null
APP	7,0	30,0	0,6216	4	Average
FPF	24,7	23,5	-0,0243	1	Null
FPP	42,9	46,5	0,0401	1	Low
REF	14,5	14,8	0,0085	1	Low
VZA	4,4	50,0	0,8382	11	High

Based on these selectivity values, we can assert that the Low Lands and Ciliary Vegetation, despite being less available, are key-habitats for white-lipped peccary survival in the study area. Therefore, these environments are of high priority and must have special treatment regarding the formulation of conservation strategies and/or the handling of the local landscape.

The next step of the analysis is to obtain a predictive pattern of potential spatial distribution of the white-lipped peccary from the data resulting from the controlling study area, and in this way, we can investigate the habitat adequacy, in macro-scale, of the landscape.

Analysis of genetic variability and population genetic structure of White-lipped Peccaries (Tayassu pecari) from the Pantanal (Brazil): Preliminary results

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Introduction

Populations of many mammalian species are subdivided into social groups that constitute reproductive units, and this social structuring promotes genetic subdivision and inbreeding. White-lipped peccaries (*Tayassu pecari*) are social artiodactyls that live in groups of 50 to 300 individuals (Keuroghlian *et al*. 2004, Fragoso 2004, Reyna-Hurtado 2007) comprising both sexes and the full range of age classes. Large regional herds are often subdivided into sub-herds. Keuroghlian *et al.* 2004, observed a high frequency of switching of individuals among sub-herds and documented periodic sub-herd fusion. There is little information about the structure and genetic variability of populations of white-lipped peccaries.

White-lipped peccaries are native to the Pantanal, an area considered one of the 200 most biologically valuable ecoregions on Earth because of its extraordinary biodiversity and wildlife abundance (Olson & Dinersteirn 1998). Today it's threatened by a variety of environmentally unsound human activities that have accelerated during the last 30 years, for example, large-scale agriculture on the plateaus encircling the Pantanal, environmentally disastrous development schemes for increasing river barge traffic, and deforestation and a number of other impacts related to "modernized" cattle ranching. White-lipped peccaries are especially vulnerable to deforestation and habitat fragmentation, because they use large areas and a diversity of habitat types (Keuroghlian et al. 2004, Keuroghlian and Eaton (in press). In the Pantanal, they may also be affected by resource overlap with exotics, i.e. feral pigs ("porco monteiro", *Sus scrofa*) and cattle (Desbiez 2007). Given these threats, conservation efforts in the Pantanal targeting landscape species, such as the white-lipped peccaries (WCS Living Landscapes Bulletin, 2001), and the elaboration of appropriate conservation and management programs should not disregard the influence of factors like genetic variability and population genetic structure.

In the present study, we used microsatellites to evaluate the degree of genetic variability and population structure of white-lipped peccaries from two locations that are 80 linear kilometers apart in the Nhecolândia and Aquidauauna subregions of the southern Pantanal (MS, Brazil): Fazenda Rio Negro (FRN) and Fazenda Campo Lourdes (FCL).

Methods

As part of a long-term ecological study, peccaries were immobilized with zolazepan and tiletamine cloridrat (Zoletil® 50), sexed, weighed, and placed in a rough age class based on tooth wear (Sowls, 1984; Bodmer *et al.*, 1996).

DNA was extracted from approximately 18 blood samples from each population using standard proteinase K and phenol-chloroform protocol (Sambrook *et al.* 1989). We amplified by PCR (Polymerase Chain Reaction) four polymorphic microsatellites using primers developed for the domestic pig, *Sus scrofa* (ACTG2, IGF1, SW444, SW857 – Rohrer *et al*. 1994, Rohrer *et al*. 1996), and one that we designed for collared peccaries, *Pecari tajacu,* (PT0226, unpublished data). The forward primers were manufactured with a 5´-M13 tail (5´-CACGACGTTGTAAAACGAC, Boutin-Ganache *et al.*, 2001). The PCR was performed in 12 µl volumes containing: 1.5 ml of DNA (20-30 ng/ml), 1.2 ml of PCR buffer (10X, Pharmacia), 1 ml of dNTP mix (2mM), 0.4 ml of $MgCl_2$ (25mM), 0.3 ml of reverse primer (10 mM), 0.2 ml of fluorescent (FAM, HEX or TET, Applied Biosystems) M13 sequence primer (10 mM), 0.1 ml of forward primer (10 mM), 0.1 ml of *Taq* polymerase (5 U/ml, Pharmacia) and 7.2 ml of MilliQ water. The cycling conditions were: 5 min at 95 ^{o}C, 35 cycles of 94 ^{o}C for 30 s, AT (annealing temperature, ACTG = 62 ^{o}C, IGF1, SW857 and SW444 = 58 ^{o}C, PT0226 = 55 ^{o}C) for 30 s and 72 ^{o}C for 30 s, followed by a final step of 72 ^{o}C for 10 min. PCR products were genotyped on an ABI 377 (Applied Biosystems) or MegaBACE 1000 (GE Healthcare) automated sequencers and analyzed with Genotyper 2.1 (Applied Biosystems) or Genetic Profiler 2.2 (Amersham Biosciences).

The genetic variability was analyzed by calculating the mean number of alleles and observed and expected heterozygosities for each population. These estimates and tests for Hardy-Weinberg equilibrium and linkage disequilibrium were performed using the program Genepop 3.4 (Raymond & Rousset 1995). The fixation index F_{ST} was used to infer the degree of genetic structure and was also calculated using Genepop 3.4.

Results and Discussion

All loci were polymorphic with a similar mean number of alleles in both populations (FRN: 4.2 $\pm$ 2.2; FCL: 4.4 $\pm$ 2.5). Mean heterozygosities were $\geq$ 0.50 in FRN (H_E = 0.58 $\pm$ 0.20; H_O = 0.50 $\pm$ 0.20) and $\geq$ 0.61 in FCL (H_E = 0.61 $\pm$ 0.19; H_O = 0.68 $\pm$ 0.17). Both populations were in Hardy-Weinberg equilibrium ($p > 0.05$) and no significant linkage disequilibrium was observed between loci pairs ($p > 0.05$). The F_{ST} value observed was low (0.02) and significantly different from zero ($p < 0.05$), indicating a low level of differentiation between the two populations. It also suggests that gene flow is occurring between the populations. We are currently analyzing if gene flow is mediated by male-biased dispersal, following the general mammalian pattern.

Based on these results, we recommend that the two populations be managed as a meta-population to guarantee the continuity of gene flow between them, thus ensuring the maintenance of their genetic variability.

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Distribución, conservación y cacería del chancho de monte (*Tayassu pecari*) en Talamanca Caribe, Costa Rica

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Introducción

El chancho cariblanco o de monte (*Tayassu pecari*) se encuentra amenazado principalmente por la destrucción del hábitat y la cacería (Oliver 1993, Chiarello 1999, Cullen et al. 2000, Peres 2000, Altrichter & Almeida 2002, Altrichter & Boaglio 2004). Esta especie es una de las presas preferidas de mucha gente campesina e indígena en América Latina quienes la usan como fuente de alimento e ingreso económico a través de la venta de los cueros y la carne (Bodmer et al. 1997, Sowls 1997, Altrichter & Jiménez 1999, Altrichter & Boaglio 2004). En muchos casos el chancho de monte provee una fuente importante de proteína, ya que es un animal de gran tamaño, con un peso de 30-33 kg, y no es difícil cazar varios individuos a la vez. Esta especie es también una de las presas más importantes del jaguar (*Panthera onca*), el felino más grande de Latinoamérica.

El chancho de monte es una especie muy susceptible a los impactos humanos, lo cual probablemente se debe a que forma grandes manadas, necesita grandes áreas sin alteración, y tiene una reproducción baja (Gottdenker & Bodmer 1998). A pesar de que el chancho de monte es una de las especies del Neotrópico más amenazadas, en muy pocas áreas dentro de su distribución se cuenta con información actualizada sobre el estado de conservación y las amenazas que afectan esta especie. Sin embargo, se sabe que es una especie muy susceptible, ya que la sobre-cacería está disminuyendo poblaciones y produciendo extirpaciones locales a lo largo de su rango de distribución (Chiarello 1999, Cullen et al. 2000, Peres 2000, Altrichter & Almeida 2002, Altrichter & Boaglio 2004, Taber et al. en prep.). El chancho de monte es una de las primeras especies en desaparecer cuando hay cacería intensa, junto con los primates y los tapires o

dantas (Bodmer et al. 1997). Poblaciones de esta especie se están reduciendo a niveles que podrían ser demasiado bajos para mantener poblaciones viables. Además, las poblaciones remanentes están quedando aisladas por la deforestación, lo que puede aumentar aún más el riesgo de extinción, debido a la disminución del flujo genético y el efecto sinérgico con la cacería (Peres 2001). Esta especie se encuentra principalmente vulnerable en Centroamérica a que existen pocas áreas protegidas de tamaño suficiente como para proteger poblaciones viables (Altrichter & Almeida 2002, Taber et al. En prep.). Este es ciertamente el caso de Costa Rica, donde la mayor población de chanchos se encuentra aparentemente en Corcovado, pero el parque no es suficientemente grande como para que los chanchos no tengan que salir fuera de los límites de su protección en movimientos anuales durante los cuales recorren parte de la Península de Osa y estan expuestos a intensa cacería (Altrichter & Almeida 2002). La situación de la especie en otras áreas protegidas del sur de Costa Rica era desconocida, así como afuera de las áreas protegidas. Poblaciones de chancho de monte sobreviven solamente en la península de Osa, en Talamanca y posiblemente en Guanacaste, Caño Negro y Tortuguero (Vaughan 1983; March 1993). La Reserva de la Biosfera La Amistad, en la Cordillera de Talamanca, representa el territorio de mayor riqueza y potencial de recursos naturales y culturales de Costa Rica (Rodríguez 1990). Dentro de esta reserva se encuentra el Parque Internacional La Amistad (PILA), el cual es el área natural protegida más grande de Costa Rica, abarcando aproximadamente 200.000 ha, lo que representa un 3.7% del territorio costarricense (Borge 2004). La Reserva de la Biosfera dentro de Costa Rica incluye, además del PILA, otras 12 áreas protegidas y 11 reservas indígenas con una extensión total en bosques superior a 450.000 ha (Borge 2004). El PILA se extiende dentro de Panamá, con un área similar y también rodeado por áreas protegidas y territorios Indígenas. Dado el gran tamaño de superficie cubierta por bosque y la existencia de reservas indígenas, es importante conocer la situación del chancho de monte y sus tendencias poblacionales en el área de la Reserva de la Biosfera La Amistad.

El chancho de monte fue elegido junto con otras especies por un grupo de especialistas como una de las especies indicadoras de la situación de conservación del Parque Internacional La Amistad (Contraloría General de la República de Costa Rica y Panamá 2004). Una especie indicadora es especialmente sensible a cambios del ambiente, por lo que cambios en la población de la especie indican un problema en el ecosistema. Por otro lado, en el Análisis de Viabilidad de los Objetos de Conservación del Sitio Internacional La Amistad, Costa Rica-Panamá (TNC, INBio, SOMASPA 2005), se determinó que el jaguar es uno de los objetos de conservación y el chancho de monte, como una de sus presas más importante, es una especie indicadora. Esta especie es también un indicador indirecto del efecto de la cacería como una amenaza para la integridad ecológica del ecosistema, así como del efecto indirecto de la deforestación en el jaguar.

Por estas razones, es importante obtener información sobre la distribución, conservación y cacería de esta especie en la región. Esta información es necesaria para crear estrategias de conservación concretas. El tipo de estrategia que se puede implementar es completamente diferente si la disminución de la especie responde a la pérdida de hábitat, cacería de subsistencia o a la existencia de un mercado de su carne. Por otro lado, al estimar la situación de uso-dependencia de la vida silvestre por parte de la gente local, se pueden proponer medidas que no afecten el bienestar nutricional de la gente local. Al devolver esta información a las comunidades, se les provee con la posibilidad de tomar sus propias decisiones de manejo en base a información confiable, así como de buscar apoyo para operativizar las medidas que ellos consideren pertinentes.

El presente artículo tiene como objetivos estimar la situación de conservación, la distribución y cacería de chacnho de monte en Talamanca Caribe, asi como entender el contexto socio-económico dentro del cual se realiza la cacería. Este trabajo forma parte de las iniciativas que TNC en Costa Rica esta llevando a

cabo en el Atlántico sur de Costa Rica, con miras a generar información para el diseño de estrategias de conservación efectiva de la diversidad natural y cultural de esta región.

Métodos

Realizamos el trabajo de campo en la parte del PILA de la vertiente Caribe y en parte del territorio indígena Talamanca Cabécar y Bribri entre Junio del 2006 y Junio del 2007. La investigación se realizó en seis comunidades de Talamanca Alta (> 200 msnm): Alto Duriñók, Alto Urén, Soki, Alto Kachabri, de la Reserva Talamanca Bribri, y Gavilán Canta y Orochico de la Reserva Talamanca Cabécar. También se trabajó en varias comunidades en el Valle de Talamanca. El objetivo de la investigación fue determinar la situación de conservación y estado de las poblaciones del chancho cariblanco en el PILA y su zona de influencia, incluyendo las Reservas Talamanca Cabécar y Talamanca Bribri. Los objetivos específicos fueron: a) Determinar el contexto socio-económico dentro del cual se realiza la cacería, b) Identificar los patrones de cacería, c) Estimar la distribución y el estado de conservación de las poblaciones de chanchos de monte, y d) Analizar la eficacia de las áreas protegidas para conservar esta especie considerando la cacería, los asentamientos humanos y el estado de la población de chanchos. El trabajo consistió en entrevistas a cazadores, seguimientos semanales de familias para determinar el consumo de carne silvestre, y transectos de observación de indicios de presencia de la especie. Las entrevistas y seguimientos semanales fueron realizados pro asistentes locales en su lengua nativa. Los transectos se ubicaron dentro del territorio indígena, cerca del límite del PILA, y en un sitio cerca del pueblo Bribri llamado Buena Vista, el cual ha sido protegido de la cacería durante los últimos 5 años.

Resultados y discusión
Tendencias poblacionales

Según los resultados de las entrevistas, el chancho de monte aun existe en Talamanca Alta, pero no en la parte baja ni en el Valle (Cuadro 1). La mayoría de los entrevistados en todas las comunidades opinó que actualmente hay menos chanchos de monte que en el pasado. Éstos respondieron que la razón por la disminución es la cacería. En Gavilán Canta y Orochico también mencionaron el crecimiento de la población humana y la deforestación como causa de disminución de la especie. En contraste, en algunos pobladores mayores de Alto Urén piensan que actualmente hay más chanchos de monte que en el pasado (Cuadro 1), lo que coincide con el hecho de que esta especie se ve más frecuentemente en esta localidad que en las otras, debido a su cercanía con la gran masa boscosa de Panamá.

