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Suiform Soundings

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Photo front page: Rafael Reyna (ecologist) and his wife Edith Rojas-Flores (DVM) working on a white-lipped peccary captured for radio-telemetry purposes in Calakmul, Campeche, Mexico.

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Editorial:

Welcome to this issue of Suiform Soundings, which I hope will keep you informed about the fascinating world of hippos, peccaries, and pigs. Although presented as the last issue of 2006, we have already reached 2007, which, according to the Chinese calendar, is the year of the pig. I am not an expert on Chinese astrology, so I am not sure whether his covers peccaries and hippos as well. As the astrology likely predates Chinese exploration of Africa and the New World, I guess they would have been unaware of the non-Asian species. But if they had been, I am sure they would included the other species in their calendar. Thus, I hope that we can make this a special year for those species that concern us. An important first step would be to arrange our first PPHSG meeting in many years, as is now scheduled to happen in Singapore.

This newsletter presents a first updated species action plan for the Sulawesi Warty Pig *Sus celebensis* and I look forward to other species updates in future issues. Also, several further contributions from our active Latin America group for which I am most grateful. I hope that all the information will help improve our conservation work on the threatened species in this group. Happy reading.

Erik Meijaard, Samarinda, Indonesia

Critical conservation crises: Hippos in Virunga National Park face extirpation

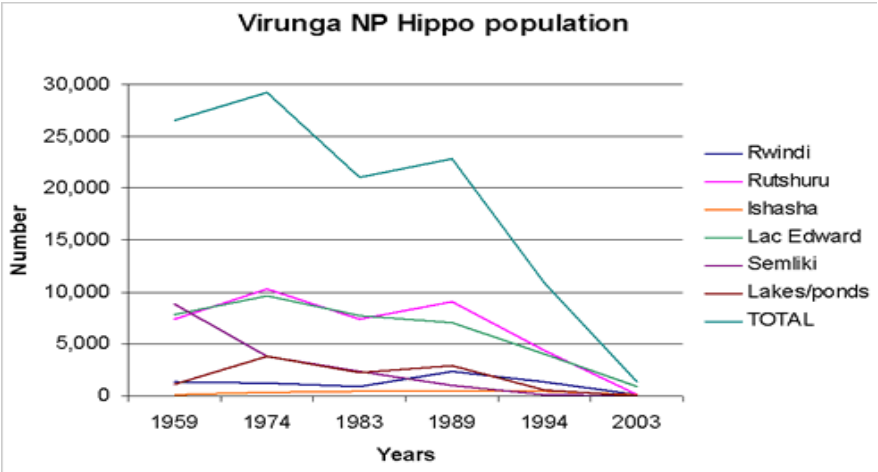
Rebecca Lewison. Coordinator of the Hippo Subgroup

One of the world's biggest population of common hippos (*H. amphibious*) has crashed by 95 percent in Africa's oldest national park. Less than 30 years ago, more than 29,000 hippos lazed in the rivers and rainforest backwaters of Virunga National Park in the Democratic Republic of Congo. Now, after a decade of civil war, there may be less than 400 remaining.

Based on a census and ongoing patrols conducted by the Congolese Institute for the Conservation of Nature (ICCN) and sponsored by the Zoological Society of London (ZSL), there is clear evidence that hunting by poachers for meat and teeth is decimating the population. ZSL conservationists have warned that hippos in the Park could be eradicated unless the culling stops.

The poaching has been particularly intense in recent months following the establishment of a base camp by the Congolese rebel militia, the Mai Mai, near Lake Edward, once home to tens of thousands of hippos. The Mai Mai militia is already thought to have killed half the remaining individuals of Lake Edward and surrounding areas. Lake Edward, in the centre of the Park, was once central to Africa's greatest concentration of these magnificent beasts.

Mai Mai fighters sell hippo meat and ivory, found in the hippo's canine teeth. The group has also attacked a number of conservation rangers and their families. Hippo meat is now being sold in local markets around Lake Edward for just 20 cents (about 15p) per kilo because the market is so overwhelmed. ICCN Rangers have been working to stop the slaughter, but the work is extremely dangerous. The rangers have been outmanned and outgunned by the militia, although a recent training program is improving their ability to protect the hippos and other wildlife populations. With fund-



ing from the EU, and strong support from the Frankfurt Zoological Society and Africa Conservation Fund, the ICCN's ranger force in Virunga is gaining teeth.

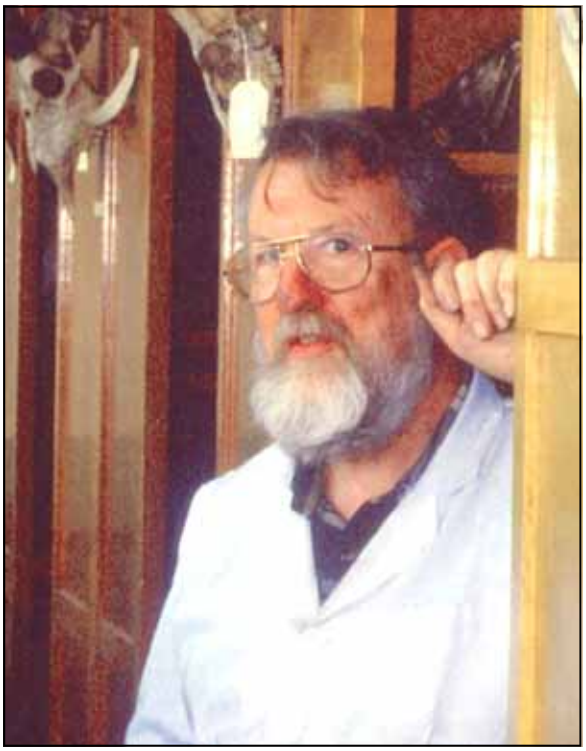
The drop in hippo populations presents a conservation crisis for hippos but has also been accompanied by a collapse of the fisheries in Lake Edward. Hippo dung helps to sustain the lake's fish and, in recent years, as the hippo numbers have declined, so the tilapia catches have plummeted in size and number, causing fishermen to target previously protected areas.

Although the situation in DRC is a dire case, it represents a similar trend that is happening, albeit much more slowly, in other African countries. Both civil unrest and agricultural and other development has threatened hippo habitat and increased the incidence of poaching and hippo-human conflicts.

Hippo conservation has gone under the radar of the conservation community for far too long. Unless there is a marked change in both attention to hippo conservation and funding for conservation programs, the hippos of Virunga NP could be a harbinger of things to come for hippos across the continent.

How you can help: If you are interested in contributing directly to protect Virunga Hippos, visit http://www.wildlifedirect.org/congo-rangers/?page_id=96. To support hippo conservation efforts across Africa, you can donate to the International Hippo Foundation, contact rlewison@sciences.sdsu.edu for more information.

Tribute to Peter Grubb



PETER GRUBB, one of the most eminent and admired mammalogists of the age, died of cancer on December 24th, 2006. He was 64.

Peter started his professional career as an ethologist; supervised by Peter Jewell, he did a three-year field study of Soay sheep in the 1960s for his PhD. A period teaching in the Zoology Department in the University of Ghana turned his interest more and more to the taxonomy and biogeography of African mammals, and it is for his vast and important contributions to this field that he is chiefly renowned.

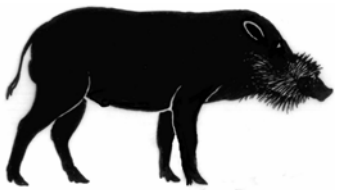
Readers of Suiform Soundings will be familiar with his work on the taxonomy of African suids, and indeed this serves as an example of his way of working and the way he achieved his insights. While at the University of Ghana, he met the palaeontologist-turned-ethologist R.F. "Griff" Ewer, who while studying the mammal remains from Late Pleistocene sites in South Africa had proposed that there were two species of warthog (*Phacochoerus*) represented, not just one as had been assumed. Peter decided to investigate this further, and his study of some of the "old literature" threw up hints that there might indeed be something in it. He therefore undertook a full-scale revision of warthog taxonomy: not only was Ewer vindicated, but both species had survived into modern times, one being still widespread and common, the other had become extinct in South Africa in early historic times but survives today… in Somalia! Only Peter could have pulled together disparate sources like this and followed up the leads with such perspicacity. He at once turned to the other African suids, which attracted his attention by the interesting biogeographic problems they posed: Giant Forest Hog (*Hylochoerus*) because of its wide distribution in the rainforest belt and its extension into isolated East African forest blocs, and Bushpig (*Potamochoerus*) because it has populations in both rainforest and savannah zones. He returned again and again to these themes (working on primates, duikers, bushbuck, elephants, squirrels and other mammals), and published several papers on African mammal biogeography which have achieved the status of standard works in the field.

Much of his work is still unpublished, and some of the rest (including his African suid work) has been published only in preliminary form. Actually, it is an amazing achievement to have published as much as he did, because most of his working life was spent as a schoolteacher. He returned from his fixed-term appointment in Ghana in the late 1960s at a very bad time academically: a flush of new graduates had grabbed all the available university posts in zoology in Britain and other English-speaking countries, and he took the position as biology teacher in a school in North London as a stop-gap, but found himself enjoying it and unwilling to leave. Essentially, therefore, his opportunities for research and writing were reduced to his spare time and occasional periods of leave.

As for myself, I am proud to have been his collaborator in many projects. We met too infrequently after I migrated to Australia, but every time we did so it was as if we were resuming yesterday's conversation: "we tired the sun with talking, and sent him down the sky". I will miss him dreadfully.

Colin Groves

Species Status Reviews



The Sulawesi Warty Pig (*Sus celebensis*), a status review

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Status and Action Plan Summary

1996 status category: Low Risk – least concern (Pigs & Peccaries Specialist Group, IUCN 1996).

2006 status category:

S. celebensis is a medium sized pig which is still found in abundance in central, east and south-east Sulawesi. It is now scarce in south and north-east Sulawesi and may be extinct on nearby Selayar Island; these areas have either been largely deforested or are under severe hunting pressure. It also occurs as a native form on the adjacent islands of Buton, Muna, Kabeana, Peleng, Lembeh and on some of the Togian Islands. The species has also been quite widely introduced elsewhere in Indonesia, e.g. to the islands of Flores, Timor, Lendu and Simeulue. The wild pigs on some of these islands are strongly modified and there is now little doubt that *S. celebensis* has been domesticated, and transported to these areas as a domestic or feral form, probably during the early migrations of settling peoples. It is still maintained as a domestic form on the islands of Roti and Savur, near Timor.

Although this species cannot be regarded as seriously threatened throughout its range at the present time, reported trends in population in specific areas, in the interceding 13 years since the last edition of this publication (1993), should be some cause for alarm. This observed patchy population decline due to severe hunting pressure is a warning that this could occur across the species range in the near future. Additionally, continued habitat destruction and genetic contamination through contact with *S. scrofa* domesticates represent potentially serious threats. For this reason, recommendations for future action are primarily directed towards control of trade in this species and elucidating outstanding questions about: a) future monitoring of the trade in hunted animals and assessment of population trend is required, combined with control of illegal hunting; b) the systematic status and future management needs of populations in certain specified areas within its original range and in locations to which it can only have been introduced by human agency; and c) promoting applied research on various aspects of its biology, its socio-economic significance to village and island societies and its potential importance as a genetic resource for further domestication.

A photo of a (presumed?) pure-bred male at Singapore Zoo (photographer unknown).

Introduction

Sulawesi warty pigs are medium sized, short-legged animals weighing between 40-70 kg. Recent forms are larger than the subfossil remains found in caves in southern Sulawesi (Hooijer 1950) and the Pleistocene specimen reported by Hooijer (1969). Adult boars are larger than sows, averaging 60 cm at the shoulder (National Research Council 1983). Adult animals are usually dark-haired, although some individuals are reddish-brown or yellowish in color, sometimes with lighter colored hairs on the trunk and abdomen Groves, 1981; Hardjasasmita, 1987). A clear yellow snout band is usually present, along with a distinctive tuft or 'crest' of longer hair on the crown of all but the oldest adults. Adult males have three pairs of facial warts: the preorbital pair is the largest, the infraorbital somewhat smaller and the mandibular warts emerging from a whorl of hair marking their position to enlarge and eventually dominate (in captive specimens at least).

A recent genetic study found that Sulawesi warty pigs are not monophyletic, instead they form two clades (Larson *et al.,* 2005). mtDNA sequences showed that these clades are distributed in a north-south pattern and contain high genetic diversity. This can be explained either by the occurrence of two colonization events onto Sulawesi, or the historic fragmentation of the island into at least two parts. Independent invasions by other species have been reported, including macaques (Evans *et al.,* 1999) and shrews (Ruedi *et al.*, 1998). Fragmentation of Sulawesi has been shown to have occurred from pollen records in at least two locations during the Late Pleistocene period (Fooden 1969).

Studies of Bosma *et al.* (1991) indicate that the Sulawesi warty pig, like the other Asian *Sus* spp., has a chromosome number of 38. However, there are significant differences in the banding of its Y chromosome when compared with either *S. scrofa* or *S. verrucosus*. The only anatomical study to date was of a female reproductive tract, which was found to be indistinguishable from that of *S. scrofa* (Macdonald *et al.,* 1984).

Former and Present Distribution

Available evidence suggests that the species formerly occurred throughout Sulawesi, as well as on the neighboring islands of Selayar, Buton, Muna, Kabeana, Peleng, Lembeh and the Togian Islands

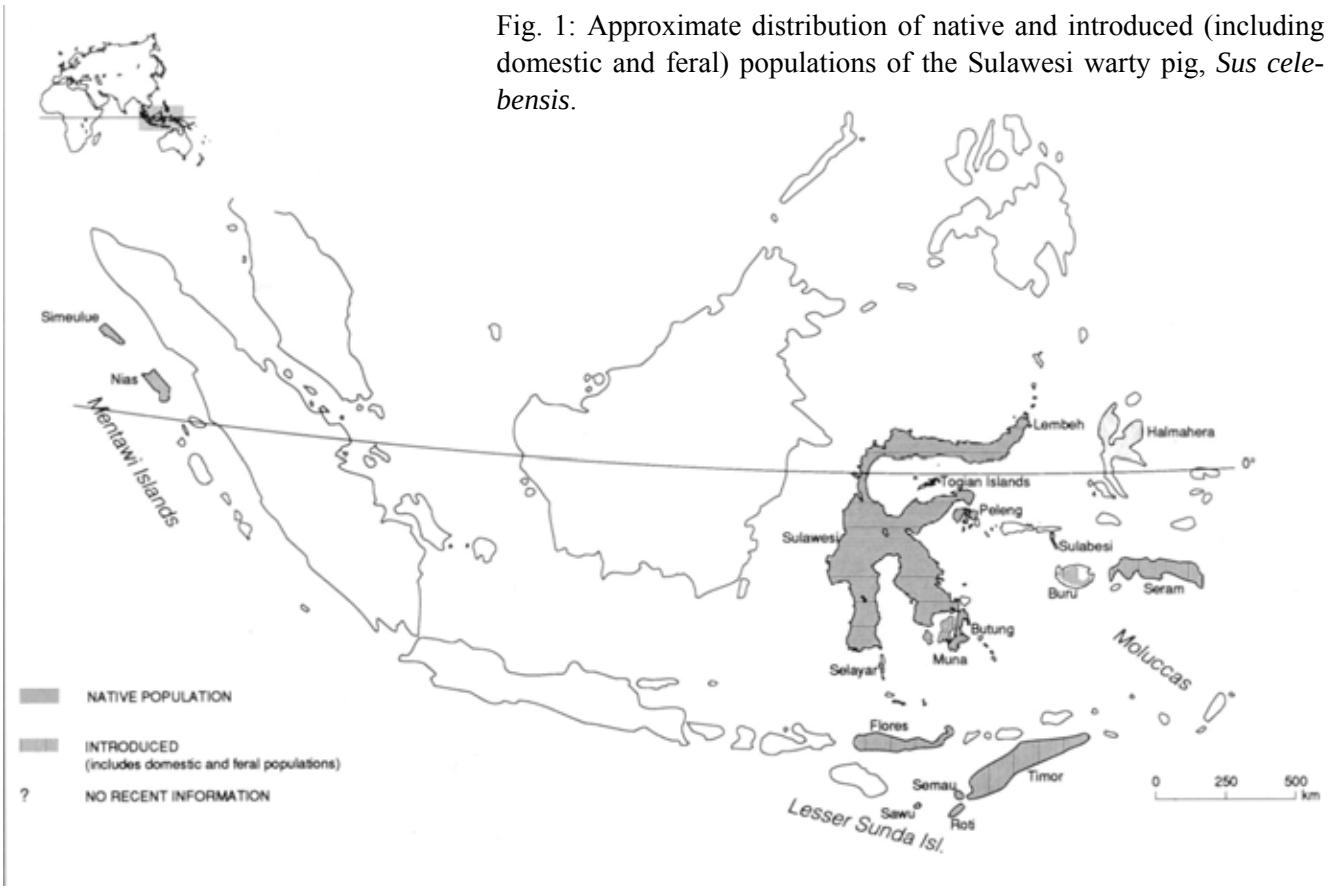

Fig. 1: Approximate distribution of native and introduced (including domestic and feral) populations of the Sulawesi warty pig, *Sus celebensis*.