Cuadro 1. **Porcentaje de entrevistados que creen que actualmente hay más, menos o igual cantidad de chanchos de monte que en el pasado.**

Tendencia	Opinión de entrevistados sobre tendencias poblacionales de chancho de monte (%)					
	Alto Duriñók	Alto Urén	Soki	Alto Kachabri	Gavilán Canta	Orochico
Menos	70	57	100	100	100	100
Más	20	43	0	0	0	0
Igual	10	0	0	0	0	0
Nunca vieron	0	0	78	100	40	17

El tiempo promedio de último avistamiento de chancho de monte fue menor en Alto Duriñók y Alto Urén que en las otras comunidades. Todas las personas entrevistadas en Alto Urén mencionaron haber visto chanchos dentro de los 12 meses anteriores al estudio, y varios de ellos mencionaron haberlos visto hacía pocos días antes de nuestra visita a la comunidad. En cambio, en Gavilán Canta y Orochico, nadie los había visto desde hacía por lo menos un año (Cuadro 2). Durante nuestro estudio, la especie no fue registrada en transectos recorridos en Talamanca Alta ni con cámaras-trampa ubicadas en los transectos por ProCat. En cambio, la especie fue registrada con alta frecuencia en Buena Vista, un área sin cacería dentro del corredor biológico Talamanca Caribe. La observación de chanchos de monte en Buena Vista llama la atención, porque desde hace muchos años no se observaban en este sector. Esto puede indicar que la especie está regresando a algunos sitios donde había desaparecido, o que los animales están realizando largos movimientos de desplazamiento, como se ha observado en la Península de Osa (Altrichter & Almeida 2002). Estos movimientos pueden responder a una baja disponibilidad estacional de alimentos. Sin embargo, el hecho de que para todas las especies observadas la cantidad de rastros encontrados en Buena Vista fue entre dos y 10 veces más alto que en los otros sitios, indicaría el efecto de la cacería.

El tamaño actual promedio de grupo de chanchos de monte mencionado por los entrevistados fue de 39 animales, y varió entre 10 y 90. En cambio, el tamaño promedio de grupo mencionado para el pasado fue de 82 animales, y varió entre 10 y 200. La mayoría de la gente reportó que en el pasado los grupos eran de alrededor de 60 animales (Cuadro 2). Personas mayores en Amubri mencionaron que los chanchos antes bajaban en grupos de 100 a 150 individuos, y era común cazar varios animales a la vez. Los entrevistados de mayor edad en Shiroles también mencionaron que los chanchos de monte antes solían bajar al valle con frecuencia.

Cuadro 2. Indicadores de tendencia poblacional de chancho de monte. Percepciones de los entrevistados.

Indicadores de tendencia poblacional	Alto Duriñók	Alto Urén	Soki	Gavilán Canta	Orochico
Tiempo promedio de último avistamiento (meses)	23	3	62	81	79
Tamaño promedio de grupos actualmente	32	26		35	79
Tamaño promedio de grupos en el pasado	85	50		68	110

Según los resultados de este estudio, el chancho de monte era común en la región hace más de 20 años, pero su abundancia ha disminuido considerablemente y actualmente se encuentra en muy bajas densidades dentro de la Reserva, sólo en las partes altas. El hecho de que los tamaños de grupos observados actualmente son de casi la mitad de número de individuos con respecto al pasado también indica una reducción de la abundancia de la especie.

Borge y Castillo (1997) encontraron hace más de 10 años que el chancho de monte era cazado frecuentemente en el valle. Actualmente en cambio, esta especie no se observa ni se caza en el valle de Talamanca. Al igual que en el valle de Talamanca, el chancho de monte ha prácticamente desaparecido en las reservas Tayni y Telire, donde la gente no lo ha observado desde hace más de 10 años, y muchos

incluso no lo han visto nunca. Sin embargo, aun es desconocida la situación de la especie en el PILA del lado de Panamá. Aunque en Talamanca de Costa Rica y las reservas indígenas esta especie es escasa o ausente, las personas mencionan que la especie es abundante del lado de Panamá.

Cacería

La cacería de esta especie fue muy intensa en el pasado, según los relatos de los mismos cazadores mayores. El chancho de monte fue mencionado por un alto número de personas como carne preferida (30%) en Alto Urén y Alto Duriñók, lo que indica que esta especie es aún cazada en estas localidades. Durante el estudio se registró un evento de cacería de chanchos de monte en Alto Urén. En comparación con la frecuencia de cacería de otras especies, la cacería del chancho de monte es muy reducida actualmente. Esto no significa que hay baja presión de cacería sino que la especie ha disminuido grandemente, ya que el esfuerzo de cacería y la preferencia por cazar animales grandes no han cambiado.

Según la distancia recorrida por los cazadores para encontrar las presas mayores y los resultados de los transectos se deduce que el efecto de la cacería es mayor dentro de los 10 km alrededor de las comunidades de Altura. Cerca de las comunidades no se encuentra chancho de monte ni mono colorado, las cuales son las especies más susceptibles a la cacería (Bodmer et al. 1997). Esto coincide con los testimonios de la gente que dicen que estas especies son poco abundantes y solo se las encuentra a largas distancias. En las comunidades de mediana altura el efecto de la cacería en especies grandes se extiende más de 10 km de la comunidad. Esto puede estar relacionado con la densidad humana, ya que Soki y Alto Kachabri están cerca de Amubri y Kachabri, los cuales son poblados grandes, y Gavilán Canta y Orochico juntos tienen más de 120 familias, en comparación con 35 en las comunidades de altura estudiadas.

Efectos de la cacería

Es evidente que existe una reducción de la abundancia de chanchos de monte en esta región. Esta disminución no se puede atribuir directamente y únicamente a la cacería, sino que hay que entender todo el contexto dentro del cual se practica la cacería. Hay que considerar que estamos hablando de un área muy grande, con alta diversidad de paisajes socio-ecológicos y una multitud de factores actuando al mismo tiempo. Los efectos de la cacería dependen de muchas variables, y no actúan de manera aislada de otros factores tales como densidad humana, deforestación, tipos de hábitats, actividades agrícolas y variaciones naturales de abundancia de fauna.

La situación socio-económico de las comunidades de Talamanca Alta induce a un uso de la biodiversidad para mantener la reproducción social y cultural. La gente depende en gran medida de la cacería de ésta y otras especies para obtener alimentos. Las familias de Talamanca Alta tienen reducidas opciones productivas, y por lo tanto, de ingresos económicos, debido a la dificultad de acceso y a la baja disponibilidad de tierras para cultivos comerciales. Esto es diferente en el valle y las comunidades al pie de las montañas, done las tierras son más aptas para los cultivos de plátano y banano para comercializar, existe mejor acceso por carreteras y ríos, y están integradas en el mercado nacional e internacional.

La cacería también se debe entender dentro del contexto histórico, político y cultural. Por ejemplo, el abandono de prácticas culturales de cacería y la incorporación de armas y perros aumentan la presión sobre la especie. Por otro lado, el desplazamiento forzado de los indígenas desde el valle hacia las partes altas de Talamanca a raíz de las bananeras y de RECOPE (Villalobos & Borge 1998) también aumentó la presión sobre ésta y otras especies de fauna. Esto ocurre no sólo por el aumento de población humana

dentro del hábitat de la especie, sino también porque la gente se replegó a áreas de pendientes abruptas y altas precipitaciones, con pocas opciones productivas, aumentando su dependencia en la fauna como alimento.

También hay que considerar que en Talamanca han ocurrido grandes transformaciones del ambiente, especialmente en la zona del valle. El chancho de monte seguramente en el pasado habitaba toda la región de Talamanca, ya que los bosques de bajura serían un hábitat ideal para esta especie. La transformación del bosque de bajura en grandes plantaciones de banano, los asentamientos humanos, la aparición de pueblos, y el desarrollo de infraestructura han disminuido grandemente el hábitat disponible para la especie. Esto también interrumpe sus desplazamientos naturales, por lo tanto aumentando la presión de la cacería al reducirse las poblaciones por efectos de falta de hábitat. El impacto de la cacería puede ser insignificante ante la ausencia de otros factores antrópicos, pero este impacto puede llegar a ser muy importante si se encuentra combinado con otros factores, como por ejemplo la deforestación. Incluso, la cacería y otros factores que producen disturbios en el hábitat pueden actuar de manera sinérgica (Peres 2001).

El ecosistema de esta región no sólo sufrió la destrucción provocada por la compañía bananera y RECOPE (Villalobos & Borge 1998), sino que también está sujeta a grandes inundaciones y otros fenómenos climáticos. Algunas de las inundaciones más grandes en el pasado reciente afectaron la fauna, y es posible que este efecto aun se mantenga (Villalobos & Borge 1998). No se sabe de qué manera esas catástrofes naturales, o inducidas por usos de la tierra no apropiados, afectan a la especie.

La disminución y desaparición local del chancho de monte indica que hay alteraciones en el equilibrio ecológico general del la Reserva de la Biosfera La Amistad. Otros estudios han demostrado que la danta y el mono colorado también son especies indicadoras de la presión de cacería ya que son las primeras en desaparecer cuando hay mucha cacería (Bodmer et al. 1997). Estas especies y el chancho de monte no han sido observadas por la gente en el Valle de Talamanca por más de 15 años. Esto indicaría que el ecosistema del valle de Talamanca ha sido alterado considerablemente, y aunque por ahora las consecuencias son evidentes solo en las especies más sensibles, se puede esperar que otras especies también desaparezcan si las tendencias actuales de perturbación antrópica continúan.

Distribución actual del chancho de monte en Talamanca

Con base en los datos de entrevistas, cacería y las observaciones de transectos, se puede delinear una distribución de chancho de monte en las regiones montañosas altas, con mayores concentraciones en la zona sur, al límite con Panamá. Se considera que el límite altitudinal del chancho de monte es alrededor de los 2.000 msnm. Por lo tanto, los chanchos pueden estar habitando una franja limitada hacia arriba por su límite altitudinal natural, y hacia abajo por el área de cacería de las comunidades de Talamanca Alta y la presencia humana. Esta sería una franja entre los 1.200 y los 2.000 msnm, con ocasionales desplazamientos hacia el Este a través de las filas Carbón y Matama (Figura 1). Hay que hacer notar que esta no es una zona amplia, ya que la distancia en línea recta entre los límites de las reservas indígenas y los 2.000 msnm varían entre los 2 km (Reserva Bribri) y los 18 km (Reserva Tayni). Los chanchos observados en Buena Vista están probablemente llegando al sitio de manera temporal o durante sus desplazamientos, ya que el sitio en sí no es lo suficientemente grande (alrededor de 500 ha) como para mantener una población residente. Es posible que los chanchos estén usando la fila Carbón y el valle Las Rosas para desplazarse desde el parque y llegar a Buena Vista. Esta fila forma parte del corredor Talamanca Caribe. Por otro lado, hay indicios de presencia de chancho al norte de la Reserva Tayni, en la fila Matama. Esta fila tiene una zona de conservación de la Reserva Tayni, y si bien existe presión de

caza no indígena, no hay fragmentación del bosque y no hay gente habitando esta zona.

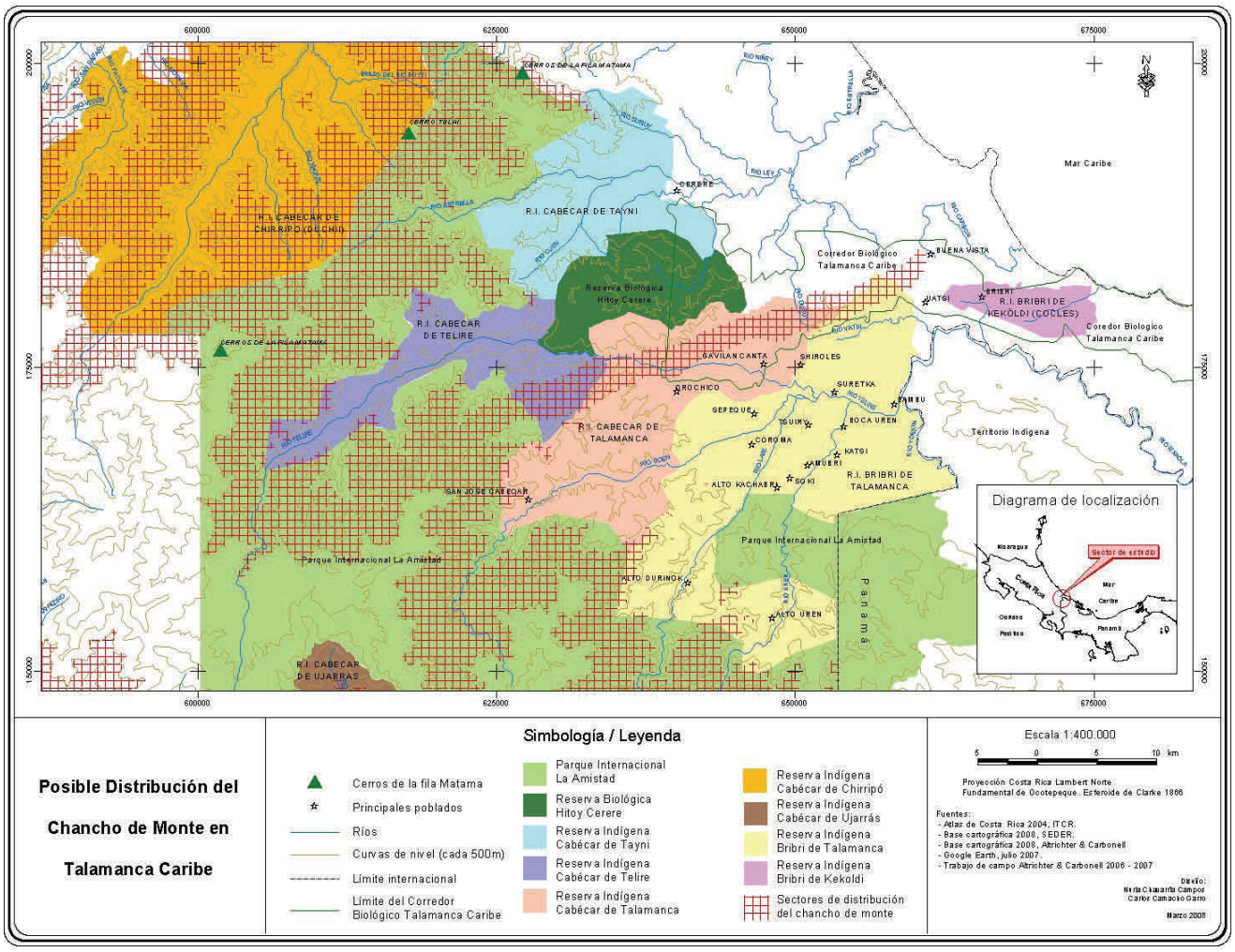

Figura 1. Posible distribución del chancho de monte en Talamanca Caribe.

El PILA y la conservación del chancho de monte

Como se mencionó anteriormente, la distribución del chancho de monte en Talamanca Caribe parece estar restringida a las áreas altas de la cordillera entre los 1.200 msnm y los 2.000 msnm, por lo tanto, aunque el PILA es un parque de gran superficie, el área efectiva de protección para esta especie con hábitat de buena calidad y poca presión de cacería es reducida. Además, el PILA protege una mayor superficie de bosques a más de 1.500 msnm, por lo que el área de distribución del chancho protegida por el PILA se reduce aun más. Peor aún, los movimientos del chancho hacia el valle, que aparentemente eran frecuentes en el pasado, han sido interrumpidos actualmente por la alta cacería y transformación del hábitat en cultivos, y sólo se mantienen en el área del corredor biológico Talamanca-Caribe. De todos modos, la existencia del PILA y su protección son fundamentales para la existencia de la especie en la zona sur de Costa Rica. Considerando que la región del PILA en Panamá es grande y que, aparentemente, tiene mayores poblaciones de chanchos, es posible que la especie no se extinga de Talamanca, si no hay un aumento importante de población cerca del parque.

Varios estudios han demostrado que la presencia de un área protegida donde no existe presión de cacería actúa como *fuente*, donde las poblaciones animales aumentan porque la natalidad es mayor que la mortalidad, y las áreas de cacería actúan como *sumideros*, donde la mortalidad por la caza es mayor que la natalidad (Novaro et al. 2000). La existencia de áreas fuente permite que la cacería cercana a esta área, aunque no sea sostenible localmente, persista a lo largo del tiempo ya que la población se mantiene gracias al influjo de individuos de la población fuente. La presencia de chancho de monte cerca de Alto Urén y Alto Duriñók probablemente indica el rol del parque La Amistad como un área fuente. Por lo tanto, la protección del parque y las rutas migratorias de estas especies son vitales para la conservación de la especie y para que las poblaciones indígenas puedan continuar usando ésta y otras especies silvestres como fuente de alimento regular.

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Status of the peccaries in the Guianas

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The Guianas region (Guyana, Suriname, French Guiana) hosts a single contiguous forest block that represents more than one third of remaining neotropical forest coverage, with expected good conservation status of several large mammals, including the Jaguar (Marieb 2006), the Giant Otter (Groenendijk 1998), the Lowland Tapir and the peccaries (Taber et al. 2006). Nevertheless, conservation policy remained unsatisfactory for a long time, with evidence of both a lack of ambition and the means to implement policy in the field. Guyana and Suriname have faced decades of political, economic and social difficulties, with biodiversity conservation featuring low on the list of priorities. In contrast, French Guiana has a stronger economy. However, due to its status as a French administrative unit, many judicial decrees relating to nature conservation remain either inappropriate for application in the territory, or legally inapplicable. In addition, divergent ambitions between local authorities and national government agencies complicate the political implementation of a conservation vision for the region.

Status of the peccaries

Habitat loss is limited in Suriname, Guyana, and French Guiana (FAO 2005). The two peccary species, *Tayasssu pecari* and *T. tajacu*, are still distributed widely within the three countries, with hunting being the main threat to these populations.

In French Guiana, only 3% of the territory is under strong protection, where hunting is totally prohibited. Outside nature reserves, there is no hunting regulation. As with other species (de Thoisy & Renoux 2004, de Thoisy et al. 2005), harvests beyond the recommended thresholds occur in the North of the country, where most of the human population is concentrated. Currently there is no regulation on peccary hunting,

however discussions with hunters are underway regarding a quota system. Although there is no specific study currently being conducted on these two species, data from multi-species surveys provides basic information on the species status. Line transects were conducted in ca. 40 different hunted and non-hunted sites, while hunting monitoring in several localities allowed for the assessment of harvest rates, associated threat levels, and basic population data such as sex and age ratios.

In Suriname, hunting regulation is restricted to the northern third of the country, with an open harvest season running from August to March for the two species. In the southern parts of the country, no regulations are in place, in order to respect the Amerindian way of life and natural resource use. This policy is now obsolete and should be urgently revised, as numbers of settlements of non-Amerindian peoples are increasing in the south, resulting in unregulated pressure.

In Guyana, protection and management are restricted to the few protected areas, covering less than 1% of the territory.

The Amazonian National Park in French Guiana, a process initiated 15 years ago

At the Rio conference in 1992, the French president stated his intention to create the "Amazonian National Park" in French Guiana. Fifteen years later, in February 2007, the decree was signed. Conflicting interests between national (i.e., from France) and local authorities, between biodiversity spots and gold mining lobbies (Hammond et al. 2007), and a lack of traditional community rights in the French laws, resulted in two aborted pre-projects, before the final signing in 2007. With this new protected area of 20,000 sq km, the country presently contains a comprehensive and well-configured network of protected areas. Together with the Tumucumaque National Park (3,8 millions ha), the ecological station of Grão-Pará (4,3 millions ha) and the Maicuru Reserve (1,2 millions ha), the largest tropical forest area in the world of more than 12 million hectares is now under the legal protection of both France and Brazil.

However, the Guianan National Park is still waiting for IUCN consideration, since I-IV IUCN protected areas status is not reached with the current park regulations. The area remains legally open to hunting practices by tribal communities for subsistence purposes only. Extractive activities are controlled by the same French decrees as outside the park, but are restricted to local communities, respecting their traditional way of life. This decision was controversial, but the Park argues that the rationale behind the decision was based on both scientific monitoring and respect for indigenous livelihoods, which is the solution when it comes to natural resource conservation in inhabited Amazonian forests. An innovative concept of National Parks may thus have been implemented, although difficulties do still remain: intense illegal gold mining pressure within the Park territory, tensions between different indigenous communities inhabiting the Park, continued denial of the project by several locally elected politicians, the implementation of a framework for the daily functioning of the park, …

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Restoration of the genus *Porcula*

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The pygmy hog *Porcula salvania* synonym *Sus salvanius* (Hodgson 1847) is one of the world's most endangered mammals (Anon., 1985; Oliver & Deb Roy, 1993). Pygmy hogs differ from members of the genus *Sus* in the extreme reduction in body, ears and tail size, the presence of only three pairs of mammae, relatively short medial false hooves, and snout disc perpendicular to axis of head. There is an absence or warts or gonial whorls. Body shape is more 'streamlined' than in other pigs; in adults tapering from relatively longer hind quarters to smaller forequarters.
Adult dentition in pygmy hog is similar to *Sus* spp.

Hodgson (1847) first described the species as *Porcula salvania* and the sole member of the genus. He argued that the pygmy hog was a genus separate from *Sus* and other Suid genera based on external character differences, especially skull and dental features. This classification was adopted by Pilgrim (1926) and later by Ghosh (1988). However, morphological disparities were subsequently interpreted as 'superficial' and a consequence of body size miniaturization, leading to the widespread acceptance of the pygmy hog as a *Sus* (Corbett and Hill, 1980; Groves and Grubb, 1993; Nowak, 1999). More specifically, Garson (1883), Corbet and Hill (1980), Oliver (1980) and Groves (1981) concluded that the various dental and other features described by Hodgson were based on the immaturity of the holotype, or were insufficient to merit generic distinction from other members of the Genus *Sus*. Following Groves and Grubb (1993), the pygmy hog was included among the non-warty pigs in the *Sus,* and later by Groves (2001) in one of three distinct clusters defined by the ratio between the width of the inferior surface and the posterior surface of the lower canine or "canine index" (Groves, 2001). In both classifications, the pygmy hog was included as a sister species of *Sus scrofa*.

Recent genetic analyses by Funk *et al*. (2007) confirm the original classification of the pygmy hog as a monotypic genus. Using three mitochondrial DNA loci (2316 base pairs of control-region, cytochrome b, 16S), combined with rigorous statistical testing of alternative phylogenetic hypotheses, Funk *et al.* (2007) distinguish the pygmy hog from all other pigs. In particular, the analyses showed that the pygmy hog

never clustered together with *Sus scrofa*, nor with any other *Sus* species (Fig. 1). The strong evidence for the phylogenetic exclusion of the pygmy hog from the *Sus* clade supports that this taxon, like the babirusa and warthogs, deserves separate recognition and, thus, that Hodgson (1847) was correct. Funk *et al.* (2007) proposed the resurrection of the original species name *Porcula salvania*, already been implemented by GenBank, a universal repository for nucleotide sequences at the National Center for Biotechnology Information (NCBI, 2007), and accepted for inclusion as an update in the 3rd edition of the Wilson and Reeder's Mammal Species of the World (Colin Groves, in litt.).

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Original paper:

Funk SM, Verma SK, Larson G, Prasad K, Singh L, Narayan G and Fa JE. 2007. The pygmy hog is a unique genus: 19th century taxonomists got it right first time round. *Molecular Phylogenetics and Evolution* 45: 427-436.http://dx.doi.org/10.1016/j.ympev.2007.08.007

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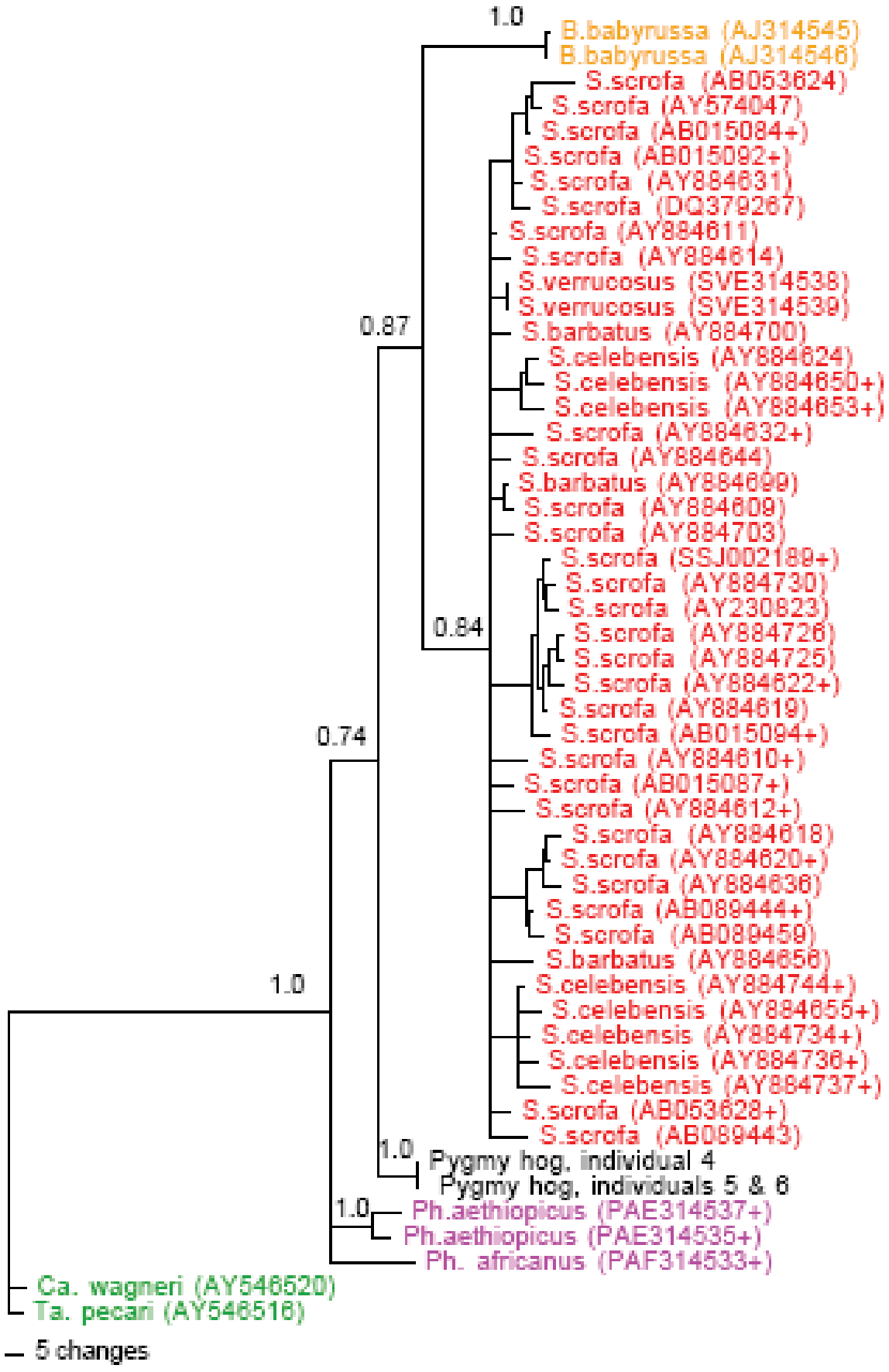
1.0
B.babyrussa (AJ314545)
B.babyrussa (AJ314546)
S.scrofa (AB053624)
S.scrofa (AY574047)
S.scrofa (AB015084+)
S.scrofa (AB015092+)
S.scrofa (AY884631)
S.scrofa (DQ379267)
S.scrofa (AY884611)
S.scrofa (AY884614)
S.verrucosus (SVE314538)
S.verrucosus (SVE314539)
0.87
S.barbatus (AY884700)
S.celebensis (AY884624)
S.celebensis (AY884650+)
S.celebensis (AY884653+)
S.scrofa (AY884632+)
S.scrofa (AY884644)
S.barbatus (AY884699)
S.scrofa (AY884609)
S.scrofa (AY884703)
S.scrofa (SSJ002189+)
S.scrofa (AY884730)
S.scrofa (AY230823)
0.84
S.scrofa (AY884726)
S.scrofa (AY884725)
S.scrofa (AY884622+)
S.scrofa (AY884619)
0.74
S.scrofa (AB015094+)
S.scrofa (AY884610+)
S.scrofa (AB015087+)
S.scrofa (AY884612+)
S.scrofa (AY884618)
S.scrofa (AY884620+)
S.scrofa (AY884636)
S.scrofa (AB089444+)
S.scrofa (AB089459)
1.0
S.barbatus (AY884656)
S.celebensis (AY884744+)
S.celebensis (AY884655+)
S.celebensis (AY884734+)
S.celebensis (AY884736+)
S.celebensis (AY884737+)
S.scrofa (AB053628+)
S.scrofa (AB089443)
1.0
Pygmy hog, individual 4
Pygmy hog, individuals 5 & 6
1.0
Ph.aethiopicus (PAE314537+)
Ph.aethiopicus (PAE314535+)
Ph. africanus (PAF314533+)
Ca. wagneri (AY546520)
Ta. pecari (AY546516)
5 changes

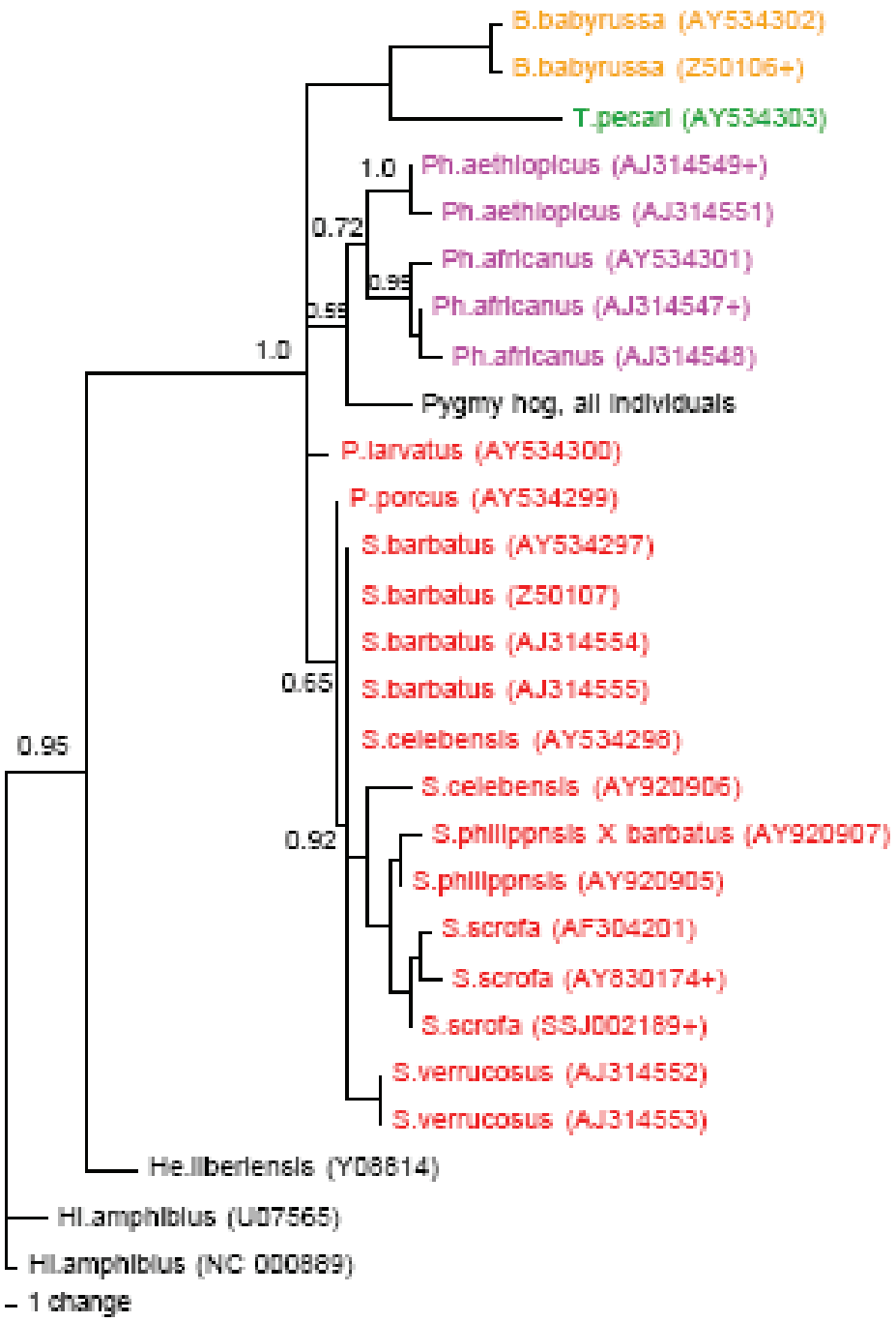

Figure 1: Phylogenetic relationship between pygmy hog and other Suidae. The tree was constructed using latest and generally most powerful approach, Bayesian inference, of concatenated mitochondrial control region (584 base pairs) and cytochrome b (180 base pairs) sequences. Probability for each cluster is indicated next to nodes (**: Bayesian posterior probabilities = 1.0; *: between 0.96 and 0.99; probabilities of 0.95 or less are not shown). Trees were rooted using peccary (Pecari tajacu) as outgroup. Included sequences for wild boar Sus scrofa, the bearded pig S. barbatus, Javan warty pig S. verrucosus, babirusa Babyrousa babyrussa, Desert Warthog Phacochoerus aethiopicus and Common Warthog P. africanus stem from genbank and represent known genetic variability within these taxa. Three pygmy hog samples from the captive population in Assam, revealing the haplotypes, were used for the analysis.