(MacKinnon, 1981; Wiles *et al.,* 2002; Macdonald *et al.,* 2005). By the early 1980s it was reported that this species was extinct or greatly reduced in numbers in south-west Sulawesi, and on nearby Selayar, following the virtual deforestation of these areas (MacKinnon, 1981).

A recent island wide survey found a striking pattern of a patchy species' distribution throughout Sulawesi Island. There were no records of pigs in three areas in the north east peninsula, and low densities in the central region of the island. Populations in both these regions appear to have been affected by demand for pig meat in Minahasa and Palu areas, respectively. While the south-east area had the highest population densities, the demand for pig meat locally was lowest. Densities ranged from 0.4-2.0 animals per km^2 (Panua Nature Reserve) in the north peninsula to 5.1-14.5 animals per km^2 (Tanjung Peropa Nature Reserve) in the south-east peninsula (Riley, 2002). This data highlights the increasing pressure from hunting on the pigs of Sulawesi, as reported elsewhere Clayton *et al.,* 1997; Clayton *et al.,* 2000; Lee *et al.,* 2005).

Wild pigs from Halmahera, previously referred to as feral *S. celebensis,* have been shown to have greater genetic affinity to the New Guinea pigs. mtDNA sequences showed that the New Guinea pigs had haplotypes that clustered with pigs from Halmahera, Hawaii and Vanuwatu and were found in the "Pacific clade" (Larson *et al.,* 2005). This rules out a significant *Sus celebensis* maternal input as previously proposed (Groves 1981). Feral *S. celebensis* reported from Flores, Timor, Lendu and Simeulue and Nias islands (Groves 1981) need to be reassessed.

The genetic study also brings into question other classifications described here and shows the complexity of the structure of the South-East Asian pigs. Domesticated animals of *S. celebensis* derivation were reported from the islands of Roti and Sawu (Groves, 1983; Bell, 1987). Hybridized forms of *S. celebensis* with other introduced pigs of *S. scrofa* derivation were reported to survive on a number of islands in this region, including Salawatti, Great Kei Island, Dobu, Seram, Ambon, Bacan, Ternate, Morotai and New Guinea (Groves 1981, 1983; Oliver and Brisbin, 1993.). All these forms on islands distant from Sulawesi are thought to have been transported by man either as a domesticate or as a barely modified wild form which was released to be hunted whenever required for eating.

Habitat, Ecology and Behavior

Sulawesi warty pigs are reported to occur in a wide variety of habitats, ranging from rainforest and swamp, to open grasslands and agricultural areas, and at all altitudes up to moss forest (>2,500 m) (MacKinnon, 1981). They usually live in groups, but the social composition of these groups is not known (Macdonald, 1991). They forage during the day, this activity being concentrated in the early morning and evening. Their diet is very varied; they will eat roots, fallen fruit (Corypha sp., *Arenga pinnata*, Ficus sp.) leaves and young shoots, invertebrates, small vertebrates and carrion (National Research Council, 1983; Mustari, 2005). They have been reported to visit a 'salt-lick' in North Sulawesi on occasion. Males were observed wallowing and potentially scent marking by rubbing the side of their heads vigorously against the bank (Macdonald *et al.* 1996).

The pregnant sow reported from south Sulawesi by Sody (1941) was probably mated in February. Birth can occur at any time throughout the year but sows usually have their young in April or May (National Research Council, 1983). Gestation length is not known for certain, and the suggestion that it may lie between 16 and 20 weeks should be treated with the caution implied by Sody (1941). Farrowing sows give birth in nests made of grasses, leaves, branches and twigs, piled over a shallow excavation of approximately 2 m

Left and below. *Sus celebensis* is among the more commonly hunted species in Sulawesi.

in length. Litter size ranges from 2-8 (National research Council, 1983), but a recent study in North Sulawesi found 6 pregnant sows killed by hunters to be carrying only 1-3 fetuses with a mean of only 2.17 fetuses per pregnancy (Budiarso *et al*., 1991). The young are striped along the length of their bodies but lose these markings as they get older (Appelman, 1955; National Research Council, 1983; and pers. obs.).

Threats to Survival

S. celebensis does not have any important natural predators on Sulawesi and its offshore islands. Changing land use and hunting pressure have caused a reduction in their former range. This pig species is not considered threatened over much of its range at the present time. However, wide scale deforestation for timber and conversion of land for agriculture, coupled with human population expansion and immigration have resulted in a marked contraction of its range in some places.

In addition, resources are insufficient to enforce controls on hunting, and there are reports that subsistence and/or organized commercial hunting is continuing even within designated reserves and national parks (Smiet, 1982; Blouch, 1990). In north Sulawesi, the Minahasa people consider wild pig meat to be superior to domestic pork, and are willing to pay 20% to 50% more for it. The high volume of trade in this species raises concerns about the sustainability of this current harvesting rate. Completion of the Trans-Sulawesi Highway (1980) probably increased importation of wildlife within and into North Sulawesi from the rest of the island. Data was recently collected from market surveys from north-east Sulawesi and road blocks on the Trans-Sulawesi Highway (Lee *et al.,* 2005). In the study it was noted that 'trade in the Sulawesi pig is alarmingly high for such a large-bodied animal'. They observed an average of ~8 individuals per hour during road blockades (29.6% of 6963 wild animals recorded). Warty pigs also accounted for 7% of all market encounters. What may be more alarming for the future of this species is the discovery that commercial hunting now encompasses the whole region. For example, 250 pigs found in a single truck were transported from Buton Island (1270 km away), in south-east Sulawesi. Of the total number of pigs recorded during road blockades in north-east Sulawesi 36.8% were reported to have come from central Sulawesi and 11.4% from south-east Sulawesi (Lee *et al.,* 2005).

A model was used to predict the effect of hunting levels and the cost effectiveness of this trade for Sulawesi pigs. The likely outcome of trade in the warty pig is that the population will stabalise at around 37% of the unexploited size (Clayton *et al.,* 2000). It remains unclear if these small isolated populations will be of sufficient size to maintain their genetic viability in the long-term.

The expansion of human settlements also brings an increased threat of genetic contamination and/

Sus celebensis hunting trophees in N Sulawesi. Photo by Dick Watling (1970s)

or disease to the wild pig populations through the importation of 'improved' (ex-*S. scrofa*) domesticates, and the carriage of these animals from coastal communities to villages in the interior.

Future threats will include the loss of this species high genetic diversity through the decline into small isolated populations. The estimated requirement is 7000 adult vertebrate individuals are protected to ensure 99% probability of persistence for the 'long-term' or 40 generations (Reed *et al.* 2003). Loss of genetic diversity could lead to a reduced potential for adaptation to such factors as future human induced habitat change and the effects of climate change on Sulawesi's habitat.

Conservation Measures Taken

Sulawesi warty pigs are known or are likely to occur in all of the principal national parks, nature and game reserves, except those in north-east and south-west of Sulawesi. Those where significant populations of warty pigs are found include Lore Lindu (2,310 km^2), Bogani Nani-Wartabone (2,871 km^2), Morowali (2,250 km^2), Rawa Aopa Watumohai (968 km^2) and many other smaller sites. Within all of these areas the species is technically fully protected by law, though it is certainly hunted in some of these areas (Setyodirwiryo, 1959; pers. obs.). Recently reports have increased our knowledge on the distribution and numbers of *S. celebensis* on Sulawesi and neighboring islands (Avalard 2000; Riley 2000). This has shown that pig densities have declined in areas of high hunting pressure such as Lore Lindu and Bogani Nani-Wartabone National Parks (Riley 2000).

A Wildlife Crimes Unit Program was developed for wildlife trade monitoring and law enforcement in North Sulawesi. This has been active since 2001, however overall trade in wild mammals has increased by 30% during this time, mainly from unprotected species (Lee *et al.*, 2005). This Unit cannot control the levels of trade in the warty pig because hunting of this species is not prohibited outside of protected areas.

Captive Breeding

The species has only very rarely been kept in captivity outside its country of origin; and, as far as is known, pure-bred animals have never been produced in captivity. Unfortunately, only the male of the pair acquired by the Singapore zoo about ten years ago appears to have been pure *S. celebensis*, and although these animals have produced several litters, various domestic traits (including piebald markings and curled tails) are evident in their progeny.

At present there seem to be no other individuals of this species held in zoological collections elsewhere, though wild-caught piglets are kept by villagers in Sulawesi. These animals are usually raised to slaughter weight and eaten or sold in local markets (Blouch, 1990). Longevity is not known in the wild population, but in captivity, animals have lived longer than 9 years.

Additional Remarks

Sulawesi and associated islands comprise the larger (southern) section of the Wallacian subregion, which also includes the eastern Philippines. Sanborn (1952) included the wild pigs of the eastern Philippines with *S. celebensis*. This treatment was followed by various authors (e.g. Sinha, 1982; and Catibog-Sinha, 1985), but

strongly refuted by Groves (1981) and Groves *et al.* (1993) who demonstrated that these animals were more closely related to the (Sundaic) *S. barbatus*. More recently Principal Components Analysis and Discriminant Analysis of skull measurements clustered *S. celebensis* with *S. philippensis* and *S. cebifrons* from the Philippines (Lucchini *et al.,* 2005). From this study and that of Groves (1997) it was proposed that these species are primitive forms and have a relict distribution. *S. celebensis* is thought to have separated from an ancestral species that inhabited Sunderland. Analysis of mtDNA found that *S. celebensis* had a greater maternal affinity to Borneon pigs than those from New Guinea (Larson *et al.,* 2005). However, pigs from the Philippines were not included in the genetic study to allow comparison. Further investigation of their affinities is warranted.

The identification of two mtDNA clades within *S. celebensis* may lend support to the proposed cline in body size on Sulawesi from north (smallest) to south (largest) (Groves *et al.,* 1993). The genetic clades were defined as being distributed in north and south regions (Larson *et al.,* 2005). Three skulls from Latimojong Mountains in South Sulawesi were reported to be of relatively small size for the region, suggesting that they represented a distinct form (Groves, 1981). The current classification of a monotypic species by Groves (1981) may warrant further genetic investigation.

Conservation Measures Proposed: An Action Plan

S. celebensis is of particular interest in that it is the only pig species, apart from *S. scrofa*, which has been domesticated and quite widely transported by human agency outside its original range. Also of interest is the fact that it has higher mtDNA sequence variation than wild *S. scrofa, S. barbatus* and *S. verrucosus* (Larson *et al.*, 2005). The available evidence indicates that it is still maintained as a domesticate in some areas, but its commercial importance and future potential as a genetic resource are virtually unknown. Detailed studies of its ecology, behaviour, physiology and regional genetic variation have yet to be undertaken, and although its apparently large population size suggests it is not seriously threatened at present, the small amount of available data is mostly anecdotal. The increasing interest in the renewable resources of this region should include studies of these animals, which have long been of great economic importance to the local people.

Sus celebensis in North Sulawesi. Photo by Tetsuo Taguchi (source: http://www6.plala.or.jp/ttaguphoto/babirusa.html)

Objectives

1. To investigate its regional genetic variation with particular reference to the identification (and, if necessary, the protection) of any possibly distinct forms, and also study its affinities to other Asian warty pigs and the origins and relationships of surviving domestic and feral populations.

2. To promote field studies relevant to an enhanced understanding of the biology and future management of this poorly known species.

3. To conduct studies of its socio-economic significance amongst societies of different ethnic origin and investigate the species potential as a genetic resource for further domestication and development.

Priority Projects:

1. Conduct genetic studies to determine if there is any genetic structure in the population of Sulawesi Warty Pig.

This could have been caused either by historical biogeographic factors, colonisation or more recent human impact. This has implications for determining conservation management units of this species. Secondly, genetic studies should be used to determine the level and locations of hybridization of

Sus celebensis in SE Sulawesi. Photo by Tetsuo Taguchi. (source: http://www6.plala.or.jp/ttaguphoto/babirusa.html)

the Sulawesi Warty Pig and the feral pig *Sus scrofa.* This will allow the identification of pure populations and where control of feral *S. scrofa* may be required. In addition, some of these domesticated Sulawesi warty pig populations on islands are likely to be of some potential genetic importance for the production of improved breeds, and efforts may need to be made to preserve some pure-bred stocks

2. Conduct status surveys in selected areas within its original known range.

Although detailed, island-wide surveys would be impractical and possibly unjustified on the basis of the present known status of this species, there is a need to assess, or reassess, its conservation and taxonomic status in certain areas. These surveys should include the Latimojong Mountains and elsewhere in south Sulawesi, and on Selayar and other offshore islands where the species is known to have occurred. Surveys to determine the pressure caused by hunting are important as these will assist in modeling the population trend.

3. Conduct surveys in selected areas where the species is known or believed likely to have been introduced.

Efforts should be made to establish the present status, human utilisation and affinities of the various introduced wild (i.e. unmodified), feral or domestic *S. celebensis* populations in the Mollucas, Lesser Sunda Islands and the west Sumatran islands of Simeulue and Nias (Oliver and Brisbin, this vol.). These studies are of considerable anthropological interest, and can be expected to throw light on the origins and affinities of these animals (and hence also the people who introduced them), as well as the history and process of animal domestication.

4. Promote studies of the biology of this species, with particular reference to its behaviour and ecology.

Very little is known about the natural history of *S. celebensis*, despite its evident importance as a basic economic resource to a number of island and village societies. Only recently has information about behavioral ecology and diet been researched, but detailed studies of its reproductive biology, parasites and diseases have never been published. Such studies should also investigate hunting pressures and practices, and the relative densities of these animals in intact and degraded habitats, with a view to assessing the impact of logging and other sources of disturbance on their populations.

5. Promote the establishment of captive breeding programmes for this species.

Although this species is not considered threatened at the present time, captive breeding should be considered for several reasons: to stimulate local interest in the species and its anthropological significance; to facilitate an understanding of its biology; and to assist the development of management techniques which may be of value to the commercial husbandry of the species.

Sus celebensis on Buton Island. Photo by Tetsuo Taguchi. (source: http://www6.plala.or.jp/ttaguphoto/babirusa.html)

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Pygmy Hog Conservation Programme—an update

Goutam Narayan. Coordinator Pygmy Hog Conservation Programme

As mentioned in our earlier reports, the conservation breeding programme for the critically threatened pygmy hog (*Sus salvanius*) in the north-eastern Indian state of Assam has been a phenomenal success. Despite the success in establishing a safety-net population by 2001, the fact remained that the global population of the species was divided only between Manas, where the future of the last wild population is insecure due to unscientific habitat management and poor protection, and Basistha, where a single catastrophe can wipe out the entire captive stock. In order to release the captive-bred hogs in the wild, a large pre-release facility where these hogs could be prepared for life in the wild, was needed. Political insecurity in Assam and lack of funds had prevented progress in the past, but now the situation has stabilised and release plans are being put on track.

A couple of reintroduction sites in Assam have been shortlisted and it was decided to release the first animals in the grasslands of Sonai Rupai Wildlife Sanctuary. The protection staff at Sonai-Rupai was more enthusiastic than their counterpart in Manas in implementing the scientific recommendations. Improved protection and controlled early burning of grass had started showing the positive results and habitat appeared better than what it was a couple of years ago. Unfortunately, the focus of the staff has recently shifted to protect wooded areas of the sanctuary from illegal encroachers who are encouraged by some local vote-seeking politicians to destroy the forests and settle down.

The pre-release centre is being established at Potasali near Nameri National Park on a large plot of land allotted by the Assam Forest Department (AFD). Besides the main supporter and collaborator, Durrell Wildlife Conservation Trust, grants for establishment of the pre-release centre have been received from Munich based Zoological Society for Conservation of Species and Populations (ZGAP), and an American donor, Joe Mayo, who incidentally had carried out pygmy hog surveys in Nepal in the1960s and had worked for CBSG. A grant from the Darwin Initiative too will help in pre-release and reintroduction exercise.

A first batch of hogs have already been shifted from Basistha to the Potasali holding enclosures. A part of the holding unit is being used to display the hogs to visitors and local villagers for awareness generation. The pre-release enclosures are nearing completion and these would remain out of bounds for everyone. Here the hogs selected for release in the wild would be kept in small social groups and managed without direct human contact to equip them to survive in the wild. Hogs shifted to simulated wild habitat in Potasali have become considerably shy and wild.

Four large pre-release enclosures have been planted with grass brought from the wild and the

Sow of *Sus salvanius* with neonate litter. Basistha, India. Photo by Goutam Narayan.

Breeding pens (left) & project house (right), Basistha Centre. Photo by Goutam Narayan.

entire area has been enclosed in an elephant proof electric fence. It has magically transformed into a natural tall grassland protected from villagers, livestock, and wild elephants.

The field studies on impact of different levels of management on grassland bio-diversity in the Bansbari grasslands of Manas National Park demonstrated that frequent dry season burning, livestock grazing and organised thatch grass collection reduces natural floral and faunal diversity in the grasslands. This adversely affects sensitive grassland specialists, such as the pygmy hog, hispid hare and Bengal florican, more than the less sensitive species not dependant on the alluvial grassland. Some other grassland fauna, such as ground nesting birds, reptiles, amphibians and invertebrates suffer from worse consequences. The burning is usually carried out by the protection staff or the local villagers to clear the habitat of dry grass to encourage growth of fresh grass that is believed to benefit large herbivores, livestock and some commercially important variety of thatch grass.

Extension activities of the programme are being carried out to spread awareness among different stakeholders in Assam. The local implementing partner of the programme in Assam, EcoSystems-India, was instrumental in formation of Manas Conservation Alliance, a partnership of several local NGOs including Aaranyak, Centre for Environment Education -Northeast, WWF-India, Wildlife Trust of India, Dolphin Foundation, and a number of grassroots organisations, to work for better protection and conservation of wild habitat in Manas through peoples participation.

Resting subadult group in Basistha. Photo by William Oliver.

Papers and communications

Chemical characterization of soils from natural licks used by peccaries in the northeastern Pantanal of Mato Grosso, Brazil

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Introduction

A wide variety of hypotheses have been proposed to animal behavior known as geophagy, and many involve the nature and properties of soils from natural licks (Jones & Hanson, 1985; Wilson, 2003). The most common explanation for geophagy is mineral supplementation, detoxification of secondary plant compounds, and treatment of acidosis and diarrhea (Kreulen, 1985; Abrahams, 1999; Gilardi *et al.,* 1999; Holdo *et al.,* 2002; Mahaney & Krishnamani, 2003). Often the soil intake is selective, concerning the exploitation of specific sites and sometimes even particular soil horizons. Such places provide calcium, iron, phosphorus and zinc among other elements required for bone, muscle and other growth in wildlife.

In this paper we present the mineral features associated with 8 natural lick sites used by peccaries in the northeastern part of the Pantanal Wetland, Mato Grosso, Brazil. The area is included in the Private Natural Heritage Reserve (PNHR SESC Pantanal) surrounded by the Cuiaba and São Lourenço rivers (Oliveira et al., 2005). Soil characteristics range from sandy to sandy-clay, with iron concentration on flooded plain terrain. Most of the reserve is covered by a mosaic of savanna physiognomy with dominance of *acuri* palms, *Scheelea phalerata* (Mart.) Bur. (ARECACEAE) (Cordeiro et al. 2006).

Methods

Samples from eight natural licks (Acauã, Catraca, Clementino, Farofa, Figueira, Morcegos, Novateiro, Sal) were collected from top to bottom along a vertical profile up to 1.00 meter depth, during low water season (August 2004). The soils at each of these licks had visual signs of scratching (Fig. 1) and, at some locations, peccaries had actually excavated caves. The soils tended to vary from lighter to darker color than those at nearby sites.

Following collection, the samples were kept in plastic bags. Concentrations of Ca, Cl, Cu, Fe, K, Mg, Mn, Na, S, SO_4 and Zn in extracts were determined by atomic absorption and emission spectrophotometry (APHA, 1999). Through a relative use index (RUI) data from camera traps, direct observations and tracks were analyzed separately to describe the use of natural licks by wildlife species (Coelho, 2006).

Figure 1. White-lipped peccaries in Morcegos lick during low water season. Northeastern Pantanal, Brasil.

Results

The soil profile, when described in its entirety, may be expected to yield important information on the consumed material by peccaries. Numerous animal teeth marks on the carved holes were present, and were accessed by clear animal paths. Peccaries are very abundant in the Reserve, and even though they use the licks, they do it with different frequency according to the lick (Coelho, 2006). Data indicate that even though peccaries use licks according to their needs, white-lipped peccaries (*Tayassu pecari*) visit most frequently the licks as compared to collared peccary (*Pecari tajacu*). During low water season rates of occurrences were higher for white-lipped peccaries in the Morcegos (RUI=52.29), Clementino (RUI=27.7) and Catraca (RUI=19.24) (Coelho, 2006). Although peccaries do not discriminate natural licks as a whole, for some reasons collared peccaries were not registered in the Clementino lick as well as white-lipped peccaries were not found at Figueira lick. Since the eight licks studied in the Reserve showed a higher concentration of several elements, it is possible for animals to exploit them according to their needs.

The majority of studies have pointed sodium to be the element attractive to animals. Although some of the natural lick sites along a vertical profile did not present high sodium concentrations, other elements than sodium were found in higher concentrations in such licks. The analysis of the eight lick soils known to occur within SESC Reserve illustrates this (Table 1). In some sites, lick soils had high content of sulfur, sulphate, calcium, magnesium and potassium. Concentration of iron was always very high.

Sodium mean concentrations were higher in the soil profiles of Acauã and Catraca licks as compared to the others (Figure 2). Besides this, Clementino lick showed a wide range of sodium concentration (from 3000 to 28600 ppm) in the soil profile. White-lipped peccaries dominate these salt lick areas during low water season.

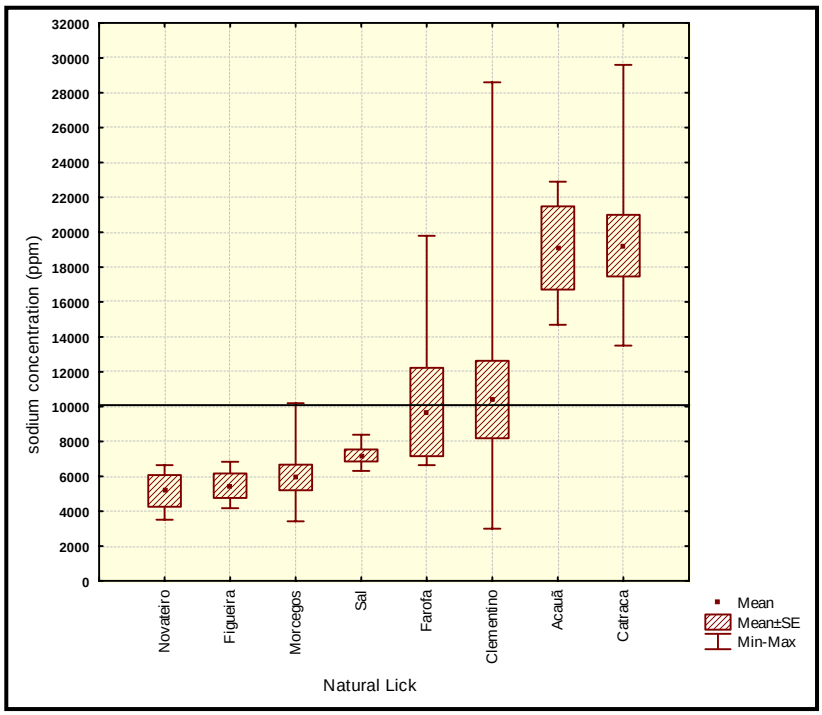

Figure 2. Sodium concentrations in soils profiles from eight natural licks in the northeastern Pantanal during low water season. Horizontal line denotes mean sodium concentration between licks.

	Na	K	Ca	Mg	Mn	S	SO4	Fe	Cu	Zn
Acauã	19100	11967	296	215	280	13	3800	19400	13	46
Catraca	19233	22778	171	371	607	29	5822	24989	12	42
Clementino	10409	37536	822	695	368	539	1607	24387	12	39
Farofa	9694	11740	536	122	549	3312	2664	27260	18	58
Figueira	5467	13050	314	98	234	100	1224	24290	12	42
Morcegos	5938	11904	309	477	588	186	1216	24630	10	44
Novateiro	5167	11600	652	817	558	17	2150	23467	10	39
Sal	7196	12460	542	124	433	46	1338	29120	12	45

Table 1. Mean element concentrations in soil profiles from eight natural licks in the northeastern Pantanal during low water season. Values are given in ppm.

These soils differ in a number of element concentrations, not only from the topsoils to the consumed horizon, but also among them to the extent that no single characteristic considered in this study can explain lick use. The reason for using licks by peccaries is not yet apparent.

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The population density to stock collared peccary (*Tayassu tajacu*) in semi-captivity: a preliminary study

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Key words: wildlife farming, environment, captivity, animal welfare.

Abstract

The collared peccary (*Tayassu tajacu*) is a social species that lives in herds comprised of individuals of both sexes and different ages. In natural conditions these social units are stable and peaceful. In captivity, however, some deadly fights and infanticides have been registered when unacquainted animals are placed together. The objectives of this study were to evaluate two densities to stock this species in semi-captivity, and to obtain information to reduce fights and attacks to offspring. Social interactions of two herds of collared peccaries maintained in two experimental densities – one individual per 125 m^2, and one individual per 250 m^2, in paddocks of 2,500 m^2 were observed. Two males and eight females composed one of these groups and four males and 16 females the other one. Both herds were composed of individuals obtained from three different sources. Daily, in the early morning, the paddocks were checked in order to count the animals, record the births and identify the mothers. After the animals were fed all occurrences of the head-to-head squabble, an agonistic behavior pattern, were registered in two hour observation sessions in a random schedule of data collection, over a three-month period. Also, during the observation sessions, we recorded in a data sheet every 10 minutes, the individuals that were feeding together. The frequencies of these social interactions were compared through chi-square methods. The sex and the source of the individuals, affected the agonistic and friendly interactions in both population densities studied. In both densities there were no deadly fights, but in the higher density there was a suggestion of a social organization rupture. Additionally, we recorded a total of 31 births in both densities and, only in the higher density, we registered infanticides. Therefore, we proposed the density of one individual per 250 m^2 in paddocks with visual barriers, like the sub-forest vegetation in this study, to breed collared peccary in semi-captivity.

Introduction

The collared peccary (*Tayassu tajacu*) is a pig-like animal ranging throughout almost the whole American continent (Sowls, 1997). This species is observed in habitats as diverse as semi-arid deserts and tropical rainforests. In Neotropical areas, the harvest of peccaries for meat and hides is widespread and overexploitation may become a threat to their natural populations (Bodmer et al., 1994). Therefore, it is necessary to experiment with new methods to exploit these species sustainably to prevent depletion of the resources (Nogueira-Filho and Lavorenti, 1997).

Captive breeding is an option that has not been explored sufficiently, despite being repeatedly quoted in the literature (Sowls, 1997). A few trials have been undertaken or are underway in research centers and some Brazilian rural producers have tamed peccaries for production of meat and leather (Nogueira-Filho, 1999). In this context, in order to settle husbandry practices that match adequately with the animal welfare requirements, behavioral studies are necessary. Mainly because peccaries are social animals that live in herds with up to 50 individuals in tropical forests, comprised of individuals of both sex and

	Larger Density		Lower Density	
Source[1]	Males	Females	Males	Females
ESALQ	2	11	1	5
Zoo-Ilha Solteira	-	3	1	3
Zoo-Paulínea	2*	2	-	-
Total	4	16	2	8

Table 1. Original group composition of the paddocks.

*An intruder white-lipped peccary killed one of these males at the end of the habituation period.

[1]Animal sources: ESALQ – animals that were born at the Departamento de Produção Animal of the Escola Superior de Agricultura "Luiz de Queiroz" of the Universidade de São Paulo; Zoo-Ilha Solteira, animals that were born at the Parque Zoológico de Ilha Solteira of the Centrais Elétricas de São Paulo; and Zoo-Paulínea, peccaries that were born at the Parque Zoológico Municipal de Paulínea.

different ages (Castellanos, 1983; Sowls, 1997; Fragoso, 1999).

The collared peccaries herds are stable and peaceful (Byers and Beckoff, 1981). Some times in captivity, however, some deadly fights and infanticides are registered when unacquainted animals are placed together (Lochmiller and Grant, 1982; Sowls, 1984; Packard et al., 1990; Nogueira-Filho and Lavorenti, 1997). Therefore, the objectives of this study are the evaluation of two densities to stock this species in semi-captivity, and to obtain information to avoid or reduce fights and attacks against the offspring.

Methods

Animals and housing

We selected randomly 30 (6 males and 24 females) adult captive born collared peccaries (*Tayassu tajacu*), obtained from three different sources, in order to establish two experimental densities – one individual per 125 m^2, and one individual per 250 m^2. Two males and eight females comprised one of these groups and four males and 16 females the other one (Table 1).

Each group was introduced in one of two non-adjacent 2,500 m^2 paddocks with Pinus-trees (*Pinus eliotti*) and natural sub-forest vegetation, surrounded by an 1.0 m high mesh wire fence, at the Departamento de Produção Animal of the Escola Superior de Agricultura "Luiz de Queiroz" of the Universidade de São Paulo. Inside each one of the paddocks there was a bait station, of 100 m^2, with a 0.5 m^2 drinker (0.3 x 0.3 x 0.2 m). Inside and outside the 100 m^2 bait stations there were several feeders (1.0 x 0.2 x 0.3 m) allowing an entire 0.3-m^2 feeder surface per individual in each paddock.

Unfortunately, at the end of the habituation period, described later, a Pinus-tree came down over the fence that divided the 20-peccaries paddock with another paddock where a white-lipped peccaries (*Tayassu pecari*) herd lived. At this time, an intruder white-lipped peccary male, that occupied the adjacent paddock, killed a collared peccary male (Table 1). In consequence, this experimental group was decreased to 19 individuals (three males and 16 females).

Experimental procedures

Before introducing them in the paddocks the animals were weighed and marked with plastic ear tags, the males in the right ear and the females in the left one. We used also different colors for each animal source. Individual identification was also possible by ear tag clutch mark code.