Digestive seed dispersion and predation by collared peccaries in the southern Bahian Atlantic forest, Brazil

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Abstract

We studied the role of collared peccaries (*Pecari tajacu*) as seed dispersers and predators of ten fleshy-fruited species, including both native and naturalized exotic plants to the Atlantic rainforest remnants of Southern Bahia, Brazil. We quantified the total number of seeds consumed and excreted by captive animals and performed germination trials on recovered seeds, and compared the viability of digested seeds with control seeds from fresh uneaten fruits. Most seeds were killed and only guava seeds had improved germination after passage through peccary guts when compared to the control (P=0.003). The implications of peccary seed dispersal and predation are discussed with respect to the remnant rainforests in the Bahian Atlantic region of Brazil.
Key words: animal plant interaction; Atlantic forest; *Pecari tajacu*; seed predation.

Introduction

The collared peccary (*Pecari tajacu*) ranges throughout the American continent from New Mexico in the USA to northern Argentina, in habitats as diverse as semi-arid deserts to tropical rainforests (Sowls 1997). This species is mainly frugivorous in tropical forests, feeding mostly on the fruits of palms (Kiltie 1981, Bodmer 1989, McCoy *et al.* 1990 Barreto *et al.* 1997, Fragoso 1999), and can survive in diverse habitats because it is opportunistic and able to utilize fruits and seeds from many plant species (Sowls 1997).

Peccaries can crush hard seeds due to their interlocking teeth, specialized muscles, and jaw morphology (Kiltie 1982). Bodmer (1991) found that only small seeds of less than 1.0 cm x 1.0 cm escape mastication by collared peccaries. Additionally, collared peccaries have pre-gastric fermentation similar to ruminants (Carl & Brown 1985, Langer 1979) and are capable of digesting fiber compounds of plant cell walls (Comizzoli *et al.* 1997, Nogueira-Filho 2005). These characteristics enable this species to destroy seeds from over 73 percent of all consumed plant species and therefore act mainly as a seed predator (Beck 2005).

On the other hand, Beck (2005) argues that seeds ingested by peccaries could be dispersed farther away from their parent trees compared to the action of most other dispersal vectors, as collared peccaries have a food retention time of up to three days (Comizzoli *et al.* 1997) and move great distances per day (Castellanos *et al.* 1983, Fragoso 1999, Keuroghlian *et al.* 2004). Because of this, Beck (2006) suggested that this species could be a crucial force for the Janzen–Connell effects thereby affecting seed survival, seedling recruitment, and distribution underneath and in close proximity to parent trees. Collared peccaries could influence recruitment, distribution, and species richness of plants thus affecting both the com-

munity composition and diversity of tropical ecosystems.

Additionally, peccaries form herds of up to 50 individuals in rainforest (Fragoso 1999), have a density from 2.8 to 8.9 individuals per km^2 and also have high site fidelity, with home ranges from 123 to 305 ha in Atlantic rainforest fragments (Keuroglian *et al.* 2004). This suite of characteristics indicates that collared peccaries play a key role in tropical forests, especially in fragments of undisturbed forests where their populations persist in spite of human impacts (Sowls 1997).

Collared peccaries are common throughout the Atlantic rainforest remnants of Southern Bahia, Brazil, where they are recognized as the primary cause of damage to cassava crops (Lobão 2006). The Bahian Atlantic rainforest is one of the last remnants of the lowland forest of eastern Brazil that once covered the entire coastal area from Rio Grande do Norte to Rio Grande do Sul and has since been deforested to a small fraction of its original cover (1-12%; Saatchi *et al.* 2001). Nonetheless, high levels of species richness and endemism persist in the remaining forest patches of Bahia (Aguiar *et al*. 2003, Thomas *et al*. 1998).

Southern Bahia is also considered Brazil's main cocoa (*Theobroma cacao*) production area (Faria *et al.* 2006). The forest-like structure of cocoa plantations simulates, to varying degrees, the native Atlantic rainforest ecosystem, because the cocoa trees were planted under native tree species, a system locally known as cacao-cabruca (cabrucas; Saatchi *et al.* 2001). These tree-crop plantations are adjacent to fragments of natural forest and they serve as a medium through which forest-dwelling species can move among forest fragments (Alves 1990, Faria *et al.* 2006). Additionally, cabrucas are highly disturbed and represent more simplified habitats compared to native rainforest (Faria *et al.* 2006). Several exotic plants were introduced in this agroforestry system to provide shade to cocoa trees and produce fruits, such as jack-fruit (*Artocarpus integrifolia*) and buri (*Polyandrococus caudensis*). After nearly one century since their introduction, these species have become naturalized in the region and can be found in secondary growth forest (Sambuichi 2002). Moreover, Santos (2006) has suggested that the jack-fruit has become the key fruit species consumed by collared peccaries in this region.

The objective of this study was to evaluate if the role of collared peccaries in the Bahian Atlantic rainforest is that of predator or disperser for native and non-native tropical fruit seeds using a similar approach to Janzen (1981). Firstly, we compiled a list of deciduous, fleshy fruited species eaten by collared peccaries from field observations in the Bahian Atlantic rainforest, of northeastern Brazil (Santos 2006) and selected 10 species that occur naturally or sub-naturally (naturalized exotic plants) in this region: araçá (*Pisidium araca*), passion fruit (*Passiflora edulis f. flavicarpa*), jack-fruit (*Artocarpus integrifolia*), guava (*Psidium guajava*), abiu (*Pouteria caimito*), papaya (*Carica papaya*), star-fruit (*Averrhoa carambola*), umbu (*Spondias tuberosas*), oil-palm (*Elaeis guineensis*), and jenipapo (*Genipa americana*). After that, we quantified the total number of seeds consumed and excreted by captive animals, performed germination trials and compared the viability of digested seeds with control seeds from fresh uneaten fruits.

Materials and Methods

Animals

We used six adult female collared peccaries in the field trials, who were born and reared at the scientific experimental farm of the Universidade Estadual de Santa Cruz-UESC. We individually placed the animals in 2 m x 2 m enclosures and gave them a pair of fruit species with different seed sizes for each of a total of five assays. There was a twenty-day interval between each assay (pair of fruits). In each assay we provided 150 g of each fruit once a day (300 g of fruit/day) during three successive days. Besides the

fruit, in the afternoon we also fed peccaries 450g of commercial pig diet (14% crude protein). Water was available *ad libitum*, and the same person fed the animals with fresh food and collected all the faeces twice a day at 0800 and 1800 h. After one hour of feeding we collected the remaining fruits and determined the total seeds present in the sample. We combined these data with the number of seeds per 100 g fruit samples to determine the total number of seeds actually ingested by the peccaries. We measured thirty seeds found in these samples and calculated the average diameter.

We collected faeces up to three days after we finished supplying fruits. We washed freshly collected faeces over a 0.01 cm sieve and counted the total number of intact seeds. Finally, we placed the seeds in germination plates (plastic containers with two layers of wet cotton) during 30 days to test viability. This research followed ASM guidelines (*Journal of Mammalogy* 88:809–823, 2007) and was approved by the UESC institutional animal care and use committee.

We determined the acid detergent fibre (ADF) of the fruits' seeds according to van Soest *et al.* (1991). The ADF is a fiber compound of the plant cell wall related to the lignified fibers that surround the hard seed coats of some seeds, a plant strategy used to minimize seed predation (Bodmer 1991; Henderson 2002). We considered the seed's ADF as an indicator of potential resistance while passing through the animal gut and we correlated ADF and seed width against the percentage of intact seeds defaecated to determine any effect on gut passage.

Additionally, we performed a control test that consisted of 50 seeds extracted directly from fresh fruits, which were also placed in germination plates. We placed the germination plates of both control and gut-passed seeds in a greenhouse with polycarbonate walls under a natural light regime. We watered them once a day to maintain moisture in the cotton. Inside the greenhouse the average daily temperature and air humidity were 33^{o}C and 60%, respectively.

We used chi-square goodness-of-fit tests to determine if there were differences in the frequency of germinated versus non-germinated seeds between control and gut-passed seeds using Minitab 14.2 (Minitab Corp. 2002).

Results

Collared peccaries chewed off the pulp from the seeds of umbu and oil-palm fruits that were too large or hard to be masticated or swallowed and spat them out while totally or partially ingesting seeds of other fruits. After the three elapsed days we collected the following percentage of intact seeds in peccary faeces: 80% of star-fruit; 42% of guava; 35% of araçá; 10% of jenipapo and papaya; and 6% of passion fruit. We did not find intact seeds of abiu and jackfruit in the peccaries' faeces (Table 1 and Figure 1).

There was a moderate negative correlation between seed diameter and percent of intact seeds collected in peccary feces ($r_P = -0.3501$, $P = 0.01$). For this analysis we did not take into account the umbu and oil palm seeds since they were not consumed. Additionally, we also observed a moderate positive correlation of seed's ADF contents and percent of intact seeds collected in peccary faeces ($r_P = 0.4727$, $P = 0.0007$).

The germination trials showed that for gut-passed seeds, only the guava had higher germination success when compared to the control ($c^2 = 13.1$, $P = 0.0003$). On the other hand, the passion fruit ($c^2 = 14.0$, $P = 0.0002$) and araçá ($c^2 = 5.4$, $P = 0.02$) seeds showed lower germination after passing through the peccary gut. The jenipapo and star-fruit seeds did not germinate either in control or in gut-passed germination tests.

Fruit	Average seed diameter in cm (SD)	Number of seeds fed per day per individual (SD)	Total number of intact seeds collected in faeces	Number of germinated seeds after gut passage	Number of germinated seeds in control plates
Araçá	0.2 (0.0)	609.5 (252.6)	4617 (42.0%)	2131 (47.2%)	38 (76.0%)
Guava	0.3 (0.0)	483.3 (38.1)	3634 (35.0%)	2383 (65.6%)	10 (20.0%)
Passion-fruit	0.6 (0.1)	271.0 (114.5)	276 (6.0%)	84 (30.4%)	38 (76.0%))
Jenipapo	0.8 (0.1)	105.0 (47.1)	210 (10.0%)	0 (0.0%)	0 (0.0%)
Papaya	0.5 (0.0)	37.1 (0.4)	68 (10.0%)	0 (0.0%)	3 (6.0%)
Star-fruit	1.0 (0.0)	7.0 (0.0)	123 (80.0%)	0 (0.0%)	0 (0.0%)
Abiu	2.5 (0.0)	1.7 (0.0)	0 (0.0%)	-	-
Jackfruit	1.9 (0.2)	4.0 (0.0)	0 (0.0%)	-	-
Oil-palm	1.9 (0.1)	0	0 (0.0%)	-	-
Umbu	2.0 (0.0)	0	0 (0.0%)	-	-

Table 1: Average diameter and number of seeds fed, number of seeds collected intact in the faeces, and number of germinated seeds after gut passage and control (%).

Discussion

The peccary's behaviour of spitting out large/hard seeds, such as umbu and oil-palm, could result in short-distance dispersal since foraging peccaries can bury some of these spat-out seeds by accidentally trampling them into the ground (Beck 2005). Near the parent trees, however, seedling mortality is high due to predators (*e.g.* Janzen 1970) and the peccary's actions could result in a real decrease of seedling success of these spat out seeds, as observed by Fragoso (1997) with *Attalea maripa* seeds. However, the peccaries could return and ingest those spat out seeds, in the same way as they do with the cutiribá (Sapotaceae, *Pouteria surumuensis*) seeds in Maracá, Brazil (K. Silvius pers. comm.). Since we recovered all non-eaten fruits after one hour in order to determine the total amount of seeds consumed, we could not verify the assertion that peccaries return to feed spat seeds.

The seeds of other fruits were almost totally ingested. This endozoochory could lead to long-distance dispersal. Whether a seedeater is a predator or a dispersal agent depends in great part on its seed processing (Janzen 1971). Seed mortality rates observed in this study ranged from 20% for star-fruit to 94% for pas-

sion fruit. According to Janzen (1984), seed mortality of 50-90% is commonplace in dispersal and can be considered the cost of reliable dispersal. However, to adequately evaluate a species' role as a seed disperser or predator we need to consider where seeds are deposited and their germination success. When seed rain is highly clumped, *e.g.* by the use of latrines as observed among collared peccaries (S.L G. Nogueira-Filho, unpublished data), seeds could experience higher density-dependent mortality, reducing germination success (Muller-Landau & Hardesty 2005; but see Fragoso 1997). On the other hand, according to Beck (2005), peccaries can be considered ecosystem engineers (*sensu* Jones et al. 1994, 1997), because their rooting and wallowing behaviours lead to removal of soil and leaf-litter, and create new habitats that may permit the establishment of many small-seeded and litter-gap-dependent species. Thus, peccaries can disperse seeds of numerous plant species and generate seed shadows, especially seeds with small width and high cell-wall contents like guava seeds, as shown in the present study. Such characteristics may influence the spatial distribution of both native and naturalized exotic plants in the Bahian Atlantic rainforest.