The caretaker fed the animals in the morning, at 1000 h with an experimental diet composed of grain corn, soybean meal, grass hay and mineral salts, with 14% crude protein and 3.5 kcal/g of crude energy. This diet was furnished at 3.5% of live weight on dry matter basis. The experimental diet was composed according to peccary nutrient

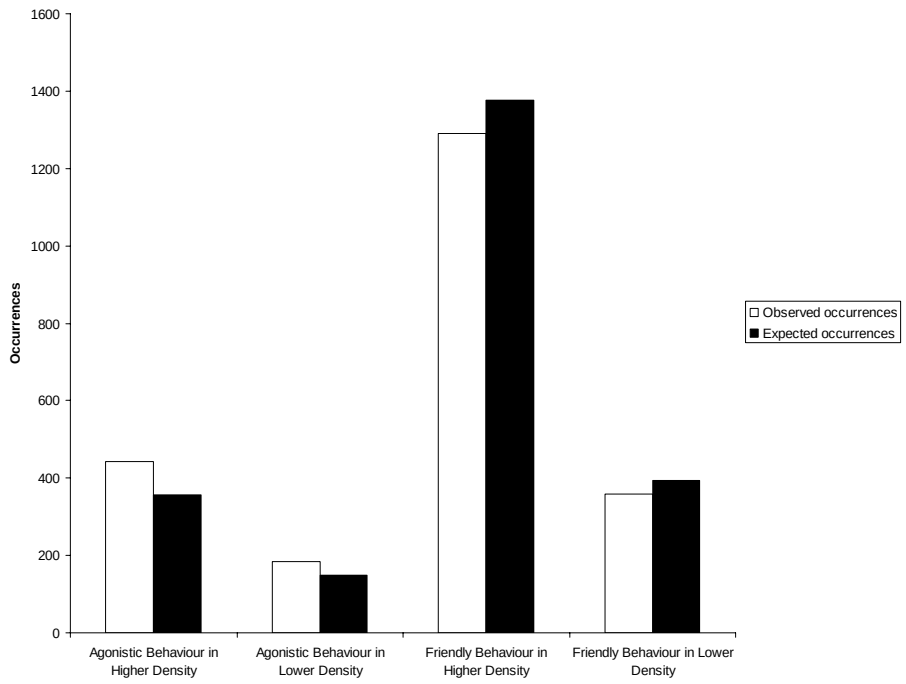

Figure 1. Observed and expected occurrences of agonistic and friendly interactions among peccaries maintained in the lower and higher densities paddocks.

requirements (Galagher et al., 1984) and roughage tolerance (Nogueira-Filho and Lavorenti, 1997). The animals had free access to water.

Daily, in the early morning, the paddocks were checked in order to count the animals, to register the births and, when it was possible, to identify the mothers or, at least, its source according ear tag color. Additionally, we verified eventual infanticides or disappear of infants. These data were registered in data-sheets during a nine months period.

Observations and data analysis

We collected 20-hours of data using the ad libitum method (Altmann, 1974) while running a 60-day habituation period. Subsequently we selected the observation methods, the patterns of behaviour to analyze and the best time to data collection.

During the experimental period, the animals were fed daily with only one meal at 10:00 AM. Immediately after that, we began the data collection in two hour observations sessions. Each group was observed during a total of 26 hours in a random schedule of data collection, totaling 52 hours over a three-month period.

Observations were made from a position in front of the paddocks, and the data collection was carried out using both the all occurrences procedure and the scan sample method (Altmann, 1974).

We registered all occurrences of the head-to-head squabble, an agonistic behavior pattern originally described by Sowls (1984): "...in this action, two animals faced each others in a sparring position, tooth chattering by both animals accompanied the action".

Through the scan sampling data collection we registered in a datasheet, every 10 minutes, the individuals that were feeding together in the same feeder. This friendly interaction, named feeding side by side and originally described by Byers and Beckoff (1981) as: "...one animal approached another feeding individual, and fed from the same food source, its mouth touching or almost touching that of the other". The objective of this sampling was to compare the occurrences (number of times) that each animal, according to its sex and source, was observed feeding side by side with the others.

The occurrences of the social interactions, head-to-head squabble and feeding side by side were compared separately, according to the sex and the sources of the individuals, by a modified chi-square method described by Altmann and Altmann (1977). This method was chosen because it allows to determine the expected frequencies even if there is only one individual in each selected category.

These frequencies were also compared together, again according to the sex and the sources of the individuals, and according the experimental density (higher vs. lower), by the usual chi-square analysis described by Siegel (1975), because, in this case, there was no restriction to use this method.

Results

When we compared the social interactions frequencies between the experimental densities we registered 1.2 times more agonistic interactions per individual among the peccaries maintained in the higher density than in the lower density (Figure 1). There were more agonistic and less friendly actions than the expected in both densities (X^2=14.54, p = 0.0001).

The null hypothesis that the sex and source of the animals did not interfere in the occurrence of the agonistic behaviour was rejected in both densities. There were more fights among individuals of the same sex and that were from different sources [X^2= 239.24, *p*= 0.005, for the lower density (Fig. 2a) and X^2 = 85.92, *p*= 0.005, for the higher density (Fig. 2b)]. Furthermore, the null hypothesis that the sex and source of the animals did not interfere with the occurrence of the friendly act was also rejected in both densities. Females sharing the same source, were observed feeding together in the same feeder in a higher frequency than other individuals, with independence of its sex, and the fact of being from different sources [X^2 = 110.04, *p* = 0.005, for the lower density (Fig. 3a) and X^2 = 118.17, *p*= 0.005, for the higher density (Fig. 3b)].

We also analyzed simultaneously the frequencies of agonistic and friendly interactions according to the sex (Figs. 4a and 4b) and the sources (Figs. 5a and 5b) of the individuals. For both densities, the peccaries of the same sex acted more friendly. Meanwhile, we observed more agonistic interactions among individuals of opposite sex (X^2 = 25.76, *p*=0.00001, for the lower density and X^2 = 5.48, *p* = 0.02, for the higher density). Among the peccaries that were maintained in the smallest density we observed the higher frequencies of the agonistic behaviour among individuals from different sources (Fig. 5a). Conversely, the friendly actions were observed mainly among individuals from the same source (X^2 = 30.36, p= 0.00001). On the other hand, the peccaries that were maintained in the higher density paddock, interacted friendly or unfriendly independently of its sources [X^2 = 0.68, p = 0.4089 (Fig. 5b)].

During the nine months of reproduction data collection period, we recorded a total of 19 litters and 31 young in both densities, with an average of 1.6 young per litter (Table 2). In the lower density 1.0 young was born per female, while in the higher density 1.4 young were born per female. In the higher density, however, we registered six infanticides (Table 2). While in the lower density no infanticide was observed, an abandonment of young was registered. This abandonment could not be related to experimental design because this female had a previous record of abandoning her young.

Discussion

Both in the wild and in captivity the head to head squabble is considered an agonistic interaction (Byers and Bekoff, 1981; Sowls, 1997; Nogueira-Filho et al. 1999). According to Nogueira-Filho et al. (1999) this is a ritualistic act that has the function to decrease the occurrence of real fights and, it is usually followed by submissive actions. In this study this act occurred mainly among unfamiliar individuals of the same sex in both population densities tested (Figs. 2a and 2b). These results show that it is possible to place together in a same enclosure males and females from different sources which is in order to avoid endogamy.

Byers and Bekoff (1981) stated that the collared peccaries in natural conditions show an altruistic behaviour when several individuals from the same herd use together the same source of food. In captivity, however, when unacquainted animals are placed together in the same enclosure, we observe that the individuals distribute themselves among the feeders in agreement to their familiarity (Nogueira-Filho et al., 1999). The results obtained in the present study show that the sex and source of the individuals affect the behaviour of side by side feeding in both population densities tested (Figs. 3a and 3b). On the other

hand, when we analyzed together the occurrences of agonistic and friendly interactions according to the animal source we observed that only in the lower density paddock the individuals from different sources acted unfriendly (Fig. 5a). Inversely, the friendly actions were observed mainly among individuals from the same source. In the higher density paddock, however, the source of the individual did not mediate the occurrence of the agonistic or the friendly acts (Fig. 5b). This fact suggests that in this density a rupture in the social organization occurred. This hypothesis is corroborated by the infanticides observed only in this density (Table 2) since, in the wild, collared peccaries females show a strong cooperative behaviour towards their young (Byers and Bekoff, 1981). Additionally, the data analysis shows that in the higher density there is a larger frequency of agonistic behaviour per individual than in the lower density (Figure 1).

The average litter size recorded in this study (Table 2) is similar to that one obtained in intensive captive breeding recorded by Nogueira-Filho and Lavorenti (1997). However, it is higher than the average of 0.9 young per litter, registered in the wild by Gottdenker and Bodmer, (1998). Possibly, these higher litter sizes were obtained as a consequence of the experimental diet meeting the nutritional requirements of the collared peccary. While in the wild, the natural diet, composed mainly of fruits of palms in the Amazon region (Kiltie, 1981; Bodmer, 1989; Barreto et al., 1997; Fragoso, 1999), does not always totally fulfill its nutritional needs.

Through the reproduction data (Table 2) it is possible to predict an annual production of 1.9 young per female in the higher density paddock and only 1.3 young per female in the lower density paddock. This higher production of young per female compensates the infanticides that occurred in the higher density treatment, since the number of live young produced in this paddock was larger to that one obtained in the lower density paddock. These data could be explained by the fact that female peccaries can begin to come into estrous three days after weaning or losing their young (Sowls, 1966) and, it is possible that after they lose their first litters by infanticide, the females learn to protect its offspring.

Furthermore, the reproductive performances in captivity are higher than the ones recorded by Bodmer (1999, p. 54) in free ranging animals from the Peruvian Amazon. This author compared two regions, one with high hunting intensity (Tahuayo/ Blanco) and another with low hunting intensity (Maiapuco). In the area with high intensity of hunt, and in consequence possibly in a more stressful condition, the annual reproductive production rate was minor (1.5 young per female) than the rate recorded in the area with light hunt (1.9 young per female). In the present study in the paddock with higher density, and consequently in a more stressful condition, an annual production rate 1.5 time higher than in the lower density was recorded (Table 2).

We acknowledge that the present social data of collared peccary is very limited, but in view of the infanticides and the fact that the individuals could not distribute themselves in sub-groups according their familiarity, we do not recommend the higher density analyzed in the present study for collared peccary production. On the basis of the results obtained, we recommend at least 250 m^2 per individual, or 40 animals per hectare, to breed collared peccaries in semi-captive conditions in paddocks with visual barriers, as the sub-forest vegetation present in this study, when acquainted females are placed together in same enclosure. However, other studies are necessary in order to verify the possibility to increase the population density stock by the use of other kinds of visual barriers, as artificial shelters, and different proportions of feeders.

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Peculiar pigs at Copenhagen Zoo

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At the beginning of August 2006 one of the Zoo's domestic pigs, *Sus scrofa,* gave birth to five piglets. Had it taken place at the Children's Zoo it would have been quite normal and no sensation whatsoever. It would simply have been five out of many million piglets born in Denmark every year. In this case the father of the piglets was a babirusa, *Babyrousa babyrussa*. That is why the birth made a world sensation! Domestic pig and babirusa should not be able to interbreed at all. They are taxonomically far apart, and their chromosomes are so different that in theory interbreeding was expected to be impossible. The equivalent would be a cow and a goat producing viable offspring or for that matter a human and an orangutan. So the animal keepers were completely surprised when they discovered five piglets one morning. Some of them looked like the female but a couple of them looked more like the male babirusa – or at least they did not look like a domestic pig.

We knew for certain that the female had not been mated by other males than the babirusa for the past year – leaving him the only possible father. Immediately after birth we contacted international experts and asked them which tests to make on the newborns. We realized that they were somewhat of a sensation – nonetheless, all the public attention the piglets attracted afterwards took us by surprise.

We received no less than six pages listing a series of tests all meant to throw light on the unusual result. Genetic examinations, descriptions of organs at autopsy, analyses of their sounds etc. – all to arrive at a better understanding of how two so distantly related animal species can interbreed. The next decisive factor is whether they will be able to breed themselves when they become sexually mature – if they reach maturity. The probability is small. But never say never! We did not believe that a domestic pig and a babirusa could interbreed – so who knows?

A summary overview of methods for study of peccaries in the wild

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Introduction

This document is an effort to bring together an array of methods that investigators from different countries have used for their research with peccaries in the wild. Our goal is to compile previous experience to enrich the development of new studies, provide research tools, and save time, mistakes and money to future students and new researchers. All this effort will hopefully serve to enhance the quality of peccary information to be gathered in the future and ultimately to elaborate better use and conservation strategies for these species.

Peccaries are very important in three aspects: social, ecological and scientific. Peccaries of the three species have a large impact on the ecosystems they inhabit by regulating density of fruit and seeds on the forest floor, rooting the soil, modifying waterbodies and serving as large prey for large carnivores (Sowls 1997). They also represent an important source of wild meat for several rural and indigenous groups throughout Latin American forests. In some cases, peccaries are the most important source of animal protein for poor families

(Bodmer *et al* 1997). Finally, peccaries present interesting characteristic: their social ecology, long and unpredictable movements (white-lipped peccary: *Tayassu pecari*) as well as their adaptability to harsh environments (Chacoan and collared peccary; *Catagonus wagneri*; *Tayassu tajacu*) (Kiltie and Terborgh 1983; Fragoso 1994).

The objectives of this exercise were:

- Compile techniques and method used in the study of peccaries in the wild
- Obtain suggestions from previous experiences
- Make accessible this information to new researchers/students that plan to work with peccaries
- Enhance the quality of peccary information gathered through field studies and consequently contribute to peccary conservation

This exercise started with a questionnaire sent to several experts all over Latin America. In the questionnaire, we asked information on the methods and techniques people have used or are using in six different research aspects: Capture, Radio-Telemetry, Camera-Traps, Density/Abundance Estimation and Resources Availability Estimation. The information was processed and summarized by Rafael Reyna. In this paper, we present a brief description (by no means exhaustive) of the different methods used, and a list of the main advantages and disadvantages that researchers have found while applying these methods and techniques for the study peccaries in the wild. We quote comments of contributing researchers to better represent their opinions. The name in the side of the sentence is the person providing the information.

We want to remark that this exercise is based mainly on opinions of researchers, derived from their field experiences. These opinions are variable and the performance of methods and techniques reported here may only apply to specific regions or types of environment.

Capture

Methods that researchers have used to catch peccaries were diverse; here we divided different techniques in: traps, use of anesthetic darts, and other methods.

Traps (Permanent and portable pens; box traps)

Description

- Traps consist of either permanent pen (of 5 x 5 and other of 2.5 x 2.5 m built of wire mesh and wood stakes), or portable pen of 2 x 2 m made of diverse materials such as wood stakes and wire mesh (A. Keuroghlian/Brazil).
- Traps are placed in specific places that peccaries visit frequently, and they are baited with different foods. Researchers mentioned bananas, salt, squash, corn and *mandioca* or *yuca* (M. Altrichter/Costa Rica; A. Keuroghlian/ Brazil).
- This technique is always used in combination with anesthesia for handling captured animals.

Advantages

- Using pens you can capture many animals at a time.
- It has been the most successful method to capture peccaries in some places (A. Keuroghlian/ Pantanal, Brazil; R. Wallace/ Madidi, Bolivia) (Fig. 1).

Figure 1. With the use of pens it is possible to capture many animals at a time. This has been the most successful method to capture peccaries in Pantanal, Brazil (photograph: A. Keuroghlian).

Disadvantages

- It is necessary to have good knowledge of the area and of sites that peccaries visit often, such as mud holes, food sources, etc.
- It is necessary to check the trap every day and several times at day (M. Altrichter/Costa Rica).
- Peccaries can be hurt by the mesh (M. Altrich-

ter/Costa Rica; R. Nallar/Bolivia).

- It may take enormous effort to set traps in isolated places.
- Other peccaries of the herd make it difficult to handle the anesthetized animal (R. Nallar/ Bolivia)
- If there is water on the pen peccaries could drown (R. Nallar/Bolivia).
- Building and setting up the trap can be expensive (R. Nallar/Bolivia).
- The method did not work in the Bosque Chiquitano and Chaco Boliviano (A. Noss/Bolivia).
- The method did not work in The Lacandon Forest (E. Naranjo/Mexico).

Use of Traps: Other Considerations and Suggestions

- It has been a successful method in Pantanal, Brazil (A. Keuroghlian), in Madidi, Bolivia (R. Wallace) and Corcovado forest of Costa Rica (M. Altrichter).
- Safe for humans and highly recommendable method (R. Nallar/Bolivia).
- In Madidi, pen capture was the most successful method, better than capture in "salitrales", capture with box traps and opportunistic captures (R. Wallace/Madidi, Bolivia).
- Collared peccaries do not enter in traps as much as white-lipped peccaries (A. Keuroghlian/ Pantanal).
- Bait and season can be important factors to improve the success.
- Probably will not work in areas with low peccary density or where peccaries do not visit specific areas repeatedly (R. Reyna/Mexico).
- Traps work better if they have two or three exit doors (R. Nallar/Bolivia).

Anesthetic Darts

Description

Use of any kind of REMOTE INJECTION SYSTEM (Telinject Inc., Dan-Inject Inc., or homemade) to sho0t a drug-filled dart into a peccary.

It can be active (walking, searching for peccaries) or passive (waiting in "salitrales", ponds, mud holes, or any specific place).

Advantages

- It works on individual basis, so it does not cause as much stress as traps for the whole group.
- It is safe, simple, and a mobile method.
- Cheaper than traps.
- It can be done by the researcher alone or with an assistant.

Disadvantages

- Peccaries can run after being shot and it may get difficult to find them.
- You need to be a good hunter!
- It is necessary to be close to the animal (the best system only provides 40 m of accurate shot, but most systems work well at 25 m and less).
- Difficult to predict where animals will pass (M. Altrichter/Costa Rica; R. Reyna/Mexico)
- The peccary anesthetized will have to find its group after being released and it can be a dangerous time for the individual (R. Reyna/ Mexico).

Use of Anesthetics Darts: Other Considerations and Suggestions

- Good Commercial Remote Injection Systems are expensive.
- There is the possibility to develop HOME-MADE (cheap) systems.
- The ones activated by CO2 are noiseless, which reduces the stress on the animal being shot and in the herd.
- It was a very successful method used in the project of Rafael Reyna in Calakmul, Mexico.
- If properly used, it is the less stressful method for the animal.

Other Capture Techniques

Use of Dogs

- The only method that has worked in the "Chiquitano" forest, the "Pampa Chaqueña" and the "Chaqueño" forest (WCS-Santa Cruz/ Bolivia).
- Could be dangerous due to the combination of drugs and the capture stress (R. Nallar/Bolivia).

Use of Fall Nets

- Method used in Bolivia and Peru; difficult to set up and requires long periods of waiting.
- It is simple and a Remote Injection System to anesthetize the animal is not necessarily needed.
- Works very well in Madre de Dios, Peru, where peccaries enter into a "Colpa" ("Salitral") (S. Carrillo) (Fig. 2).

Figure 2. The use of fall nets works very well in Madre de Dios, Peru (photograph. S. Carrillo).

Radio-telemetry

Description

- The use of a transmitter that is attached to an animal for its subsequent remote localization through a receptor.

Advantages

- The only method that allows the later localization of the animal (therefore the herd) in the forest.
- It can be used to obtain localizations by triangulation or to find and follow the peccaries directly (M. Altrichter/Costa Rica; R. Reyna/Mexico).
- By using radiotelemetry to follow herds it is possible to obtain behavioral and habitat use information through direct observation.
- In white-lipped peccaries, the transmitter serves as a mark for the group and allows monitoring group size, reproduction and mortality.
- It is the best method to estimate home range of an individual or a group.
- It is useful to find migratory routes.
- It is a good method to estimate movement rate when direct observations are not possible.
- It can be used to estimate habitat use in a macro-scale.

Disadvantages

- It is necessary to capture enough number of peccaries to have representative samples.
- Once an individual has been captured, there are several physical considerations when attaching a collar to a peccary
- Collars could hurt peccary skin (A. Keuroghlian/Brazil)
- The big question always is: how loose or how tight to place the collar? (A. Keuroghlian/ Pantanal)
- The animal can get a leg trapped in the collar
- They can get rid of the collar easily (Collared peccary/Costa Rica).
- The time after the collar has been put on the individual is dangerous because the animal can stop eating, or it may move slowly and therefore be exposed to predation (R. Reyna/ Mexico). (Fig. 3).
- The time when the animal re-unites with the group is also very dangerous, because it may take from few hours to a week (R. Reyna/ Mexico; E. Carrillo/Costa Rica).
- The signal often does not travel well through the forest, or it may get distorted by hills (M. Altrichter/Costa Rica; R. Reyna/Mexico)
- Signal may be weak and have a small range in the tropical, dense forests (M. Altrichter/ Costa Rica; R. Reyna/Mexico; E. Naranjo/ Mexico)
- Satellite radio-telemetry has many problems because the forest cover did not allow the collar to locate satellites to perform well (WCS/ Bolivia)
- It is necessary to use a high place (top of a hill, big trees, etc.) or an ultra light plane to capture the signal when peccaries move long distances (J. Fragoso/Brazil)

Radio Telemetry: Suggestions and Other Considerations

- Tree stands work well if you are able to build

Figure 3. The time after the collar has been put on the individual is dangerous because the animal can stop eating, or it may move slowly and therefore be exposed to predation. A peccary killed by a jaguar a few hours after its capture can be observed in the photo, in Kalakmul, Mexico (Photograph: R. Reyna).

new ones when animals move out of range (R. Wallace/Bolivia; R. Reyna/Mexico)

- Terrestrial radio-telemetry did not work in Madidi, Bolivia (R. Wallace)
- Satellite radio-telemetry did not work in Madidi (using collars Televilt POSREC) (R. Wallace/ Bolivia)
- In Calakmul, Mexico, the radio-telemetry VHF signal only traveled 1.5 km at the forest understory level, but it is possible to locate individuals as far as 9 km approx. from above the Mayan Temple, a of 60 m height structure (R. Reyna/ Mexico)
- Satellite radio-telemetry (using Televilt collars) works well in the Chaco forest and with limited success in the Chiquitano forest in Bolivia (D. Rumiz/Bolivia).
- VHF telemetry works with limited results in the same place (D. Rumiz, C. Vanegas/Bolivia).
- Model 500 (Telonics Inc) was used in Pantanal, Brazil (A. Keuroghlian), in Costa Rica (M. Altrichter), and in the Lacandon Forest, Mexico (E. Naranjo).
- In the Atlantic forest Model 500 (Telonics Inc, weight= 570 grs) was used for white-lipped peccary and HLPM-31100 (Wildlife Materials, weight= 340 grs) was used for collared peccary.

Model TRX 1000s from Wildlife Materials and a hand-held directional antenna.

- In Calakmul, Mexico, Rafael Reyna used Model 400 (Telonics, Inc weight=400 grs approx, which is lighter but only has two years of maximum battery life, and TR-4 receivers (Telonics).
- Collars ATS and Telonics receivers were use in the Chiquitano forest in Bolivia (D. Rumiz, C. Venegas/Bolivia).
- Collars ATS are used in Madidi, Bolivia (R. Wallace) with good results.
- It is a good idea to use VHF in combination with satellite radio-telemetry to obtain better results (D. Rumiz/Bolivia).
- Telonics equipment is resistant (E. Naranjo/ Mexico).
- Collars ATS are used in Los Amigos in Peru (S. Carrillo/Peru).
- It is good idea to train the human team on climbing techniques (R. Wallace/Bolivia)

Camera-traps

Description

- The use of remote self-triggered cameras to obtain animal pictures.
- Generally, there are two systems: the passive (i.e. Cam-Trakker®) which is activated by the animal's heat, and the active (i.e. Trail-Master®) which is activated when an ultra-red beam is interrupted by an animal movement.

Advantages

- The sample effort is high and it is not necessary to be on the field all time.
- It is not an intrusive method (N. Estrada/Costa Rica).
- It allows to sample a large area (N. Estrada/ Costa Rica).
- It reduces men-hours work (N. Estrada/Costa Rica).
- It is a suitable technique to study daily activities pattern.
- It can be used as a relative abundance index.
- It can be used to monitor a specific place or resource (i.e. "salitrales", C. Venegas/Bolivia;

fruit patches, T. Van-Holt/Pantanal; Y. DiBlanco/Argentina; D. Varela/Argentina).

- The best method to know the use of a specific resource.
- Sometimes it is the only way to confirm the presence of a species in a particular location.

Disadvantages

- The high cost of the equipment (N. Estrada/ Costa Rica; I. Lira/Mexico).
- Cameras present problems with excessive humidity (N. Estrada/Costa Rica).
- Capture-recapture methods can be done only with species where individuals can be recognized and differentiated (i.e. Spotted or lined felids).
- Camera or equipment theft could be a big problem in some areas (A. Novack/Guatemala).
- It requires a great effort to place cameras in the forest.
- Technical problems such as ant nests on cameras (N. Estrada/Costa Rica), cables broken by animals (R. Reyna/Mexico), or film waste due to leaves fall (R. Reyna/Mexico; only for Trail-Master) are common.
- It can not be used for densities estimation without previously marking the groups or individuals (Y. DiBlanco/Argentina)
- Could lead to a bias in the estimation of sex proportion for some species (J. Soto/ Guatemala).

Camera Traps: Suggestion and Other Considerations

- This technique was not able to differentiate habitat use by white-lipped peccary in Corcovado, Costa Rica (N. Estrada).
- The high number of cameras-traps needed to completely survey an area increase the cost.
- The long distances to walk to review the cameras make the use of this methodology difficult (K. Kawanishi/Malasya; N. Estrada/Costa Rica; A. Novack/Guatemala).
- It was used as a complimentary technique to a radio-telemetry study in Bolivia (C. Venegas).
- It could be used to estimate group size in white-lipped peccary if the camera could be place in a high (open) site by modifying the length of the wire (R. Reyna/Mexico).
- It can be used to test "occupancy" of a specific area in conjunction with the "Patch Occupancy" method (Williams 2002) (Y. D. Blanco/ Argentina; R. Reyna/Mexico).
- Cam-trakker performs better under high humidity and heat than Trail-Master (K. Kawanishi/Malasya).
- Technique used to confirm presence of the species and abundance index in the Dry forest near Santa Cruz, Bolivia (A. Noss, L. Maffei, E. Cuellar, D. Rumiz, R. Arispe, and K. Rivero).
- 26 photos of Collared peccary were obtained during 2408 trap-days (Camtrakker) (L. Rodrigo and L. Moraes/Minas Gerais, Brazil, IUCN Newsletter).
- An index of relative abundance was obtained for collared peccary in Minas Gerais, Brazil with the use of camera-traps (L. G. Vieira et al, IUCN Newsletter).
- Argentina is charging 100 % of the cost in taxes to import cameras and equipment (D. Varela/Argentina).

Relative density and/or abundance estimation

Description

- Methods aimed to obtain relative abundance or density index of peccaries on one specific area. Several Methods are used:
- Direct counts on transects: DISTANCE
- Tracks counts in transects.
- Tracks-traps along transects.
- Census attempt (total counts in known areas).
- Hunting records (local interviews).

<u>Direct Count on Transects (DISTANCE, Buckland et al 2001)</u>

- It works on the Lacandon Forest, Mexico but long distances are required due to small number of animals observed, more than 1500 km walked (E. Naranjo/Mexico).
- It works on Madidi, Bolivia but it is necessary to sample large areas to satisfy the method sample size required, also it is necessary to design spatially where to place the transects (R. Wallace/Bolivia).

- It works in The Pantanal, Brazil but it is time consuming due to large sample size required. More than 2000 km walked (A. Desbiez/Brazil).
- The method did not work in the Argentine Chaco Forest because no animals were observed (M. Altrichter/Argentina).
- No white-lipped peccaries (and few collared peccaries) were seen in three years of transect sampling in Calakmul, Mexico (M. Weber and R. Reyna/Mexico).
- Apparently the method does not work on areas where peccary density is low and there is hunting pressure (M. Altrichter/Argentina; R. Reyna/ Mexico).
- There were few observations (especially of white-lipped peccaries) in thousands of km walked in transects in hunted areas in dry forest in Bolivia (A. Noss/Bolivia).
- Difficult to do observations of peccaries for density estimations in Oaxaca, Mexico (I. Lira/ Mexico).
- In a study in Nhumirim (Brazil) A. Desbiez found a rate of a one collared peccary observed between 0 to 20 km and a white-lipped peccary among 20 to 40 km of transects walked, while in a different study site (Manduvi) he needed more than 80 km to see a collared peccary and never saw a white-lipped peccary.
- Transects are used to estimate peccaries' densities in Yasuni National Park (E. Suarez, G. Zapata/ Ecuador).
- There are special consideration when using DISTANCE with social animals (especially white-lipped peccaries):
- Generally, it is recommended to measure the distance to the animal at the center of the group, but this is always difficult. According to DISTANCE creators it is better to measure individual distances of all animals seen (R. Wallace/ Bolivia).
- It is difficult to apply DISTANCE for white-lipped peccaries because: to measure the distance to the first sighted animal may be biased; to find the geometric center for huge herds is difficult; and to measure distances to every animal is impossible (A. Desbiez/Brazil).
- other considerations in the use of DISTANCE when calculating densities are the transect layout, and time and space sampling. Also, problems can be serious when doing density comparisons between two species when one doesn't explicitly indicate how to correct for the differences in group size and social structure (J. Fragoso/Brazil).

Track Counts in Transects of Traps

- Provides good results but a big effort is required.
- Soils and climate can affect results.
- Same group can be walking the same transects several times.
- If you standardize your method of data collection, it provides a reliable abundance index (R. Reyna/Mexico).
- It can also be used as habitat use index (R. Reyna/Mexico).
- Impossible to get density estimations using this method alone.
- Most common abundance index.
- Used as complimentary method in Yasuni National Park (Ecuador) (E. Suarez, G. Zapata / Ecuador).
- Tracks-traps represented a large effort and few data were collected in the Argentine Chaco, but it may be the most feasible method to use in sites where field conditions are difficult (such as the arid Argentine Chaco), and where other alternatives do not work (M. Altrichter/Argentina).
- Tracks are difficult to count during the dry season of the year but the method is simple, effective and of low cost (R. Reyna/Mexico; E. Naranjo/Mexico).
- Track counts was a reliable, low cost method to confirm habitat use and abundance index in the dry forest of Bolivia (C. Venegas/ Bolivia).
- Track counts is cheap and does not represent any risk for animals or people (A. Noss/ Bolivia).

Other Methods to Estimate Density, abundance and/or population trends

- Local interviews; highly recommended as complimentary to other methods, or alone if

other methods do not work. It is simple and of low cost, and provides a lot of information (M. Altrichter/Argentina).

- Total counts (direct observations, tracks, signs) of peccaries using a site of known area; the method proved to be feasible in the Argentine Chaco but it provided only a rough estimate of density. It requires the help of good local hunters. It is more reliable for estimates of collared peccary density (less for white-lipped peccaries that use huge areas) (M. Altrichter/Argentina)
- Total counts in specific sites; This method is only a proposal from WCS Guatemala and consist in simultaneously sampling several ponds during the dry season of the forest. It assumes that every group of white-lipped peccary will have to visit the ponds daily (J. Soto, R. Garcia, J. Radachowsky/ Guatemala).

Resources availability estimation

Description

- Estimates of resources availability are key to understand several aspects of peccaries ecology. There are several ways to estimate resources availability.

Transects

- In Calakmul, Mexico Rafael Reyna used 20 km of line transects where all fruit or food items that were within 1 m of each side from the center line were registered, and the abundance in 2 square meters under the parent tree was recorded (R. Reyna/Mexico, following the method first developed by M. Altrichter/Costa Rica).
- Rafael Reyna also counted earthworms under different season and habitats in plots pf 15 m^2 divided in three 5 m^2 sets in each habitat per month.
- Wallace and Painter (2002) used transects 100 m x 1 m long to estimate fruit availability and tree phenology in Bolivia and concluded that for terrestrial animals fruit trails are more appropriate.

Fruit fall traps

- The use of fruit fall traps has serious problems because it usually samples only small fractions (less than 0.00 % of the area in study) of the forest and requires a lot of effort to place the traps (Colin Chapman Pers. Comm.).