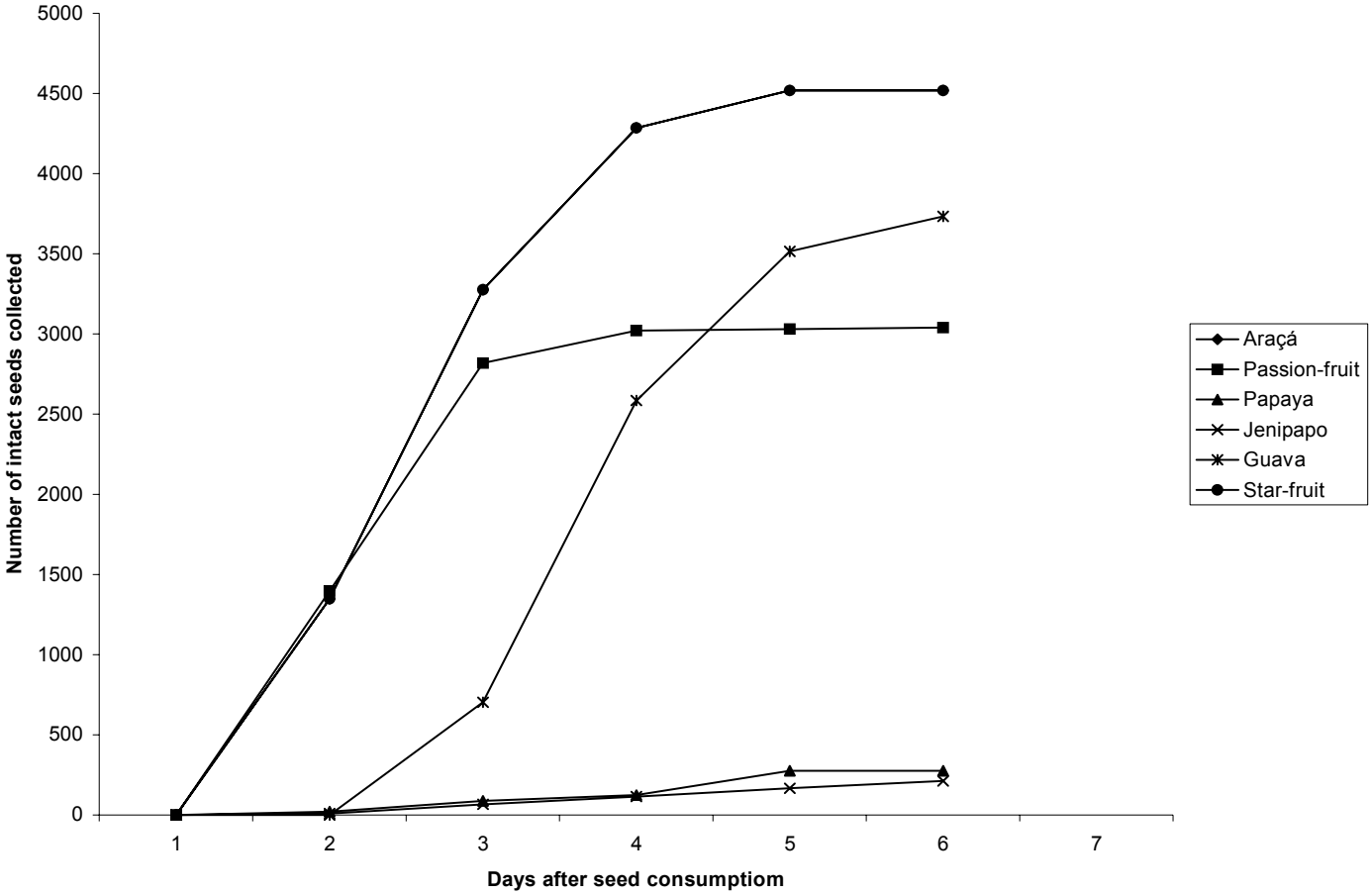

Figure 1: Number of seeds collected intact in the feces of collared peccaries according the days of consumption.

Hunting within Neotropical forests has severely decreased the populations of *P. tajacu* (Sowls 1997). In contrast to other regions, however, collared peccary were able to persist within the mosaic of primary forest, secondary forest, and cocoa cabruca agro-forest systems of Southern Bahia (Lobão 2006). Moreover, their populations thrived after the cocoa crisis, due to a low international price of cocoa and the witches' broom disease that led to a rural population exodus of more than 200,000 people from these rural areas

and a resultant decrease in hunting pressure (Saachi *et al.* 2001, Chomitz *et al*. 2005, Faria et al. 2006).

With the decrease in the hunting pressure and availability of introduced food resources such as jackfruit (Santos 2006), the populations of collared peccaries are increasing, making them a nuisance to the rural producers when they forage in cassava crops (Lobão 2006). Additionally, the peccary's action as seed disperser and predator could affect plant recruitment, spatial distribution, and population dynamics of Bahian Atlantic rainforest patches where this species thrives. In this region, they may have a positive role in promoting plant diversity by preventing the dominance of superior competitor plant species (see Dirzo & Miranda, 1991). However, since only one study of the effects of peccaries on the population dynamics of a tropical plant species was made (Ticktin 2003), clearly long-term monitoring will be necessary to better assess the implications of the peccary's impact on spatial structure of the threatened remnants of the Bahian Atlantic rainforest.

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La dieta de los pecaríes (*Pecari tajacu* y *Tayassu pecari*) en la región de Calakmul, Campeche, Mexico

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Abstract

From May 2005 to July 2006 we determined the main components as well as any seasonal differences in the diet of *Tayassu pecari* and *Pecari tajacu* in the Calakmul Region in Southern Mexico. Analyses of 22 stomach contents of *P. tajacu* revealed that this species consumes more fruits (57.9 %) than leaves (30.1) during the whole year. Of 37 species consumed by *P. tajacu*, the main ones were: *Brosimum alicastrum*, *Manilkara zapota*, *Pipper amalago*, *Zea maiz* and one unidentified species. We analyzed the contents of nine stomachs and 10 faeces samples of *T. pecari* and found that the main components were fruits (81.2 % in the stomach and 66.8 % in faeces). The main species consumed by *T. pecari* were *B. alicastrum, Chamaedorea sp, M. zapota, Mimosa sp, P. amalago* and one unidentified species. Despite the fact that both peccary species shared 32 species in their diet, their feeding niche showed no significant overlap (Qjk= 0.58, Schoener 1968). Collared peccary and white-lipped peccary could be playing a dispersal role for some of the seeds of the species on which they feed.

Resumen

Se determinaron los componentes principales y su variación estacional de la dieta del *Tayassu pecari* y *Pecari tajacu* en la región de Calakmul, Campeche, durante el período de mayo de 2005 a julio de 2006. Del análisis de 22 estómagos de *P. tajacu*, se encontró que los componentes más abundantes durante el año fueron los frutos (57.9%) y las hojas (30.1). De las 37 especies vegetales consumidas por *P. tajacu* las principales fueron: *Brosimum alicastrum*, *Manilkara zapota*, *Pipper amalago*, *Zea maiz* y una más no identificada. Se analizaron 9 estómagos y 10 excretas de *T. pecari*, encontrando que el componente más abundante en contenidos estomacales fueron los frutos (81.2%) y (66.8%) en excretas. Las principales especies consumidas por *T. pecari* fueron *B. alicastrum, Chamaedorea sp, M. zapota, Mimosa sp, P. amalago* y una más no identificada. Ambos pecaríes compartieron 32 especies y sus nichos alimenticios no se sobrepusieron significativamente (Qjk= 0.58). El PC y PLB podrían estar influyendo de manera importante en la distribución y dispersión de algunas de las especies de las que se alimentan.

Palabras clave: Dieta, Coexistencia, Calakmul, Tayassuidae, *T. pecari* y *P. tajacu*

Introducción

En México habitan dos de las tres especies de pecaríes existentes, el pecarí de collar (PC, *Pecari tajacu*) y el pecarí de labios blancos (PLB, *Tayassu pecari*). El pecarí de labios blancos puede ser considerado como indicador del estado del hábitat, ya que desparece de áreas perturbadas a diferencia del pecarí de collar el cual es relativamente común en bosques talados o vegetación secundaria (Leopold, 1965; March, 1990). Ambas especies actúan como reguladoras de poblaciones de plantas de las que se alimentan al depredar sus frutos y semillas; también modifican los suelos en gran medida al hozar en busca de raíces e invertebrados (Beck, 2004). Actualmente el PC y el PLB están considerados dentro del Apéndice II de la Convención sobre el Comercio Internacional de Especies Amenazadas de Flora y Fauna Silvestre (CITES) 1971. Las principales amenazas a las que se enfrentan son la pérdida de hábitat, la cacería y la introducción de especies exóticas (Robinson y Redford, 1994; Naranjo, 2002). La presión humana se ha manifestado en mayor medida en el PLB que ha desparecido de su rango histórico en México en un 84 % (Taber *et al* in prep.). Ambas especies de pecaríes comparten gran parte de su territorio en los bosques Neotropicales , haciendo uso de recursos similares; esto las ha llevado a crear estrategias de exclusión competitiva por el alimento y a pesar de que la dieta de ambas esta basada en el consumo de frutos, se ha comprobado que la composición de sus dietas varía de acuerdo a la disponibilidad alimenticia, la cual es distinta en temporada de lluvias y secas. (Fragoso, 1999; Altrichter et al., 2000).

Este estudio presenta por primera vez para México, la descripción y el análisis de las hábitos alimentarios de ambas especies en una zona donde coexisten en simpatría lo cual nos ha permitido comparar sus nichos ecológicos de una manera mas precisa. Esta información es primordial para conocer el impacto ecológico y para elaborar planes para la conservación de ambas especies de ungulados tropicales que actualmente han visto reducidos sus rangos de distribución en México.

Área de Estudio y Metodos

La Región de Calakmul se encuentra ubicada en el sureste del Estado de Campeche, México, aproximadamente a los 19°15´17°45´ de latitud N y 90°10´ 89°15´ de longitud W. Su extensión territorial cuenta con una superficie de 14,681.05 km^2 (Gobierno del estado de Campeche, 2004) de los cuales 7,231.85 km^2 le corresponden a la Reserva de la Biósfera Calakmul (RBC) (Morales-Rosas y Magaña-Rueda, 2001) (Fig. 1). El clima predominante es cálido subhúmedo con lluvias en verano y con menos de 60 mm de precipitación en el mes más seco (Aw1). La temperatura media anual es de 24.6° C con una máxima de 35° C y una minina de 12° C. La región esta caracterizada por la escasez de escurrimientos y cuerpos superficiales de agua debido a la alta permeabilidad de los suelos, y donde la única fuentes de agua para la fauna silvestre durante la época de secas son los áreas donde el suelo permite el almacenamiento temporal del agua, áreas conocidas localmente como “Aguadas”. Los tipos de vegetación predominantes son la selva mediana subperennifolia, selva mediana caducifolia y selva baja subperennifolia respectivamente, también se encuentra representada la selva alta perennifolia, selva baja inundable y selva baja caducifolia. El buen estado de conservación y la variedad de hábitats en la región permiten que en Calakmul, muchas especies de animales sobrevivan en poblaciones más grandes en comparación con otras regiones del país.

Para conocer la dieta de los pecaríes en el área de estudio aplicamos diversos métodos, el primero consistió en la colecta de estómagos de pecaríes abatidos por cazadores de subsistencia. También colectamos excretas de PLB y llevamos a cabo observaciones directas de esta última especie. A continuación detallamos estos métodos.

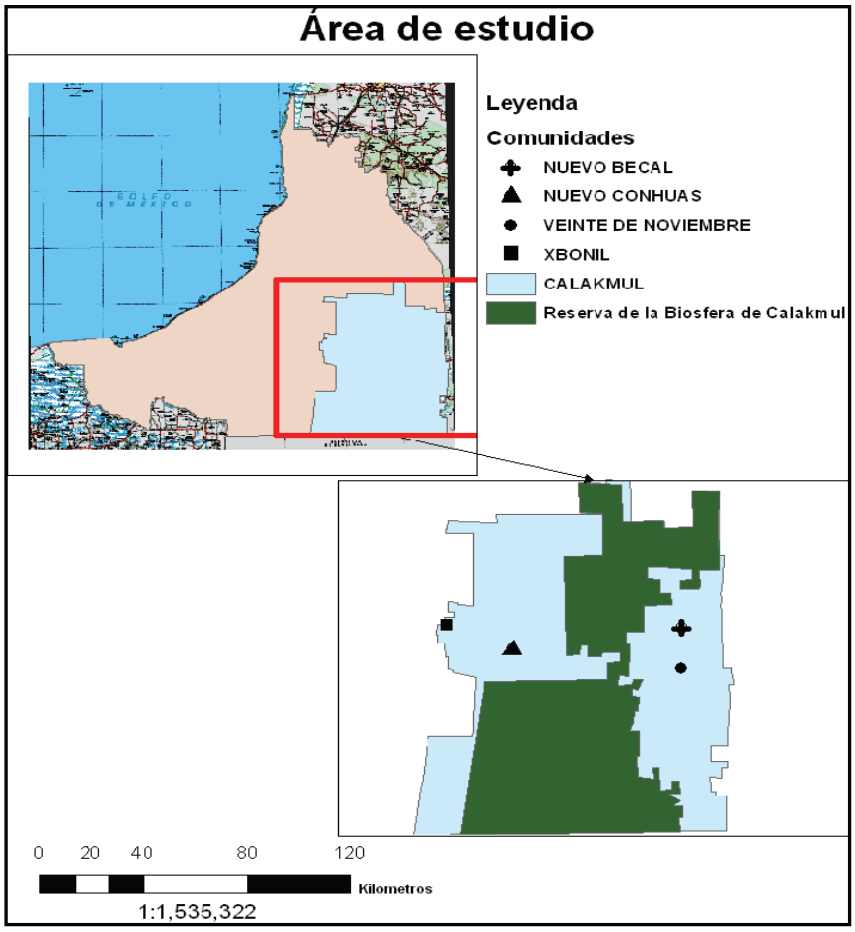

Figura 1: Imagen del Estado de Campeche, el municipio de Calakmul y las comunidades participantes, Calakmul Campeche, México.

Previo a la colecta de estómagos se llevó acabo un análisis bibliográfico y se aplicó una entrevista no estructurada a cazadores de la región, en la cual se les preguntó sobre las plantas consumidas por los pecaríes para formar un listado de referencia de especies potencialmente consumibles disponibles en la región de Calakmul.

A través de la participación voluntaria de cazadores, de mayo de 2005 a mayo de 2006 se obtuvieron muestras de contenidos estomacales de ambas especies de pecaríes en cuatro comunidades del municipio de Calakmul: Veinte de noviembre, Nuevo Becal, Xbónil y Conhuas. Los contenidos estomacales se conservaron y analizaron en base al método propuesto por Bodmer (1989). Se lavaron con agua, se almacenaron y etiquetaron dentro de frascos de plástico de 3 litros de capacidad con formol al 5%, posteriormente fueron colados utilizando una malla colador con un haz de luz de 5 mm^2, las partículas fueron separadas en dos grupos (menores y mayores de 5 mm^2) y se colocaron bajo exposición al sol para su secado, una vez secas, se colocaron en bolsas de sellado hermético y se almacenaron hasta ser analizadas. Las excretas se rotularon y conservaron en recipientes con alcohol, posteriormente se lavaron con agua y detergente para eliminar las grasas y otros materiales adheridos, después se secaron exponiéndolas al sol; une vez secas se analizaron colocándolas en un papel rectangular y utilizando un marco con 10 agujas separadas a 1 cm una de otra, se marcaron 100 puntos para registrar la frecuencia de ocurrencia de hojas, frutos, fibras y materia animal en la muestra (Korschgen, 1980).

Durante un año se registraron también observaciones directas de hábitos alimentarios de cuatro grupos de

PLB que fueron seguidos a través de la técnica de radio-telemetría para un proyecto adicional (Reyna-Hurtado 2007). Obtuvimos más de 100 horas de observación de los cuatro grupos donde registramos las principales especies consumidas por los PLB así como la estacionalidad de consumo.

Las muestras colectadas en campo y las partículas de frutos, semillas, hojas y materia animal encontradas en contenidos estomacales y excretas fueron identificadas con la ayuda de personal del Laboratorio de Vida Silvestre y Colecciones Científicas del Centro de Estudios de Desarrollo Sustentable (CEDESU) de la Universidad Autónoma de Campeche. Se identificaron por familia, género o niveles de especies cuando fue posible y cuando no pudieron ser identificados en ni un nivel taxonómico y presentaban diferencias morfológicas, se clasificaron como "morfoespecie"

Análisis De Datos
Las muestras de excretas y contenidos estomacales fueron clasificadas de acuerdo a la estación en las que se colectaron y por especie.

Para obtener los porcentajes de ocurrencia por especie en los contenidos estomacales a lo largo del año se aplicó la siguiente formula:
% Oc= Nx100/n (N= es el número de veces que aparece el componente o la especie de planta en particular y n= es el número de estómagos por cada especie de pecarí).

Para determinar la división de recursos entre las especies y para comparar el uso de un recurso con otro, tanto de excretas como de contenidos estomacales, se aplicó el método de determinación del grado de sobreposición del nicho por Schoener (1968)., al igual que una prueba T de student.
Qjk= 1-1/2 Σ lpij -pik l (**Qjk**= sobreposición en el consumo de alimento entre especie j y especie k; **pi**= uso proporcional del alimento por la especie j ó k). Los valores del índice van del 0 al 1 siendo cero la segregación total y uno la sobreposición absoluta. Para calcular las diferencias estacionales entre las excretas y las diferencias estaciónales entre los contenidos estomacales, se aplicó la prueba no pareada de Mann-Whitney.

Resultados

En base a datos reportados por otros autores, entrevistas y datos obtenidos durante el estudio, se enlistaron las especies consumidas y potencialmente consumibles por los pecaríes en Calakmul (Apéndice I). A lo largo del muestreo se colectaron un total de 10 excretas, nueve estómagos y más de 100 horas de observación de grupos de PLB. Respecto al PC se colectaron 22 estómagos (Cuadro 1).

Las dietas de ambos pecaríes se compuso de más de 62 especies, ambos compartieron 32 especies en su dieta, lo cual significa que el PC compartió 66.7% de las especies consumidas con el PLB, mientras que éste compartió el 68.1%. Sin embargo, el consumo de las especies entre ambos pecaríes indica que sus nichos alimenticios no se sobreponen significativamente (Qjk= 0.58). Las especies más consumidas por el PC fueron *B. alicastrum, Byrsonima crassifolia, P. amalago, Z. maiz* y larvas de escarabajo (*Psilotrix sp*.) y las más consumidas por el PLB fueron *Chamaedorea sp., P. amalago, M. zapota y B. alicastrum* (Apéndice II).

La composición de la dieta del PC fue menos diversa durante las lluvias a comparación con las secas. Sin embargo, durante la temporada de lluvias tuvo mayor número de especies dominantes (seis) que en la de secas (cuatro). Del total de especies, solo 21 fueron consumidas a lo largo del año, 19 especies fueron consumidas exclusivamente en secas y cuatro en lluvias, lo que significa que el 84% de las especies

consumidas durante la estación de lluvias es compartido con la de secas y a su vez, el 52.5% de las de las especies consumidas durante la temporada de secas es compartido con la de lluvias (Cuadro 2).

Cuadro 1: Comunidad y hábitat de origen de las muestras

		Nvo. Becal				Xbónil		V. de Nov.		Conhuas	RBC
		A	**b**	**m**	**s**	**a**	**m**	**m**	**s**	**m**	**s**
P. tajacu	lluvias		1	1	1		5				
	secas		2	8		1		1	1	1	
T. pecari	lluvias										1
	secas	7							1		
Total		7	3	9	1	1	5	1	2	1	

a) aguada, **b)** bajo, **m)** milpa y **s)** selva mediana

Dieta por componentes alimenticios en estómagos y excretas de *T. pecari*

El análisis de excretas y contenidos estomacales mostró que la dieta del PLB está basada en el consumo de frutos ya que dicho componente tuvo valores elevados en ambos tipos de muestras (Fig. 2). Debido a que el 89% de los estómagos colectados del PLB se obtuvieron durante la temporada seca, no fue posible hacer la comparación de la proporción de los componentes consumidos por temporada.

Al comparar los diferentes componentes alimenticios encontrados en las excretas del PLB, entre la temporada de lluvias y secas, el único que mostró diferencias significativas fueron los frutos ($U= 49$, $P< 0.05$), aparentemente consumiendo mayor proporción de este componente durante la estación seca.

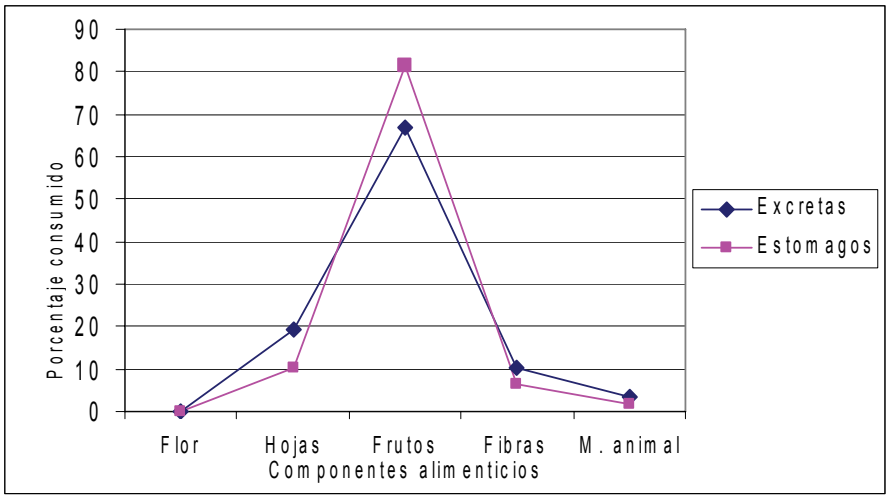

Figura 2: Porcentaje encontrado de las diferentes clasificaciones de componentes alimenticios en los contenidos estomacales y excretas de *T. pecari* a lo largo del año

Familia	Especie	Estación lluviosa % frec. de ocurrencia	Estación seca % frec. de ocurrencia
Apocynaceae	*Tabernaemontana alba*	12.5	-
Caesalpinaceae	*Caesalpinia gaumerii**	25	28.6
Celastraceae	*Crossopetalum sp.*	**37.5**	-
Convolvulaceae	*Ipomoea alba**	12.5	14.3
Curcubitaceae	*Crecenta cujete*	-	14.3
Curcubitaceae	*Curcubita lundeli**	**37.5**	14.3
Ephorbiaceae	*Morfoespecie 1*	-	7.14
Euphabeaceae	*Morfoespecie*	-	21.42
Leguminosae	*Haematoxylum campechianum*	-	**50**
Malpighiaceae	*Byrsoima crassifolia*	**50**	-
Mimosaceae	*Acacia sp.**	12.5	7.14
Mimosaceae	*Mimosa sp.**	12.5	21.42
Mimosaceae	*Zapoteca Formosa**	25	21.42
Moraceae	*Brosimum alicastrum***	**50**	**50**
Opiliaceae	*Agonandra obtucifolia*	-	7.14
Orquidaceae	Morfoespecie 16	-	28.57
Palmae	*Attalea cohune*	-	7.14
Palmae	*Chamaedorea sp.**	**37.5**	21.4
Palmae	*Cryosophila argentea**	**37.5**	21.42
Passifloraceae	*Pasiflora sp.*	-	7.14285714
Pipperaceae	*Pipper amalago***	**37.5**	**78.6**
Pipperaceae	*Pipper sp.**	25	21.42
Poaceae	*Gramia sp.*	**-**	14.3
Poaceae	*Zea maiz***	**87.5**	**50**
Sapindaceae	*Talisia olivaeformis**	12.42	14.3
Sapotácea	*Manilkara zapota***	**37.5**	**71.4**
Sapotácea	*Pouteria campechiana*	-	7.14
Violaceae	*Hybantus sp.*	-	7.14
Desconocida	Morfoespecie 3*	**50**	14.28
Desconocida	Morfoespecie 4	-	7.14
Desconocida	Morfoespecie 6	25	-
Desconocida	Morfoespecie 10*	12.5	7.14
Desconocida	Morfoespecie 11*	12.5	42.3
Desconocida	Morfoespecie 12*	12.5	**71.3**
Desconocida	Morfoespecie 13*	-	21.43
	Componentes de materia animal		
	Abeja	-	7.14
	*Amblyomma sp.**	7.14	7.14
	Anélido	**75**	7.14
	Atta sp.	-	7.14
	Aves	-	7.14
	Fellipponea sp.	12.5	-
	Grillidae	-	14.3
	Phyllophaga sp. (larva)	**50**	7.14
	Reptil	-	14.3
	Triatoma sp.	-	14.3

Cuadro 2: Dieta del *P. tajacu* (PC) en temporada de lluvias y secas. (Porcentaje de frecuencia de ocurrencia). Especies encontradas en los contenidos estomacales de *P. tajacu.* Especies dominante en **negritas, -**Especie ausente, *Especies compartidas**Especies dominantes compartidas

Dieta por componentes alimenticios en *P. tajacu*

La sobreposición en el consumo de los componentes para el PC durante la estación seca y de lluvias tuvo un valor de (Qjk= 0.63). El consumo de hojas fue significativamente mayor en secas que en lluvias (U= 94 P< 0.05) y por otra parte el consumo de frutos tuvo mayor importancia durante la estación de lluvias (U= 91, P< 0.05) (Fig. 3).

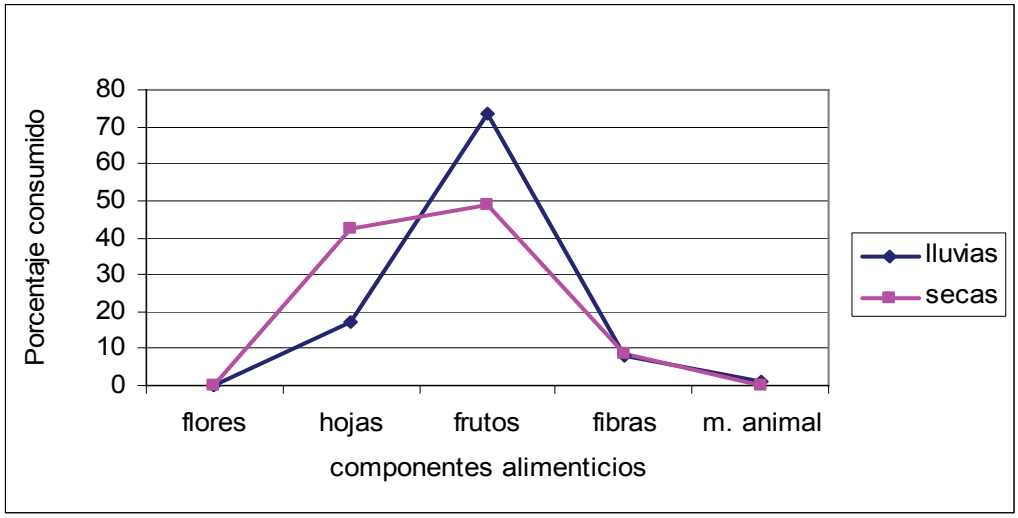

Figura 3: Porcentaje encontrado de las diferentes clasificaciones de grupos alimenticios en los contenidos estomacales de *P. tajacu* durante lluvias y secas.

Al comparar el consumo de recursos (grupos alimenticios) entre el PC y el PLB se observó que el consumo proporcional de los recursos es muy similar entre ambas especies (Qjk= 0.74), ($t_{0.17,\,(1.76)}$ $p_{(0.05)}$). Sin embargo, comparando el consumo de frutos entre ambos se comprobó que hay diferencia significativa en el consumo de dicho recurso entre las especies, siendo mayor el uso proporcional de frutos por parte del PLB que el PC, (U= 99, P< 0.05), ($t_{0.35,\,(4.54)}$ $p_{(0.05)}$). En el caso de la comparación entre el consumo de hojas se encontró que también hubo diferencias significativas en el uso de dicho recurso (U= 102, P<0.05) ($t_{1.02,\,(10.41)}$ $p_{(0.05)}$) siendo el PC quien consume mayor proporción de hojas (Fig. 4).

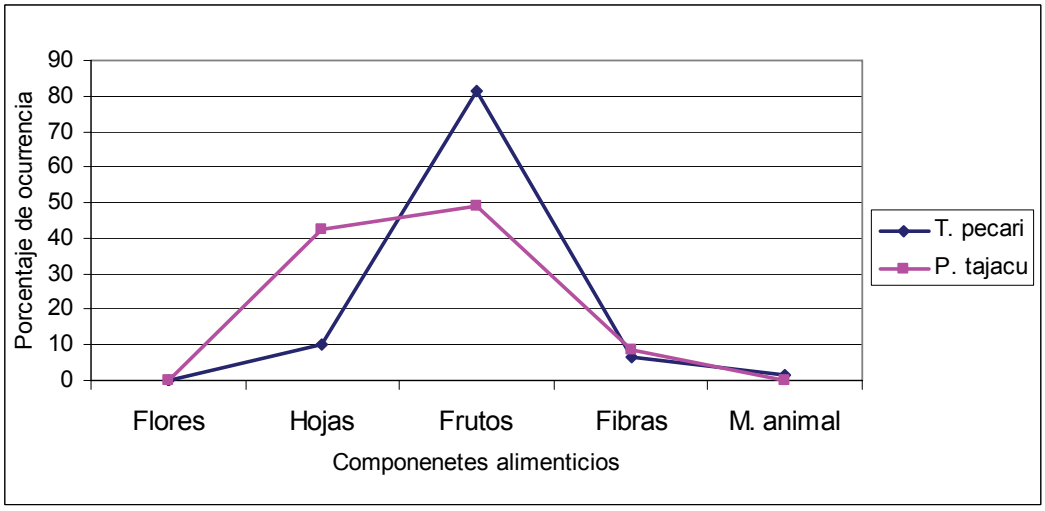

Figura 4: Porcentaje de ocurrencia encontrado de los componentes alimenticios en los contenidos estomacales de *P. tajacu* y *T. pecari* en la estación de secas.

Discusion

Es necesario evaluar la importancia de ambos pecaríes como predadores y dispersores de semillas ya que aparentemente es el PC quien cumple mejor la función de dispersor de semillas de especies como *B. crassifolia, Cryosophila argentea, Curcúbita sp., Hybanthus sp., Gramia sp., Euphabaceae, M. zapota* y *Passiflora sp.* En el caso del PLB no se puede decir que cumpla la función de dispersor de semillas ya que en sus excretas únicamente se encontraron semillas enteras de *Ficus sp*. y *Pasiflora sp*. Por otra parte, es probable que tanto el pecarí de labios blancos como el de collar sean importantes reguladores de las poblaciones de algunas de las especies que consumen, de igual modo están compitiendo con otras especies herbívoras y frugívoras, que comparten el uso de recursos como con las dos especies de roedores que habitan las selvas de la Península de Yucatán, el "Tepezcuintle" (*Cuniculus paca*) y el "Serete" (*Dasyprocta punctata*), también compiten con las tres especies de venados que habitan el sureste de México: el temazate rojo *Mazama americana,* el temazate cafe *Mazama pandora,* y el venado cola blanca *Odocoileus virginianus,* así como con el ultimo representante de la megafauna americana el tapir centroamericano *Tapirus bairdii*.

Las aportaciones de esta y otras investigaciones han mostrado que la dieta del PLB esta basada en el consumo de solamente ciertas especies por lo que se le considera "selectiva", mientras que la dieta del PC se comporto de forma menos selectiva, ya que dos de las 37 especies de plantas que éste consume, son cultivadas por el hombre en la región (*Z. maiz* y *Curcubita sp.*), lo cual demuestra efectivamente que es generalista y oportunista, tal como lo indican otros autores (Kiltie, 1981; Sowls, 1984; Bodmer, 1989; MacCoy y Vaughan, 1990; Barreto et al., 1997; Martínez-Romero y Mandujano, 1995; Fragoso, 1999; Keuroghlian, 2003).