Vegetation Plots

- Wallace and Painter also used plots of 20 x 50 m to identify and estimate densities of tree and herbaceous species (20 m).
- Some times measuring the DBH and number of fruiting trees is simple and provides a good estimate of fruit production for that specific period of time (Wallace and Painter 2002; Chapman Comm. Pers).

Resources Availability Estimation: Suggestions and Other Considerations

- For phenology monitoring, Rob Wallace (Bolivia) recommend a minimum of 20 individuals of each species.
- Diego Varela (Argentina) is using exclosures (4.5 x 4.5 m) and control plots to estimate peccary and other ungulates impact on a palm species (*Euterpe eduli*).
- Resources availability can be measured also in a landscape scale (G. Vidolin/Brazil).
- Harald Beck is also estimating peccaries seed dispersal and predation in Peru by using exclosures of 5 x 2 m.
- Resources other than food and minerals, such as water ponds, were very important in determining white-lipped peccary groups distribution in Calakmul (R. Reyna/Mexico).

Conclusions

There is not a single technique or method that solves the complexity of studying peccaries in the wild, therefore, the best strategy is to use a combination of methods that are complimentary.

Success of methods seem to be site-specific, probably depending on many variables. Pilot work and testing seems to be highly necessary before investing in one technique.

All of the methods have disadvantages and some of them have to be taken seriously in consideration and reported in publications. The perfect method may not exist. Decisions have to be based on trade-offs analysis, keeping in mind the research question.

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Fisiología reproductiva de la hembra de pécari de collar (*Tayassu tajacu*)

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Introducción

La supervivencia del pécari de collar (*Tayassu tajacu*) en condiciones naturales depende de su capacidad reproductiva. Igualmente, la cría en cautiverio de esta especie puede considerarse como fuente alternativa de proteína de origen animal y de ingresos familiares para las comunidades locales donde esta especie se encuentra. Por otro lado, su cría puede permitir responder a la fuerte demanda nacional e internacional a la que se ve sometida esta especie. La viabilidad de esta cría en cautividad depende en gran medida de los aspectos reproductivos. Igualmente, en los últimos años se han dedicado enormes esfuerzos al estudio de la fisiología reproductiva de esta especie en la región Amazónica. El siguiente artículo pretende exponer los resultados de estudios sobre la fisiología reproductiva realizados bajo el marco del proyecto europeo INCO-PECARI en diversas granjas experimentales de pécari de collar: Iquitos (Perú), Belém (Estado de Pará, Brasil), e Ilhéus (Estado de Bahía, Brasil), y a partir de individuos cazados en su hábitat natural gracias a un programa de manejo comunal con los cazadores locales (Departamento de Loreto, Perú). El objetivo de este trabajo consistió en analizar, predecir en lo posible y diagnosticar gran parte de los sucesos reproductivos que se desarrollan en la hembra del pécari de collar a lo largo de su vida reproductiva.

Características del tracto reproductivo

Pruebas diagnósticas de la fase del ciclo estral

A partir del examen anatomohistológico del aparato genital femenino de 24 hembras de pécari de collar, se observaron cambios histológicos en el epitelio vaginal de hembras en función de la fase sexual de la hembra. Este hallazgo sugirió que el examen de las células del epitelio vaginal (citología vaginal) podría ser un método diagnóstico preciso de la fase sexual del pécari de collar.

La citología vaginal y el estudio de la apariencia de los genitales externos son técnicas sencillas aplicables en el manejo de la especie y proporcionan rápida información sobre el ciclo sexual de las hembras. El estudio de 47 ciclos estrales de 14 hembras de pécari de collar mantenidas en cautividad confirmó la utilidad ambas metodologías como técnicas diagnósticas de detección del periodo de estro y de aceptación de la monta por parte de la hembra de pécari de collar (Mayor et al., 2006a).

La presencia de células vaginales superficiales en una proporción superior al 40% y de células eosinófilas (superficiales e intermedias) en proporciones superiores al 60% en la citología vaginal, fue considerada como indicador de estro en el pécari de collar. El valor predictivo positivo de este método diagnóstico fue del 80.8%.

Durante la fase de estro, la hembra de pécari de collar presentó los labios vulvares rojizos y tumefactos, y moco vaginal fluido y traslúcido. La apariencia rojiza y la tumefacción de los genitales externos se prolongó durante un período medio de 4 días, y la presencia de moco vaginal durante 2.5 días. El valor predictivo positivo de este método diagnóstico fue del 88.4%. Es posible que los niveles variables de estrógenos y progesterona a lo largo del ciclo estral expliquen el patrón de cambio de los signos de los genitales externos y de la citología vaginal. Ninguna de las pruebas diagnósticas estudiadas se consideró suficientemente fiable para predecir el celo post-parto debido a que la agresión que supone el parto provoca que no exista un evidente patrón de cambio en genitales externos ni en epitelio vaginal.

En las diferentes regiones de estudio se ha observado que la hembra de pécari de collar es una especie poliéstrica no estacional. La tasa ovulatoria media observada fue de 2.3 ± 0.6 oocitos, y la prolificidad de 1.9 fetos o neonatos por gestación. Consecuentemente se observó una baja mortalidad de 0.4 ± 0.6 oocitos o embriones por gestación (Mayor et al., 2006b). El pécari de collar en fase folicular presentó un número medio de 30.4 folículos antrales, de los que 5.2 folículos fueron antrales grandes. Este hecho sugiere la existencia de una ola folicular que implica el crecimiento sincrónico de un grupo de folículos.

La receptividad sexual por parte de la hembra de pécari de collar se produjo 1 ó 2 días después del pico de estrógenos (último tercio del ciclo estral) (Mayor et al., 2006a). El día de la monta, los genitales externos se observaron rosáceos, ligeramente tumefactos y se evidenció la presencia de abundante moco vaginal. Este periodo se caracterizó por un patrón de células del epitelio vaginal con unos valores muy homogéneos en todas sus líneas celulares, por lo que no se observa la predominancia de ningún tipo celular del epitelio vaginal.

La presencia del tapón vaginal, como indicio de la monta, fue observada de forma esporádica. Es posible que la baja frecuencia de encuentro del tapón vaginal sea debido a que la hembra de pécari de collar lo elimina rápidamente, o bien debido a que, al igual que en el caso de algunos roedores, el tapón se localiza tan profundo que puede no ser detectado con una simple inspección.

Diagnóstico temprano de gestación

El diagnóstico temprano de gestación y el establecimiento de la edad gestacional de las hembras es esencial para realizar un manejo correcto de las hembras gestantes y para realizar un manejo de puerperio adecuado. A través del estudio ecográfico de 10 hembras gestantes se logró realizar el diagnóstico precoz de gestación a un promedio 22 días de gestación (Mayor et al., 2005). No obstante, el diagnóstico de gestación más temprano se realizó a los 18 días de gestación. A efectos prácticos, el diagnóstico ecográfico precoz de gestación en pécari de collar presenta un valor

predictivo del 100% a partir de los 28 días de gestación.

Gran parte del manejo reproductivo de cualquier especie se concentra en el período peripartal. El conocimiento de la edad gestacional del feto permite la predicción del momento de la fecundación y del parto. Con la finalidad de estimar la edad gestacional del feto, se realizó el seguimiento de diversas medidas fetales a lo largo de la gestación. Las medidas fetales que presentaron una mayor correlación con la edad gestacional, y consecuentemente mayor valor predictivo, fueron la longitud total (r^2=0.9923) y las medidas torácicas (diámetro, r^2=0.9804; y longitud, r^2=0.9441) del feto (Mayor et al., 2005). En la Tabla 1 se muestran las ecuaciones que relacionan estas medidas con la edad del feto. Sin embargo, debido a que las medidas torácicas sólo pueden ser evaluadas a partir del día 40 de gestación, se considera que la longitud total del feto es la medida predictiva de elección ya que puede ser obtenida desde la primera detección del embrión.

Tabla 1: Ecuaciones matemáticas que estiman la edad gestacional del feto a partir de diferentes medidas fetales (Mayor et al., 2005).

EGA= -4,953 + (0,26*LT) + (0,000278*LT2)

EGA= -2,926 + (0,12*LTx) + (0,000134*LTx2)

EGA= -0,365 + (0,05*DTx) + (8,012e-005*DTx2)

Donde: EG A: Edad Gestacional Estimada

LT: Longitud Total del Feto

LTx: Longitud Torácica

DTx: Diámetro Torácico

Celo post-parto

La presencia de celo post-parto y el desarrollo de una nueva gestación constituyen un factor positivo para la especie pues garantiza una mayor productividad y una rápida reposición del tamaño poblacional del grupo. En la mayoría de mamíferos, el parto está seguido de un periodo post-parto anovulatorio de duración variable que tiende a prolongarse con la lactación (Peters and Lamming, 1990). Sin embargo, el estudio del periodo de post-parto de 20 hembras en lactación de pécari de collar confirma que esta especie puede presentar un celo ovulatorio y fértil durante este período (Mayor et al., 2006c). La presencia de este celo post-parto podría estar causada por el pico de estrógenos que tiene lugar en la última fase de gestación, tal y como ocurre en el cerdo doméstico (Holness and Hunter, 1975).

En el 80% de las hembras estudiadas se observó la presencia de un pico de 17b-estradiol a los 7 ± 1.5 días post-parto. En estas hembras se evidenció un patrón de cambio de las células del epitelio vaginal compatible con una citología de celo. El 56% de estas hembras aceptaron la monta el día 8.8 ± 1.3 post-parto, y el 67% resultaron gestantes. Estos datos confirman la existencia de un celo post-parto (Low, 1970; Sowls, 1984 y 1997). No obstante, y en contraposición a lo observado por otros autores, este celo puede ser fértil sin necesidad de realizar un destete temprano.

Desarrollo de técnicas no invasivas de detección hormonal

Las técnicas no invasivas de detección hormonal se basan en que los metabolitos de las hormonas excretados vía fecal o urinario pueden presentar una buena correlación con los valores sanguíneos. En nuestros estudios, el porcentaje de correlación de la progesterona fecal y sérica presentó valores próximos al 80%. La ventaja obvia del análisis hormonal vía orina o heces es la evitar el manejo al animal, evitando reacciones fisiológicas adversas como el estrés. Los resultados preliminares del estudio de los niveles fecales de progesterona en el pécari de collar mostraron una longitud del ciclo estral de 28.66 ± 4.24 días.

Parámetros reproductivos del pécari de collar mantenido en cautividad

La Tabla 2 resume los parámetros reproductivos resultantes del seguimiento de un sistema de cría en cautividad de pécari de collar en Belém (Estado de Pará, Brasil) durante un período de

Tabla 2. Parámetros reproductivos del pécari de collar mantenido en cautividad en Belém (Estado de Pará, Brasil).

Parámetros reproductivos	n	Promedio ± DS
Número de hembras		29
Número de partos		74
Número de crías		134
Tamaño de camada (crías por parto)	74	1.85 ± 0.43
Crías vivas por parto*	74	1.34 ± 0.71 (73.2%)
Crías muertas por parto*	74	0.51 ± 0.69 (26.8%)
Edad a la primera concepción (en días)	14	499 ± 243
Edad al primer parto (en días)	14	639 ± 243
Intervalo entre partos (en días)	49	196.0 ± 103.7
Intervalo parto-concepción (en días)	49	58.0 ± 103.7
Camadas por hembra y año	74	1.03 ± 0.73
Camadas por hembra multípara y año	67	1.40 ± 0.50
Crías por hembra y año	74	1.86 ± 1.35
Crías vivas por hembra y año*	74	1.36 ± 1.21

65 meses (Mayor et al., 2006d). Es importante destacar que en la estación experimental no se ha realizado ningún tipo de control reproductivo ni de selección de individuos. Es de esperar que el establecimiento de un programa de manejo ayude a mejorar considerablemente estos resultados.

Se ha observado una gran variabilidad reproductiva en las diferentes hembras. De esta forma, existe un porcentaje importante de hembras que no se reproduce de forma regular. Es posible que exista un efecto inhibitorio de la eficacia reproductiva de unas hembras sobre otras debido a la fuerte naturaleza jerárquica de la especie. No obstante, es necesario realizar estudios que interrelacionen la estructura social y la eficacia reproductiva de la especie para, en último término, poder determinar el tamaño de grupo o unidad reproductiva ideal.

Conclusiones

El pécari de collar ha sido considerado una especie interesante para la cría en cautividad porque presenta un corto ciclo reproductivo con varias camadas anuales y una rápida tasa de crecimiento similar a la de otros Suidos. Los estudios realizados nos permiten ampliar la información de la hembra del pécari de collar a lo largo de todas sus fases reproductivas. Estos resultados muestran que el pécari de collar silvestre ha logrado adaptarse a los sistemas de explotación. Sin embargo, es importante destacar que se han detectado factores, como la estructura jerárquica de la especie, que limitan la capacidad reproductiva de la especie mantenida en cautividad. Es de esperar que el establecimiento de buenas prácticas de manejo permita la optimización de los parámetros reproductivos.

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Exploración de datos de radio-collares gps en pecaríes de labio blanco: ¿qué podemos aprender de una muestra de n=4?

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Abstract

We analyzed gps data obtained from four radio-telemetry collars (Televilt C600 posrec) affixed to white-lipped peccaries at three WCS study sites in Bolivia. Each site represented a different ecoregion, including pre-Andean wet forest, Chiquitano semideciduous forest, and Chaco dry forests/ shrublands. Collars were programmed to collect 4-6 locations per day, were deployed in the field for 112-384 days until recovery, and rendered 15-745 locations in 9-213 'successful' days. Date, coordinates and signal quality of the positions were managed in spreadsheets and plotted in Arcview, Trackmaker and Google Earth. Locations from the tall pre-Andean forest were very scarce and of little use (only 1-3 locations on 9-14 out of 112-384 potential days) compared to those of the Chiquitano forest (up to 6 per day, on 172 out of 192 days) and Chaco forest and shrubland (6 per day, on 213/244 days). By selecting positions by their quality and date in the Chaco it was easy to detect real movements and the time when the animal died. This was more difficult in the Chiquitano forest because gps error was larger. We propose some spreadsheet and mapping tools that are useful to compare gps data under different conditions. We also believe that vegetation height and density may severely impair the performance of these collars.

Introducción

El objetivo de este artículo es examinar los registros obtenidos de collares gps Televilt colocados en pecaríes de labio blanco o 'troperos' (Tayassu

pecari) en tres áreas boscosas diferentes de Bolivia. Describimos algunas herramientas de exploración y análisis de datos geográficos que nos permiten estimar el desempeño de los radiocollares gps, determinar el momento de la muerte del animal marcado y diferenciar los movimientos reales de los errores de localización. Adicionalmente, sugerimos procedimientos básicos para presentar archivos de gps sobre imágenes de Google Earth o Worldwind.

Materiales y Métodos

Area de estudio y captura de animales

Los datos provienen de tres sitios de estudio de WCS en Bolivia, dos en Santa Cruz y uno en La Paz (Fig 1):

- Campamento Guanacos, SW del Parque Kaa Iya ('Chaco', 20º 14' S y 62º 26' W): es un área de pampa, matorral y bosque seco chaqueño sobre arenales, a 400 msnm. El bosque es bajo o medio (8-10 m), con dosel irregular, y está intercalado con arbustales y pastizales (Cuéllar y Fuentes 2000, Navarro y Maldonado 2002).
- Estancia San Miguelito ('SM', 17º 05'S y 61º 47' W): es una propiedad ganadera y reserva privada; el sitio de estudio se ubica en la llanura aluvial a 300 msnm y está cubierto por bosque semideciduo chiquitano y de transición al chaco. Estos bosques son medianos a altos (10-20 m), con dosel y sotobosque densos (Fuentes y Navarro 2000, Rivero et al. 2005).
- Campamento El Hondo, Area Natural de Manejo Integrado Madidi ('Madidi', 14º 35' S y 67º 40' W): bosque húmedo preandino amazónico a 300 msnm, con dosel de 20-25 m, emergentes de 30 m o más, y alta riqueza de palmeras (Navarro y Maldonado 2002, De la Quintana 2005)

En los tres sitios se hicieron esfuerzos de captura y seguimiento de pecaríes con radiocollares gps o VHF convencionales (e.g. Noss et al. 2002, Ayala et al. 2006). La captura fue realizada por los veterinarios de WCS Rodolfo Nállar, Christine Fiorello y Sixto Angulo, anestesiando con dardos a los animales atrapados en corrales o perseguidos con perros. Los radio collares gps usados fueron

Figura 1: Ubicación de los tres sitios de estudio con collares gps Televilt en una imagen Modis de Bolivia.

Televilt C600 Posrec, programados para bosque denso y para tomar seis o cuatro localizaciones gps por día (a las 0:00, 4:00, 8:00, 12:00, 16:00 y 20:00 en Santa Cruz, y a las 11:00, 13:00, 19:00 y 21:00 en La Paz). También emitían una señal VHF convencional de rastreo y estaban programados para liberarse del cuello del animal a los 12-15 meses de actividad.

En San Miguelito se capturó y marcó con un collar gps una hembra adulta el 7 de diciembre de 2003. Se la halló muerta el 3 de junio 2004 y se recuperó el collar. El segundo animal fue un macho adulto capturado en el Chaco el 17 de junio del 2005, y hallado muerto el 16 de febrero del 2006. Los pecaríes de Madidi fueron capturados en un corral el 22 de septiembre del 2004 y sus collares fueron recuperados el 11 de enero y el 11 de octubre del 2005.

Obtención y manejo de datos digitales

Con el programa provisto por el fabricante (gpsposrec) y un cable de conexión USB bajamos los datos del collar a la PC en la forma de un archivo 'txt' nombrado automáticamente con la fecha y hora de la conexión. Importados en Excel, estos archivos tenían seis campos o columnas (Tabla 1) y para facilitar el análisis agregamos cuatro columnas más (marcadas con *). Los campos originales son: fecha, hora, longitud, latitud, 'type' o calidad de la posición (2D, 3D, etc.) y 'tow' o tiempo de la semana de la posición (que es equivalente al número acumulado de segundos en un período de 7 días, o sea de 1 a 604800). La calidad de cada localización depende del número

# *	fecha	fecha # *	hora	lon	lat	type	type # *	sum *	tow
1	6/17/05	38520	20:06:43	-62.461008	-20.208359	3D+	4	1	504416
2	6/18/05	38521	0:05:54	-62.460996	-20.208348	3D+	4	1	518767
3	6/18/05	38521	4:01:42	-62.459463	-20.205854	3D+	4	1	532915

Tabla 1: Ejemplo de tabla de datos bajados del gps y de campos agregados (*) para facilitar el análisis

de satélites contactados, y tiene su mayor confiabilidad (≤ 15 m en el 90% de las veces, según el fabricante) cuando recibe más de 3 señales útiles (3D+). Cuando no se consiguen 3 señales útiles, el gps usa uno (2D) o dos (1D) satélites de la posición anterior para calcular la actual, lo que puede generar bastante error. En la tabla agregamos una columna 'type #' que convertía las cuatro clases de calidad del punto (1D a 3D+) en clases numéricas de orden (de 1 a 4) de las cuales obtuvimos luego las medianas de calidad por día. También agregamos una primera columna con el número correlativo de registro, otra con la fecha convertida en número de días, y una última con valor 1 en cada registro para poder 'contar' las frecuencias en las operaciones (Tabla 1).

Examinamos las hojas electrónicas de cada collar en Excel, e hicimos uso de filtros, tablas dinámicas, gráficos y otras funciones del programa para obtener:

- Número de localizaciones del período de estudio: identificando o desechando las pruebas de fábrica, la inicialización antes de la captura, y los registros post-recuperación.
- Número de días de seguimiento, número de localizaciones obtenidas, efectividad % sobre los días/posiciones programadas, y calidad de las localizaciones (1D a 3D+).
- Correlación entre el número y la calidad de las posiciones diarias (coeficiente r de Pearson) y comparación entre medianas de la calidad (test de Mann Whitney).
- Distribución temporal (por hora del día y por período de tiempo) de la recepción y calidad de las localizaciones.

Mapeo de datos en un sistema de información geográfica

Para examinar la distribución espacial de las localizaciones obtenidas del collar gps usamos programas que permiten graficar los puntos en un sistema de coordenadas, estimar distancias, definir polígonos, y superponer coberturas geográficas del área de estudio para buscar relaciones con hábitats y otros factores (ArcView, TrackMaker y Google Earth). El primer paso fue convertir la tabla de puntos de Excel (con su columna adicional numerada) a un archivo 'shp' de Arcview de puntos, y luego a otro de líneas (o 'tracks') uniendo los puntos en su orden correlativo. Lo mismo puede lograrse en el programa de uso libre Track Maker (TM, www.gpstm.com) a partir del archivo shp de los puntos.

Con los archivos de puntos y tracks de cada collar (inicialmente en coordenadas geográficas gg.ggg y datum WGS84) identificamos por su fecha y hora los puntos de captura y de recuperación del collar. Para realizar mediciones de distancias y áreas en ArcView debimos 'proyectar' los datos a un sistema rectangular de coordenadas que usa unidades en metros (como 'utm', para nuestra zona 20). El mismo procedimiento se pudo realizar en TM (al igual que el cambio de datum) para superponer los puntos a coberturas de vegetación, ríos, límites administrativos, o imágenes satelitales del área de estudio. Finalmente, los datos fueron editados y fueron exportados desde TM como archivos 'kml' de Google Earth (GE) para superponerlos a las vistas satelitales de acceso libre de GE (www.earthgoogle.com) o Worldwind (http://worldwind.arc.nasa.gov/) que hay en Internet.

La primera examinación visual de los puntos y líneas de las posiciones no permitió distinguir claramente los desplazamientos reales vs. el error del gps, ni identificar el momento de la muerte del animal. Luego, esto fue aclarado con el uso de herramientas de ArcView que permiten corroborar el número, fecha y calidad de cada posi-

	Chaco	San Miguelito	Madidi 1	Madidi 2
Días esperados	244	192	112	384
Días con registro	213 (87%)	172 (89%)	9 (8%)	14 (4%)
Posiciones esperadas	1464	1152	448	1536
Posiciones obtenidas	745 (51%)	659 (57%)	15 (3%)	20 (1%)
Posiciones ≥ 3D	641 (86%)	508 (77%)	9 (60%)	15 (75%)

Tabla 2: Días de registro y localizaciones obtenidas de cuatro animales en tres ecorregiones diferentes de Bolivia

ción en la tabla de datos a la vez que uno ve la distribución de puntos en el mapa. Con las funciones de selección de datos separamos las posiciones de buena calidad (≥3D), identificamos sus concentraciones, las comparamos con las dudosas de los mismos días, e identificamos el período de actividad y el posterior a la fecha de muerte.

Resultados

Los collares gps estuvieron durante 112 a 384 días en los animales y registraron señales en 9-213 días que resultaron entre 15 y 745 posiciones por collar (Tabla 2). La efectividad en cuanto a días con registro (87-89%) y posiciones obtenidas (51-59%) fue notoriamente mayor en el Chaco (bosque seco, matorrales y pampas) y en San Miguelito (bosque semideciduo) que en el bosque húmedo de Madidi (registros sólo en 4-8% de los días y en 1-3% de las posiciones esperadas). Los días sin registros en el Chaco (31/244) se intercalaron en los dos tercios finales del estudio de forma aislada o como grupos de 2-10 días sucesivos, mientras que en SM (21/192) ocurrieron como días aislados en las semanas del inicio y del medio del estudio (Fig 2). En Madidi, los escasos registros ocurrieron de manera coincidente en ambos animales en la fecha de captura, los dos días siguientes, y luego a los 18, 70 y 86-89 días, ocupando unas 5 de las 16 semanas del estudio. En el collar que duró más tiempo, los registros posteriores ocurrieron en días aislados de sólo 4 de las 36 semanas restantes.

El número de localizaciones en el Chaco (745) y en SM (659) como también sus días con registros (213 Chaco y 172 SM) fueron suficientes como para buscar patrones de variación en los dos sitios (Tabla 3). El número de posiciones obtenidas por día (sobre el máximo de las seis programadas) varió entre 0 y 6, y fue similar entre el Chaco (media: 3.46, ds: 1.80, 51% obtenido sobre el máximo) y SM (media: 3.59, ds 1.58, 57% de efectividad). La distribución de estas frecuencias (Tabla 3) mostró un pico en 4 y 5 posiciones diarias en SM, pero un patrón de variación menos claro en el Chaco. La calidad de las posiciones totales, sin embargo (Tabla 2) fue mejor en el Chaco (mediana 4, 86% ≥ 3D) que en SM (mediana: 3, 76% ≥3D) (Mann-Whitney U = 293867, $p < 0.001$).

La relación entre el número de registros diarios y la calidad de las posiciones fue positiva y clara en el Chaco ($r = 0.50$), no tan clara en SM ($r = 0.19$), y variable a lo largo de las semanas de muestreo en ambos sitios (Fig 2). En el Chaco se distinguió un período inicial de registros casi completos y de alta calidad, pero luego el número de registros disminuyó y la calidad fue más variable. En SM estos parámetros variaron pero sin un patrón claro. A una escala temporal más fina, examinamos si las frecuencias por clase de calidad mostraban alguna variación asociada a la hora del día del registro (los seis horarios programados), pero su distribución pareció homogénea y no encontramos indicación que de día o de noche cam-

Días de registro de datos			Número de localizaciones		
posic./día	**Chaco**	**SM**	**Calidad loc.**	**Chaco**	**SM**
0	31 días	20 días	*sin datos*	31 días	20 días
1	45 (21%)	15 (9%)	*1D*	3 (0%)	1 (0%)
2	31 (15%)	19 (11%)	*2D*	101 (13%)	151(23 %)
3	29 (14%)	32(19%)	*3D*	216 (29%)	254(38%)
4	31 (15%)	44(26%)	*3D+*	425 (57%)	253(38%)
5	40 (19%)	47(27%)			
6	37 (17%)	15(9%)			
totales	213(100%)	172(100%)	*totales*	745(100%)	659 (100%)

Tabla 3: Frecuencias del número de posiciones gps registradas por día y calidad de las localizaciones de un radiocollar en el Chaco y otro en San Miguelito (SM)

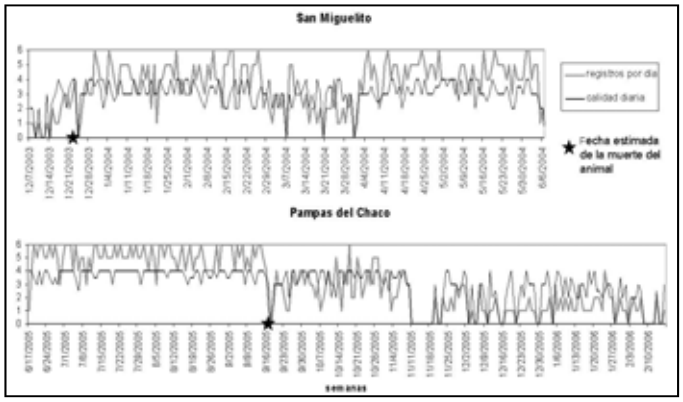

Figura 2: Número de registros (0-6 por día) y calidad de las posiciones (media entre calidades 1D= 1 y 3D+ = 4) obtenidas de dos collares gps llevados por pecaríes de labio blanco en San Miguelito y Pampas del Chaco.

biara la recepción.

Luego de examinar la distribución de las localizaciones en la pantalla, seleccionarlas por su calidad y estimar el posible error del gps, pudimos identificar el sitio y fecha de muerte de los animales del Chaco y SM. En las primeras 13 semanas del collar del Chaco (junio-septiembre 2005, 470 puntos, Fig 2) se ven amplios movimientos del animal, pero en las 22 semanas siguientes los puntos se concentran con escasa dispersión (120 m) alrededor del sitio de muerte del animal (Fig 3). El collar fue encontrado bajo unos árboles densos, que aparentemente limitaban la recepción. El cambio de patrón en los registros diarios (Fig 2) fue muy claro luego de la muerte del animal, y sugiere que la recepción era muy buena en las pampas del chaco cuando el animal estaba activo, ya que se obtuvieron más registros diarios (media 5.05) y de mejor calidad (mediana 4) que después de la muerte (2.24 y 3 respectivamente). La distribución de frecuencias por clase de calidad durante el movimiento en el Chaco mostró que cuando se obtenían 5 o 6 satélites diarios la mediana de la calidad era más alta.

En SM, el momento de la muerte del animal fue más difícil de estimar aunque parece haber ocurrido luego de los primeros diez puntos de diciembre de 2003 (correspondientes a 6 días más 4 días intermedios sin registros, Fig. 2 y 4). Las 650+ posiciones ocurridas en los seis meses posteriores aparentemente sólo reflejan el error de gps alrededor del animal muerto, incluyendo una 'ida y vuelta' de 800 m hacia el N (calidad 2D) en febrero 2004 que es el mayor 'outlier' registrado. La muerte del individuo probablemente ocurrió alrededor del 20 de diciembre del 2003, por lo que los cambios en el número y calidad de localizaciones posteriores se deberían a la geometría de los satélites y a posibles 'sombras' sobre el collar en el suelo del bosque.

Discusión y recomendaciones

Hasta el momento, el uso de collares gps para el seguimiento de pecaríes en los bosques neotropicales ha sido limitado (Reyna et al. 2006). Los collares gps Televilt han resultado con éxito en estudios de jaguares en bosques semideciduos intercalados con cerrado y humedales en la Mata Atlántica (Cullen et al. 2005) y en el Pantanal (Soisalo y Cavalcanti 2006), pero por nuestra experiencia parecen tener una fuerte limitación en la recepción de la señal en bosque altos y densos. En el bosque húmedo preandino de Madidi, las escasas localizaciones ocurrieron en similares fechas y sitios para los dos animales, sugiriendo que éstos estuvieron juntos en sitios de mejor recepción. Los 15 - 20 puntos registrados (1-3% del total posible) no permiten hacer mayores interpretaciones sobre el método o la ecología de los pecaríes en este sitio, aunque con un considerable esfuerzo el seguimiento de individuos marcados con collares VHF está generando esta información (Ayala et al. 2006). En el bosque amazónico

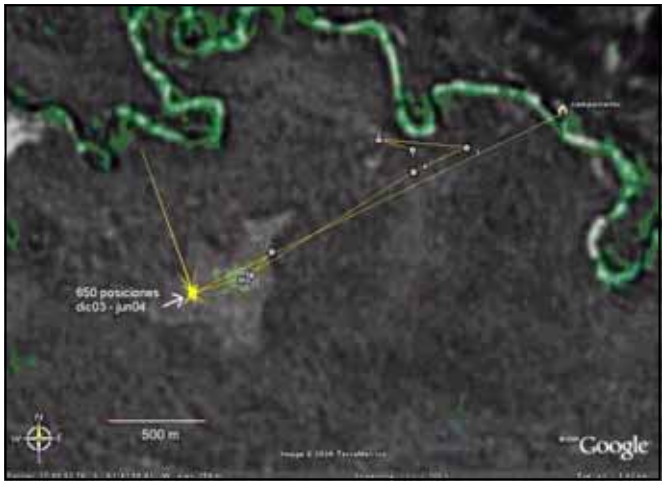

Figura 3: Líneas de movimiento (470 posiciones) y concentración de localizaciones (375) en el sitio de muerte de un chancho de tropa con collar gps en las pampas y bosques de arenales del Chaco.