De las especies encontradas en esta región como parte de la dieta del PLB únicamente *B. alicastrum, Cordia dodecandra, Ficus continifolia* y *M. zapota* habían sido reportadas en otros estudios (Janzen, 1985; Bodmer, 1990; Dirzo y Miranda, 1990; Altrichter et al., 2000) y *Acacia sp., Attalea cohune, C. argentea, Pouteria campechiana, Serjania adiantoides* y *Talissia olivaeformis*, coinciden en género con otras especies mencionadas para de la dieta de esta especie (Kiltie, 1982; Barreto et al., 1997; Fragoso, 1999; Altrichter et al., 2000). Tres de las cuatro especies más consumidas por el PLB también son base de la dieta de las tres especies de cervidos en Calakmul (Weber, 2004). De las especies consumidas por el PC solo se han reportado *Acacia sp., B. alicastrum* y *M. zapota* (Leopold, 1972; Sowls, 1983; Dirzo y Miranda, 1990; Bodmer, 1989; Martínez-Romero y Mandujano, 1995; Martínez-Gallardo y Cordero, 1997). Sin embargo, se han reportado especies del mismo género de algunas de las especies encontradas en este trabajo (*Caesalpinea sp., Attalea sp., Talisia sp.* y *Pouteria sp.*) (Jordano 1983). El consumo de proteína animal por parte de ambas especies de pecaríes coincide con lo reportado por otros autores (Kiltie, 1981; Fragoso, 1999; Altrichter et al., 2000).

En otras regiones se ha demostrado que la dieta del PC y PLB presenta una variación temporal en cuanto a la proporción de los componentes y las especies que la componen (Robinson y Eisenberg, 1985; Bodmer, 1989; MacCoy y Vaughan, 1990; Martínez-Romero y Mandujano, 1995; Fragoso, 1999; Altrichter et al., 2000). Probablemente la preferencia y el mayor consumo de ciertas especies este relacionada con la calidad nutricional de cada una de ellas, López et al., (2005) encontró una relación positiva entre el valor energético y nutricional de los componentes de ciertas especies y su consumo por parte de *T. pecari* en Costa Rica. Sin embargo, la composición y variación de las dietas esta en función a la disponibilidad de los recursos, los cuales se ven afectados por el comportamiento fenológico de las especies de plantas disponibles en la región así como del uso y manejo de los recursos por los pobladores, que también influye en la tasa de movimiento y el uso de hábitat de los pecaríes, (Bodmer, 1989;

Fragoso, 1999; Altrichter et al., 2000). De igual manera el uso de hábitat y el rango de movimiento por parte de PLB y PC, son factores determinantes en la diferencia en el aprovechamiento de los recursos entre ambos (Bodmer y Sowls, 1993; Fragoso 1999; Robinsón y Eisenberg, 1985; McCoy y Vaughan, 1990). Mientras que el PC se mueve a una escala espacial a nivel de hábitats, el PLB se mueve a nivel de paisaje lo que le permite acceder a diferentes recursos y/o a recursos que varían en su disponibilidad espacial (Fragoso 1999). El *P. tajacu* hace mayor uso de hábitats parcialmente perturbados, a diferencia de *T. pecari* que prefiere hábitats no perturbados (Bodmer, 1989; Fragoso, 1999; Weber, 2000; Quijano, 2001; Keuroghlian, 2003; Reyna-Hurtado y Tanner, 2005). Lo cual implica que tienen acceso a diferentes recursos alimenticios permitiendo la coexistencia de PLB y PC a lo largo de su distribución.

Es importante estudiar a fondo la variación fenológica *de B. alicastrum, M. zapota, Pipper sp.* y *Chamaedora sp.*, así como su disponibilidad y riqueza nutricional, ya que en la región de Calakmul, son especies importantes en las dietas de ambos pecaríes a lo largo del año; un descenso en la disponibilidad de estas plantas podría afectar en las dietas de ambas especies en especial a *T. pecari*, en la estación de secas.

La conservación de *T. pecari* en la región de Calakmul necesariamente implica la conservación de extensos territorios de selva baja y selva mediana con poca perturbación para que pueda satisfacer sus necesidades de alimento y refugio. La conservación de *P. tajacu y T. pecari* tendría un efecto positivo en los esfuerzos de conservación de otras especies como el jaguar *Panthera onca* y el puma *Puma concolor*, los cuales son sus principales depredadores, pero sobre todo la conservación de ambas especies tiene una gran importancia ecológica y económica para los ecosistemas y la población humana de la región de Calakmul.

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Agradecemos a los cazadores de las comunidades de Conhuas, Nuevo Becal, Veinte de Noviembre y Xbónil en especial a Don Enrique Tamay, Jaime Raigoza, Héctor Arias (Pola), Nicolás Arias y Gilberto Arias. Al Museo de Colecciones Biológicas de la Universidad Autónoma de Campeche de (CEDESU), a Celso Gutiérrez, Ricardo E. Góngora Chin, Rosa M. Chan Cocom por su ayuda en la identificación de plantas e insectos, a profesores y amigos Jorge A. Vargas Contreras y Griselda Escalona Segura por su ayuda, orientación y por habernos permitido consultar su acervo bibliográfico, a Jorge A. Benítez por su apoyo durante la etapa final este proyecto. Fondos para este proyecto fueron proporcionados parcialmente por la Sociedad para la Conservación de la Vida Silvestre (WCS por sus siglas en ingles) y por CONACYT a través de una beca (150332) a RRH.

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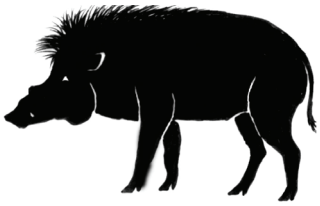
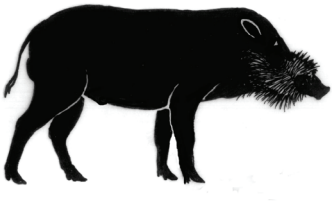


News in Brief



Hero porker

(AFP - Monday, June 23 05:31 pm)

BEIJING (AFP) - A pig that survived for 36 days buried beneath rubble in quake-hit southwest China on a diet of charcoal has been hailed as a symbol of the will to stay alive, state press reported Monday.

The pig, who weighed nearly 150 kilograms (330 pounds) at the time of the magnitude-8.0 earthquake on May 12, had lost two thirds of its weight when found last week, the Chongqing Evening Post said.

"It didn't look like a pig at all when it was saved. It was as thin as a goat!" a witness told Xinhua news agency.

According to the report in the Chongqing Evening Post, the pig survived on water and a bag of charcoal that had been buried with the one-year-old in the ruins of Pengzhou city, Sichuan province.

Although charcoal has no nutritional value, it is not toxic either and it filled the pig up, it said.

The curator of the local Jianchuan Museum has already bought the pig for 3,008 yuan (436 dollars) and will keep the animal for the rest of its life "as a living symbol of the earthquake disaster," the report said.

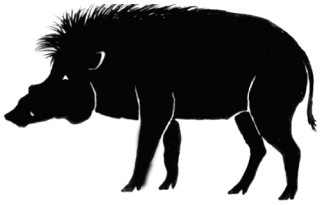
The museum has named the pig "Zhu Jianqiang," which means "Strong Pig," it added.
Owner Wan Xingming had given up the animal for dead, but when he heard that soldiers were going to

clean up the rubble around his house on June 17, he rushed back to warn them that the dead pig could be infectious.

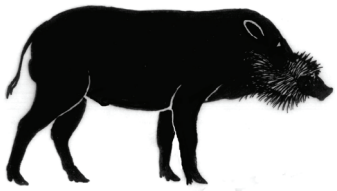
That is when the skinny porker was pulled out of the rubble.

Wan said he was willing to sell the pig for 3,008 yuan, charging 10 yuan for each pound it had previously weighed and adding eight yuan for good luck, the paper said.

Nearly 88,000 people were left dead or missing following the May 12 quake, the biggest earthquake disaster to hit China in three decades.



New Literature on Suiformes



Veterinary and Physiological studies

Jeseta M, Petr J, Krejeova T, Chmelikova E and Jilek F. 2008. In vitro ageing of pig oocytes: effects of the histone deacetylase inhibitor trichostatin A. Zygote 16(2): 145-152.

After in vitro maturation, the unfertilized pig oocytes underwent the process called ageing. This process involves typical events such as fragmentation, spontaneous parthenogenetic activation or lysis. Inhibition of histone deacetylase, using its specific inhibitor trichostatin A (TSA), significantly delayed the maturation of pig oocytes cultured in vitro. The ageing of oocytes matured under the effect of TSA is the same as the ageing in oocytes matured without TSA. The inhibition of histone deacetylase during oocyte ageing significantly reduced the percentage of fragmented oocytes (from 30% in untreated oocytes to 9% in oocytes aged under the effect of 100 nM of TSA). Oocytes matured in vitro and subsequently aged for I day under the effects of TSA retained their developmental capacity. After parthenogenetic activation, a significantly higher portion (27% vs. 15%) of oocytes developed to the blastocyst stage after 24 h ageing under 100 nM TSA when compared with oocytes activated after 24 h ageing in a TSA-free medium. The parthenogenetic development in oocytes aged under TSA treatment is similar to the development of fresh oocytes (29% of blastocyst) artificially activated immediately after in vitro maturation.

Fenati M, Monaco A and Guberti V. 2008. Efficiency and safety of xylazine and tiletamine/zolazepam to immobilize captured wild boars (*Sus scrofa* L. 1758): analysis of field results. European Journal of Wildlife Research 54(2): 269-274.

During a 2-year study on wild boar ecology in a semiagricultural area of Northern Apennines (central Italy), 47 animals were caught with traps and subsequently immobilized with chemical restrain based on a 1:1 mixture of xylazine and tiletamine/zolazepam (1 ml contains: 50 mg of xylazine, 25 mg of tiletamine, and 25 mg of zolazepam). Effective chemical immobilization was observed in 55% of the caught wild

boars, and a high capture mortality rate occurred (in 10.6% of wild boars). A posteriori analysis, by means of a logistic regression model, was performed to assess potential factors associated with wild boar chemical immobilization failure. Underdosage and increase in the number of animals caught together significantly increase the wild boar chemical restrain failure, while the capture mortality appears to be positively related to the sole trap size alone. The stress developed during the capture plays a relevant role influencing the outcomes of the anesthesia. Thus, the use of alternative handling or catching procedures with the aim to reduce stress in captured animals could maximize the safety and the efficiency of the wild boar chemical immobilization.

Zanella G, Durand B, Hars J, Moutou F, Garin-Bastuji B, Duyauchelle A, Ferme M, Karoul C and Boschiroli ML. 2008. *Mycobacterium bovis* in wildlife in France. Journal of Wildlife Diseases 44(1): 99-108.

In early 2001, tuberculosis-like lesions were detected in three hunter-killed red deer (*Cervus elaphus*) in the Brotonne Forest (Normandy, France), and *Mycobacterium bovis* was isolated. In subsequent hunting seasons, two surveys were conducted in the area. In the first survey (2001-02 hunting season), nine (13%) of 72 red deer sampled were positive for *M. bovis*. In the 2005-06 hunting season, the prevalence of *M. bovis* infection increased to 24% (chi(2) = 3.85, df= 1, P=0.05; 33 positive among 138 sampled). The prevalence remained stable in juveniles, but it increased significantly in adults: from 13% in 2001-02 to 32% in 2005-06 (chi(2)=5.13, df= 1, P=0.02). Wild boar (*Sus scrofa*) were heavily infected in both surveys. One roe deer (*Capreolus capreolus*) and one red fox (*Vulpes vulpes*) also tested positive in the second survey. *Mycobacterium bovis* was not isolated from Eurasian badgers (*Meles meles*). Spoligotyping and inycobacterial interspersed repetitive unit-variable number tandem repeat analysis demonstrated that all *M. bovis* strains isolated from wildlife were of the same genotype. Thus, the wildlife outbreak involved only a single strain, and this strain was the same as that circulating in nearby cattle herds since 1995. Sensitivity, specificity, and predictive values of the presence of macroscopic lesions as a diagnostic criterion were evaluated from the data obtained from red deer. Necropsy seems to be satisfactory as a routine tool to monitor the disease in wild red deer populations in which bovine tuberculosis has become established.

Fajardo V, Gonzalez I, Martin I, Rojas M, Hernandez PE, Garcia T and Martin R. 2008. Differentiation of European wild boar (*Sus scrofa scrofa*) and domestic swine (*Sus scrofa domestica*) meats by PCR analysis targeting the mitochondrial D-loop and the nuclear melanocortin receptor 1 (MC1R) genes. Meat Science 78(3): 314-322.

This work describes the differentiation of European wild boar (*Sus scrofa scrofa*) and domestic swine (*Sus scrofa domestica*) meats by PCR targeting sequences from two molecular markers: the mitochondrial displacement loop (D-loop) region and the nuclear melanocortin receptor 1 (MC1R) gene. A polymorphic D-loop fragment (similar to 270 bp) was amplified and sequenced in a number of wild and domestic Sus scrofa meat samples, to find a nucleotide region suitable for PCR-RFLP analysis. Sequence data showed the presence of only a few point mutations across Sus scrofa D-loop sequences, not allowing direct discrimination between wild boar and domestic swine meats. Later, the MC1R gene was targeted and Sits scrofa-specific primers designed to amplify a 795 by MC1R fragment. Subsequent RFLP analysis of the MO R swine-specific amplicons allowed selection of BspHI and BstUI endonucleases to carry out intraspecific Sus scrofa differentiation. Digestion of MC1R amplicons with the chosen enzymes generated characteristic PCR-RFLP profiles that allowed discrimination among meats from wild and domestic swine specimens. The technique also enabled the detection of samples that yielded heterozygous profiles, suggesting hybrids resulting from wild boar and domestic pig breeding. The PCR-RFLP reported

here, targeting the MO R gene may be routinely applied to verify the correct labelling of game products.

Martelli F, Caprioli A, Zengarini M, Marata A, Fiegna C, di Bartolo I, Ruggeri FM, Delogu M and Ostanello F. 2008. Detection of Hepatitis E virus (HEV) in a demographic managed wild boar (*Sus scrofa scrofa*) population in Italy. Veterinary Microbiology 126(1-3): 74-81.

Hepatitis E virus (HEV) is the causative agent of Hepatitis E. Swine and human HEV strains are genetically related, suggesting the occurrence of zoonotic transmission. Recently, in Japan, cases of food-borne HEV transmission have been described in people after consuming raw or undercooked meat from wild boars or pigs. Although, swine HEV strains have been detected in pig herds in many European countries, only minimal information is presently available about the circulation and the prevalence of HEV in wild boars in Europe. In this study, we investigated the presence of HEV in a demographic managed wild boar population in Italy. Detection of HEV RNA was accomplished using a nested reverse-transcription polymerase chain reaction on bile samples from 88 shot animals. HEV RNA was detected in 22 out of 88 animals tested (25%). Phylogenetic analysis on the nucleotide sequences obtained from 10 positive PCR products indicated that only one HEV strain was circulating in the wild boar population considered, and that this strain was closer to human and swine HEV strains circulating in Europe than to wild boar Japanese strains.

Cowled BD, Lapidge SJ, Smith MI and Staples LD. 2008. Vaccination of feral pigs (*Sus scrofa*) using iophenoxic acid as a simulated vaccine. Australian Veterinary Journal 86(1-2): 50-55.

Objectives: To develop an encapsulation method for delivery of vaccines to feral pigs, and quantify the effect of iophenoxic acid on captive feral pig blood iodine concentrations to assist in investigation of factors affecting vaccine uptake.

Design and methods: Feral pigs were administered iophenoxic acid by oral gavage, and consumption was assessed for different encapsulation methods in baits. Blood iodine concentrations were monitored for eight days after consumption. The relationship between dose rate, time since dosing and blood iodine concentration was assessed for gavaged and baited captive feral pigs. Wild feral pigs were baited with PIGOUT((R)) baits containing 20 mg of encapsulated iophenoxic acid to simulate a vaccination program. Using knowledge from the pen studies, bait uptake and factors affecting bait uptake were investigated.

Results: Bait-delivered iophenoxic acid led to variable and inconsistent changes in blood iodine concentrations, in contrast to pigs receiving iophenoxic acid by gavage. This precluded accurate assessment of the quantity consumed, but still allowed a conservative determination of bait uptake. Iophenoxic acid in smaller capsules was consumed readily. Increasing baiting intensity appeared to increase bait uptake by wild feral pigs, and pigs of varying sexes, ages and weights appeared equally likely to consume baits.

Conclusions: Encapsulated liquids can be delivered to feral pigs within baits, should the need to vaccinate feral pigs for fertility or disease management arise. High baiting intensities may be required.

Naranjo V, Gortazar C, Vicente J and de la Fuente J. 2008. Evidence of the role of European wild boar as a reservoir of Mycobacterium tuberculosis complex. Veterinary Microbiology 127(1-2): 1-9.

Bovine tuberculosis (bTB) is caused by *Mycobacterium bovis* and closely related mycobacteria of the Mycobacterium tuberculosis complex. They have an extensive host range and may cause zoonotic TB. A major obstacle to bTB eradication in livestock is the implication of wildlife in the natural cycle of the

pathogen. The identification of wildlife reservoir hosts is crucial for the implementation of effective control measures. The European wild boar (*Sus scrofa*) is frequently considered a spillover or dead end host rather than a true reservoir, and scientific evidence is conflicting outside Mediterranean Spain. The aim of this review is to update current scientific evidence of the wild boar as a TB reservoir and to underline those aspects that need further research. Evidences supporting that wild boar is a TB reservoir host include: (i) presence of common M. tuberculosis complex genotypes in wild boar, domestic and wild animals and humans, (ii) high prevalence of *M. bovis* among wild boar in estates fenced for decades in complete absence of contact with domestic livestock, and other wild ungulates (iii) TB lesions are frequently seen in thoracic lymph nodes and lungs, suggesting that respiratory infection and excretion may occur, and (iv) extensive tuberculous lesions in more than one anatomical region occur in a high proportion of juvenile wild boar that probably represents the main source of mycobacterial excretion. Hence, epidemiological, pathological and microbiological evidence strongly suggests that, at least in Spanish Mediterranean ecosystems, wild boar are able to maintain TB infection in the wild and are most probably able to transmit the disease to other species, acting as a true wildlife reservoir. These results expand the list of wildlife species that act as natural reservoirs of TB in different parts of the world and suggest the need to control the infection in wild boar populations for the complete eradication of the disease in Spain.

Romero-Castanon S, Ferguson BG, Guiris D, Gonzalez D, Lopez S, Paredes A and Weber M. 2008. Comparative parasitology of wild and domestic ungulates in the Selva Lacandona, Chiapas, Mexico. Comparative Parasitology 75(1): 115-126.

We surveyed gastrointestinal and ectoparasites in wild and domestic ungulates in the Selva Lacandona, Chiapas, Mexico, including Baird's tapir (*Tapirus bairdii*), collared peccary (*Pecari tajacu*), white-lipped peccary (*Tayassu pecari*), white-tailed deer, (*Odocoileus virginianus*); red brocket deer (*Mazama americana*), horses (*Equus caballus*), cattle (*Bos taurus*), and pigs (*Sus scrofa*). We collected 97 fresh fecal samples from the domestic species and 46 from the wild species and examined digestive tracts of 21 wild specimens. We identified 18 species of nematodes and 7 species of protozoans in feces and 3 nematode species, 2 trematode species, and. I cestode species during postmortem examination. Paramphistomid infections in peccaries and deer were both prevalent: and intense, representing a potential risk to populations of these ungulates. Ectoparasites included 14 species of Ixodidae and a hippoboscid. Of the endoparasites, 10 are new host records and 15 are new geographic records for Mexico: Ectoparasites included 7 new host records and 14 new geographic records for Mexico. Morisita's similarity index revealed, the greatest similarity between the 2 deer species and between the 2 peccary species, while the greatest similarity between wild and domestic species was between *B. taurus* and *O. virginianus*. We discuss possible routes of interspecific transmission as well as the potential of the ectoparasites identified as disease vectors.

Taxonomic, Morphological, Biogeographic and Evolutionary Studies

Kullmer O. 2008. The fossil suidae from the Plio-Pleistocene Chiwondo Beds of northern Malawi, Africa. Journal of Vertebrate Paleontology 28(1): 208-216.

The fossil suids from the Chiwondo Beds in northern Malawi constitute four separate assemblages that may be used for internal and external biostratigraphic correlation. Pig remains occur in two stratigraphic units. Unit 2 contains *Notochoerus jaegeri*. The younger stratigraphic unit 3A can be subdivided by the suid fauna into an older zone 3A-1 containing *Notochoerus euilus* and zone 3A-2 with more advanced forms such as *Notochoerus scotti* and early *Metridiochoerus andrewsi*. Unit 3B contains advanced *M.*

andrewsi and *M. compactus*. Bushpig and warthog remains have also been recovered but their stratigraphic position could not be determined. A method of documenting the structural density of enamel bands on the occlusal surface of suid check teeth can be used to correlate the Chiwondo Beds suids with similar species from elsewhere in sub-Saharan Africa and thereby for estimating the age of the two hominins discovered by the Hominid Corridor Research Project.

Abbazzi L, Carboni S, Delfino M, Gallai G, Lecca L and Rook L. 2008. Fossil vertebrates (Mammalia and Reptilia) from Capo Mannu Formation (Late Pliocene, Sardinia, Italy), with description of a new Testudo (Chelonii, Testudinidae) species. Rivista Italiana di Paleontologia e Stratigrafia 114(1): 119-132.

In the North-West Sinis Peninsula (Western Sardinia) a stratigraphic sequence, the Capo Mannu Fm., that evolves from marine-littoral to continental-dunar, is present. A vertebrate fauna is reported within the middle part of this coastal dune complex. These new remains, here referred to as the Capo Mannu D4 Local Fauna, are slightly younger in the sedimentary succession than the Local Fauna known in the literature as Mandriola and here re-named the Capo Mannu D1 Local Fauna.
Vertebrates from Capo Mannu D4 include reptiles (Chelonii) and mammals (Bovidae and Suidae). The tortoise fossil shows peculiarities of shape that require the naming of a new species. The suid material includes a fragmentary palate and a partial mandible, referable to the endemic species *Sus sondaari*. Bovids are well represented in the assemblage, although quite fragmentary. They have been identified as belonging to at least two forms. One of these is comparable in morphology to Nesogoral, one of the most characteristic taxa of the Late Pliocene-Early Pleistocene Sardinian endemic fauna (the so called "Nesogoral complex"). On the whole, the Capo Mannu D4 assemblages open a new window on the Plio-Pleistocene terrestrial faunas of the Sardinian Island.

Scandura M, Iacolina L, Crestanello B, Pecchioli E, di Benedetto MF, Russo V, Davoli R, Apollonio M and Bertorelle G. 2008. Ancient vs. recent processes as factors shaping the genetic variation of the European wild boar: are the effects of the last glaciation still detectable? Molecular Ecology 17(7): 1745-1762.

The European wild boar is an important game species, subjected to local extinctions and translocations in the past, and currently enormously and worryingly expanding in some areas where management is urgently required. Understanding the relative roles of ancient and recent events in shaping the genetic structure of this species is therefore not only an interesting scientific issue, but it represents also the basis for addressing future management strategies. In addition, several pig breeds descend from the European wild boar, but the geographical location of the domestication area(s) and the possible introgression of pig genomes into wild populations are still open questions. Here, we analysed the genetic variation in different wild boar populations in Europe. Ten polymorphic microsatellites were typed in 252 wild boars and the mtDNA control region was sequenced in a subset of 145 individuals. Some samples from different pig breeds were also analysed. Our results, which were obtained considering also 612 published mtDNA sequences, suggest that (i) most populations are similarly differentiated, but the major discontinuity is found along the Alps; (ii) except for the Italian populations, European wild boars show the signature of a postglacial demographic expansion; (iii) Italian populations seem to preserve a high proportion of preglaciation diversity; (iv) the demographic decline which occurred in some areas in the last few centuries did not produce a noticeable reduction of genetic variation; (v) signs of human-mediated gene flow among populations are weak, although in some regions the effects of translocations are detectable and a low degree of pig introgression can be identified; (vi) the hypothesis of an independent domestication centre in Italy is not supported by our data, which in turn confirm that Central European wild boar might have represented an important source for domestic breeds. We can therefore conclude that recent human activities

had a limited effect on the wild boar genetic structure. It follows that areas with high variation and differentiation represent natural reservoirs of genetic diversity to be protected avoiding translocations. In this context controlling some populations by hunting is not expected to affect significantly genetic variation in this species.

Locke M. 2008. Structure of ivory. Journal of Morphology 269(4): 423-450.

Profiles with all orientations have been used to visualize the 3D structure of ivory from tusks of elephant, mammoth, walrus, hippopotamus, pig (bush, boar, and warthog), sperm whale, killer whale, and narwhal. Polished, forming, fractured, aged, and stained surfaces were prepared for microscopy using epi-illumination. Tusks have a minor peripheral component, the cementum, a soft derivative of the enamel layer, and a main core of dentine = ivory. The dentine is composed of a matrix of particles 5-20 mu m in diameter in a ground substance containing dentinal tubules about 5 mu m in diameter with a center to center spacing of 10-20 mu m. Dentinal tubules may be straight (most) or curly (pigs). The main findings relate to the way that dentinal tubules align in sheets to form micro-laminae in the length of the tusk. Microlaminae are sheets of laterally aligned dentinal tubules. They are axial but may be radial (most), angled to the forming face (pigs and hippopotamus canines), or radial but helical (narwhals). Within the microlaminae the dentinal tubules may be radial, angled to the axis (whales, walrus, and pigs), or may change their orientation from one microlamina to the next in helicoids (canines of hippopotamuses, incisors of proboscidea). In the nonbanded, featureless ivories from the hippopotamus incisors, the dentinal tubules form radial microlamina from which the arrangements in other ivories can be derived. In the canines of hippopotamuses and incisors of proboscidea, the dentinal tubule orientation changes incrementally from one microlamina to the next in a helicoid, a stack of dentinal tubules that change their orientation by 180 degrees anticlockwise. Dentinal tubules having different orientations are laid down concurrently, not layer by layer as in most examples of helicoidal architecture (e.g., insect cuticle). In proboscidean ivory, the microlaminae are radial, normal to the banding of growth layers marking the plane of deposition. They form radial segments with each 180 degrees turn in the orientation of their constituent dentinal tubules. Below the cementum they are almost complete 180 degrees helicoids, but nearer to the core they become narrower with the loss of radially oriented dentinal tubules. These truncated helicoidal patterns appear in longitudinal profile as VVVV feather patterns rather than boolean AND boolean AND boolean AND boolean AND, each V or boolean AND being the side view of a partial or complete helicoid. The Schreger pattern in proboscidean ivory consists of these helicoids divided tangentially into columns in the length of the tusk. Narwhals have the most abundant matrix particles with their radial/helical dentinal tubules having a twist opposite to that in the cementum.

Ecology and Conservation Studies

Gimenez-Anaya A, Herrero J, Rosell C, Couto S and Garcia-Serrano A. 2008. Food habits of wild boars (*Sus scrofa*) in a Mediterranean coastal wetland. Wetlands 28(1): 197-203.

A population of wild boars (*Sus scrofa*) became established during the 1990s in the Natural Park of Aiguamolls de l'Emporda, a wetland on the western coast of the Mediterranean Sea (Catalonia, Spain). Between 2001 and 2004, a culling program was conducted to reduce the boar population. We collected and analyzed the contents of 142 stomachs to characterize boar diets, estimate impacts on ground-nesting birds, especially threatened species, and determine the relationships between boars and agricultural areas-surrounding the park. The boar population consumed primarily plant material (94% by volume), particularly underground roots and rhizomes (33%). Agricultural (37%) and non-agricultural plants (49%)

comprised very similar proportions of the diet. The primary foods were alkali bulrush (*Scirpus maritimus*) (24% by volume, and in 47% of the stomachs) and corn (*Zea mais*) (19% by volume and in 29% of the stomachs). Animal matter represented only 5.6% of the diet by volume, but occurred in 84% of the stomachs. The most important animal foods were, by volume, birds (2.3%) and crayfish (*Procambarus clarkii*) (1.7%) and, by frequency, snails (44%) and terrestrial arthropods (47%). Wild boar diets shifted seasonally between agricultural plants in summer and non-agricultural plants and acorns (*Quercus* sp.) in winter. Consumption of animal matter varied seasonally, crayfish were consumed primarily from May to October, terrestrial arthropods in May and June, and birds from March to April and September to October. Birds, especially ducks, were consumed most frequently while moulting, when vulnerable to predation. Given the high frequency of birds in the diet and the extensive rooting for underground parts of plants, the wild boar population might pose a threat to the coastal wetland ecosystem of the Natural Park of Aiguamolls de l'Emporda if allowed to become overabundant.

Fonseca C. 2008. Winter habitat selection by wild boar *Sus scrofa* in southeastern Poland. European Journal of Wildlife Research 54(2): 361-366.

Research was conducted on habitat selection by the wild-boar population in the Carpathian foothills, southeastern Poland. In two forest districts (Bircza and Krasiczyn) with a total area of forests of 47,000 ha, 21 line transects were designated (total length, 284 km). In February 2001, tracks that wild boar left during the day were counted on five subsequent days. Using a car mileage meter and forest maps, the locations of tracks in seven forest types, forest meadows and agricultural fields situated inside the forests were determined. The Bailey's test was applied to calculate the boars' preference for each forest type and non-forest areas. Spatial distribution of 284 wild-boar tracks shows that the animals do indeed prefer European beech-hornbeam *Fagus silvatica-Carpinus betulus* forest and avoid silver fir *Abies alba* forest. The hypothesis raised is that in the European beech-hornbeam forests, there are foraging areas and bedding sites crucial for the animals.

Noirard C, le Berre M, Ramousse R and Lena JP. 2008. Seasonal variation of thermoregulatory behaviour in the Hippopotamus (*Hippopotamus amphibius*). Journal of Ethology 26(1): 191-193.

The hippopotamus (*Hippopotamus amphibius*) spends more than 12 h a day in the water. Hippos are often submitted to water temperatures that vary with the seasons. We hypothesize that this difference between cool and warm water temperatures leads to variations in behavioural thermoregulation. We recorded the exposure of hippos to sunshine at the beginning and at the end of the dry season. Our results show that (1) sunshine exposure lasted much longer in cool water and (2) sun-bathing occurred during the hottest hours. It is therefore likely that in cool water hippos were cold and expressed an original behaviour of search for heat.

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The newsletter of the IUCN/SSC Pigs, Peccaries and Hippos Specialist Group (previously Asian Wild Pig News)

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The IUCN/SSC Pigs, Peccaries and Hippos Specialist Group PPHSG is one of several Specialist Groups of the Species Survival Commission (SSC) developed by the IUCN to foster conservation, research and dissemination of information for species of conservation concern.

It consists of a group of technical experts focusing on the conservation and management of wild pigs, peccaries and hippos.

The broad aim of the PPHSG is to promote the long-term conservation of wild pigs, peccaries and hippos and, where possible, the recovery of their populations to viable levels.

Pigs, peccaries and hippopotamuses are non-ruminant ungulates belonging to the Suborder Suiformes of the Order Artiodactyla (the even-toed ungulates).
Within the Suborder Suiformes, pigs belong to the Family Suidae, peccaries to the Family Dicotylidae and hippopotamuses to the Family Hippopotamidae.

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