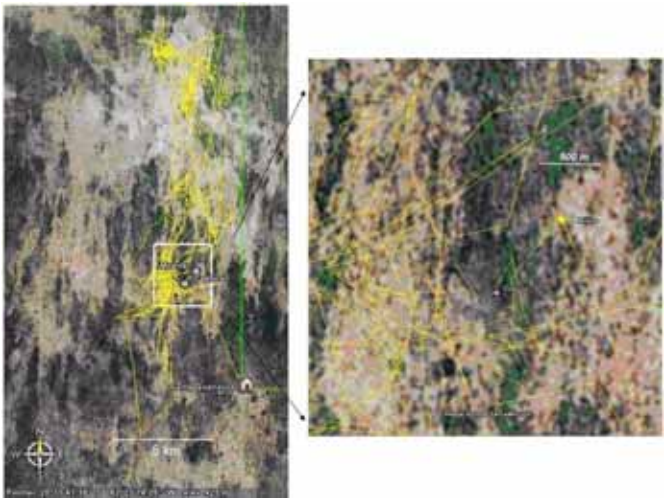

Figura 4: Desplazamiento inicial (10 posiciones) y concentración de la trama (650+ posiciones) en el sitio de recuperación del collar gps de un chancho de tropa en el bosque transicional chiquitano-chaqueño de San Miguelito.

peruano se está probando un nuevo sistema de collares gps en tapires que puede obtener 25/100 localizaciones diarias (Tobler 2006) y que sería útil adaptar a pecaríes.

La mayor frecuencia de registros y mejor calidad de localizaciones gps se obtuvo en el Chaco cuando el animal marcado se desplazaba por los bosques abiertos, arbustales y pampas de arenales, pero cuando el animal murió (probablemente atacado por un puma), los registros fueron menos frecuentes. La ausencia de registros por 10 días pudo deberse a la obstrucción temporaria del collar por la acción de animales carroñeros, pero de todos modos, con más del 51% de éxito sobre los datos esperados estos collares se muestran muy adecuados para este hábitat.

Si bien los registros de San Miguelito fueron tan frecuentes como los del Chaco, éstos fueron escasos durante los días de actividad del animal en el bosque transicional chaco-chiquitano y parecen haber estado limitados a los sitios con bosque más abierto (Fig 4). El sitio de recuperación de este collar fue un claro con arbustos densos pero sin árboles altos por encima, lo que probablemente permitió la buena recepción. Una prueba con uno de estos collares puesto cerca del suelo en tres hábitats de SM (Venegas 2006) mostró que la recepción en un sitio de bosque alto semideciduo chiquitano fue nula sobre 31 localizaciones programadas, en el bosque transicional chiquitano-chaqueño fue baja (15%, o 5/24) y en la variante chaqueña sobre suelos mal drenados que tiene menor altura la recepción fue alta (68%, o 11/18). Dado que el mosaico de vegetación de esta área incluye también palmares abiertos, pasturas implantadas y humedales, igual aconsejamos el uso de collares gps para estimar los poco conocidos desplazamientos de las tropas. Sin embargo, habrá que tener presente en los análisis que la proporción de uso del bosque alto será subestimado en relación a hábitats más abiertos.

De esta experiencia queremos dar las siguientes recomendaciones:

- Es importante definir un seguimiento complementario por telemetría VHF de los animales con collares gps para confirmar la actividad y agilizar la recuperación de los collares en caso de muerte. Un período de 60 días de seguimiento podría cubrir efectos de posibles lesiones cardíacas relacionadas con la captura, ya que en la persecución los niveles de estrés pueden causar luego muertes por miocarditis (R. Nállar, com. pers.).
- Para el tratamiento de datos de gps recomendamos preparar hojas electrónicas, agregar campos extra (obs #, calidad de señal, y 'cuenta') y explorar con tablas dinámicas, filtros y gráficos sus patrones de variación. Sugerimos reportar la eficiencia y calidad de las localizaciones para diferentes tipos de hábitats y explorar otras relaciones de manera de entender mejor las limitaciones de esta tecnología.
- El análisis de los puntos en el SIG permite identificar los períodos con desplazamientos 'reales' y separarlos de los errores en la localización. Es muy importante poder ver las tablas de datos, hacer 'sorts' y 'queries' mientras se mira el mapa (como en ArcView). En TM se mira más rápido, pero sus análisis son limitados. Las localizaciones de baja calidad (1D, 2D), pueden dar errores de hasta 800m en el bosque semideciduo. Hay que poder identificar estos errores usando la lógica y el patrón visto en otras localizaciones de la

zona.

- Recomendamos a quienes no tienen ArcView la aplicación de TrackMaker debido a su facilidad de uso y su capacidad para exportar archivos a Google Earth (ver Rumiz 2006). Con el uso de GE es posible examinar los desplazamiento animales sobre imágenes recientes que muestran el hábitat, la elevación, y permiten medir distancias con bastante facilidad.

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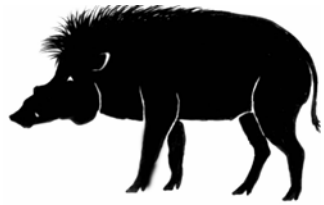

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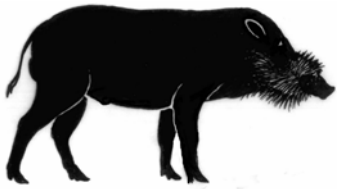

The Whole Hog—Exploring the Extraordinary Potential of Pigs

The Whole Hog is just that, an attempt to encompass everything that is known about all the pigs of the world.

George Orwell was right. Pigs are unquestionably the farmyard animals most likely to succeed. But why, exactly? Science has been slow to pin down the source of their superiority. Pigs are dramatically different from their closest and more placid relatives, sheep, deer and cattle. During forty million years of evolution, they seem to have made a series of canny decisions, adapting to changing circumstances much as humans have - by becoming more versatile, more gregarious and more curious. Sixteen species of wild pigs now occupy every continent except Australia and Antarctica, filling in the environmental gaps by deploying a panoply of domestic and feral forms - pigs for all seasons.

The Whole Hog is their story. The biologist Lyall Watson has tracked pigs in the wild, observed their resourceful and playful lives, deciphered their grunts and oinks - and is convinced pigs deserve new respect.

About the Author : Lyall Watson is a curious naturalist and author of more than twenty books, including Supernature, Lifetide, Lightning Bird and Jacobson's Organ. He divides his time between a farmhouse on the west coast of Ireland and a ranch house in the high desert of New Mexico.

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The society of swine

Lyall Watson's The Whole Hog and Fergus Henderson's Nose To Tail Eating are enough to get Ian Sansom reaching for the pork scratchings

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The Whole Hog: Exploring the Extraordinary Potential of Pigs by Lyall Watson. 288pp, Profile.

Nose to Tail Eating: A Kind of British Cooking by Fergus Henderson. 256pp, Bloomsbury.

You wait for ages and then along come two great, eccentric books both at the same time: one about a man and his love of pigs, and the other about a man and his love of pigs. The only difference is that Lyall Watson, author of The Whole Hog, is a naturalist, so obviously he spends his time watching animals and communing with them, while Fergus Henderson, author of Nose to Tail Eating, is a chef, so he cooks them. Watson explores the extraordinary potential of pigs by offering a natural history of peccaries, hogs and all breeds of the *Sus scrofa domesticus*. Henderson, on the other hand, explores their extraordinary potential by offering their spleens, hams, knuckles, trotters, cheeks, tongues, and tails variously crisped, baked, cured, boiled, stuffed and served with lentils.

Surprisingly perhaps, the two books complement each other perfectly, like beans and bacon, or warthogs and the savannah. In an opening sentence that you couldn't make up, but you might wish you had, Watson writes: "I have had close relationships with three species of wild pigs, each a chance encounter on a different continent, and all continue to enrich my life in surprising ways." This is extremely moving, if slightly mad, but it gets better: "I know of no other animals that are more consistently curious, more willing to explore new experiences, more ready to meet the world with open-mouthed enthusiasm." What's really funny is that by the end of the book Watson's convinced you that he's absolutely right. Forget love and marriage and children. Take the shortcut - get a piggery.

Watson says that he warms to pigs because they're gregarious, but it's possible the pigs warm to him because he's gregarious; he comes across, in his ramblings and adventures through pig history, pig-human relationships and "swine society" as a dour sort of Doctor Dolittle. Pigs have been boon companions to humans for centuries and they are now also, as Watson notes, "on the cutting edge of transplant technology" and full of potential, apparently, in warfare, used like packhorses and sniffer dogs. Mr Rumsfeld has no doubt already considered this.

Watson writes about scratching posts, dungsites and resting places, proto-pigs (the entelodont, "a scavenger with a head over 3ft long, decorated with knobby flanges wrapped around a tiny brain"), hog calling, pig evolution, and the inevitable industrial disassembly: "18% ham, 16% bacon, 15% loin, 12% fat back, 10% lard and 3% each of spare rib, plate, jowl, foot and trimmings." At which point, enter the brilliant and bespectacled Fergus Henderson, with his beautiful Nose to Tail Eating , "the classic cookbook from the chef of St John Restaurant". The book was first published in 1999 and, according to fellow chef Anthony Bourdain, who froths about it like a pan of burning butter, it is a "cult masterpiece".

Henderson's signature dish, apparently, is roast bone marrow and parsley salad; my wife forbade me from even attempting it. I can, however, report positively and at first hand on the mushy courgettes, the green sauce "and its possibilities", the treacle tart, and the pot roast brisket, which are all excellent, and, more importantly, easy. In a coy, winning prefatory list of "Four things I should mention", Henderson notes: "This is a book about cooking and eating at home with friends and relations, not replicating restaurant plates of food."

There are a lot of pig recipes in the book, and lots of useful hints and facts that readers may not have come across before - you only need one spleen per person, for example, and a head generally does for two - but for those who for religious or sheer piggy- snuffling reasons balk at the idea of pig's trotter stuffed with potato, Ferguson also offers plenty of interesting things to do with odd bits of ducks, quails, pigeons, sheep, cows, rabbits and hares. One suspects that if he got a hold of a dog, he'd make a pretty good job of that too.

Brief conservation news (1) - Revenge of the boar as herd wrecks town

Source: China Daily

Shaken burghers in the quiet Bavarian country town of Veitshoechheim were left licking their wounds and counting the cost after a herd of wild boars went on the rampage. The pack of boars, trying to escape from hunters, stormed through the town, knocking down a cyclist and running amok in a boutique. The 15 boars caused damage worth several thousand euros in Veitshchheim and Margetshchheim, before police killed some, while others escaped across a river.

Eyewitnesses said further mayhem ensued when one of the wild boars attacked a man in the street. The 44-year-old man needed hospital treatment after being bitten twice on the leg. A 76-year-old cyclist

was also knocked off her bike, police said. In Veitshchheim, a normally quiet town of only 10,000 people, the boars went on a two-hour rampage. One even breaking into a store, forcing the shop assistant to flee. "The shop assistant couldn't believe her eyes. She fled into a back room and called the police," Karl-Heinz Schmitt, from the regional police, said. "The boar broke several things in the store and then ran out again. It was later hit by a car."

Three of the pack were shot by police, while the boar from the store and one other were run over. One angry motorist was left with thousands of euros of damage to his blood-splattered car after he cannoned into a frenzied boar, knocking it dead. "We had some angry calls from people asking, 'Was it necessary to shoot them?' But I believe we had no choice," said Schmitt. "The animals were... in panic and they presented a great danger." Terrified children had to climb walls to get out of the boars' path, he added. Police marksmen intervened after officers received dozens of phone calls from scared townsfolk. One of the boars was cornered in a back garden and shot dead. Another was shot and killed while trying to swim across the nearby river Main. "It took more than two hours before peace could be finally restored," Schmidt said. The boars were probably born in spring but had grown to full size, said hunters.

Damage to cars will cost several thousand euros to repair, while the boutique has been left with a bill for 1,000 euros (US$1,315). The boar hunt was apparently called off early. The incident is believed to be one of the most devastating attacks by wild boars on record. The animals are normally regarded as harmless and will run away from people unless provoked or cornered with young offspring. Police attributed the aggressive behaviour to the fact that the animals were young, probably having been born only last spring.

Brief conservation news (2) - Wild boar may not be extinct after all

Source: Joe Lewis, Cyprus Mail

The Cypriot scientist who discovered the `Cyprus mouse' has said he has received reports of wild boar sightings in Paphos forest, contradicting the belief that they died out at least two years ago. Dr Eletherios Hajisterkotis, who organised of the biannual `International wild boar symposium' recently held at Kykkos Monastery, said that a study conducted two years ago concluded that wild boars were completely extinct from Cyprus. However, reports from villages near Paphos forest suggest that this may not be the case.

"Some of the villagers say that they have found boar tracks, and there are even reports of sightings," said Hajisterkotis. But the eminent scientist is erring on the side of caution, saying that, as of yet, there is no hard evidence to backup these anecdotal reports.

The animal is not indigenous to the island and was introduced to the wild in the early 90s, although archeological evidence suggests that people have kept pigs on the island for thousands of years. Over the past 10 years, hunting and inbreeding has reduced the numbers to the point of extinction. "It is illegal to hunt them, but the fact is that they were hunted. We didn't think it could happen because the hunters didn't have the correct ammunition. "On top of this, there has been inbreeding upon inbreeding." All Cypriot boars were descended from only five animals, significantly reducing the genetic diversity of the population. With such limited diversity it was unlikely that the population would flourish.

The wild boar symposium, held earlier this month, was attended by international experts from over 20 countries and was described as a great success. “It was one of the most successful scientific congresses that I have ever participated in,” said Dr Peter Heise-Pavolv from Australia.

Hajisterkotis explained that even though there may not be wild boars on the island, the conference provided an opportunity for the wider and pressing issue of conservation to be discussed. “Just by having these eminent international scientists here in Cyprus allowed us to learn a lot about conservation in general.” According to Hajisterkotis, the Cyprus Moufflon, the largest wild animal on the island, is currently under threat. “The Turkish invasion of 1974 not only caused enormous material destruction, but also burnt down, with napalm bombs, a large past of our forests. At least a third of Paphos forest was destroyed, (the only place that moufflon inhabit), and many moufflon were killed.” Although the animal is protected by law there is evidence that, like the wild boar, the moufflon is still being hunted. The species is also threatened by the limitation of its habitat. “The fact that the moufflon only exists in the Paphos forest also threatens its survival,” concluded Hajisterkotis. A full report on the International wild boar symposium will be available on the ministry of interior website (www.moi.gov.cy) in the next couple of weeks

Brief conservation news (3) - Extinct island pig spotted again

Source: BBC NEWS: http://news.bbc.co.uk/go/pr/fr/-/2/hi/uk_news/scotland/north_east/6155172.stm

An extinct Shetland pig with tusks which roamed the islands in the 1800s is brought back to life at a museum. A model of the grice - which was the size of a large dog and had tusks - has been created after work by researchers and a taxidermist. The pig, which attacked lambs, was kept domestically until the 1800s, when landowners forced islanders to keep fewer swine and the breed died out. The model will go on display at the new Shetland Museum and Archives.

The grice was covered with long stiff bristles over a fleece of coarse wool. In order to reconstruct it, Dr Ian Tait, curator of collections at Shetland Museum, trawled through published sources to find various descriptions, and investigated artefact and archaeological findings. His colleague Angus Johnson, archives assistant at Shetland Archives, also researched documents. Their work was put together to produce a detailed description of what the pig looked like. The job of bringing the pig back to life was then handed to taxidermist David Hollingworth.

They decided to use an immature wild boar, adding tusks and a ridge of four inch long black hairs down the animal's back.Dr Tait said: "No-one alive today has seen a Shetland grice, so making this reconstruction relied on months of research, finding out how large the animal was and what colour and shape it was. The result has been well worth all the hard work.

"We are confident that the reconstruction is an excellent interpretation of the pig breed that lived in Shetland for many centuries. "We're delighted that visitors to the museum will now be able to see for themselves an animal that had such a large part in Shetland's farming history." Shetland Museum and Archives is due to open to the public in spring 2007.

Right: The grice had tusks and would attack lambs

Brief conservation news (4) - Thailand tigress adopted baby pigs

In Thailand a royal Bengalese tigress playing with baby pigs at a zoo in Chonburi province, 80 km east of Bangkok. The tigress was born in Captivity and breast-fed by a female pig for four months after her birth. See the following URL for more photos: http://pigtrop.cirad.fr/en/inquisitive/SV_thailand_tigress_adopted_baby_pigs.htm

Brief conservation news (5) - DR Congo hippos 'face extinction'

Source: BBC News, UK

Poaching has brought the hippopotamus population in Democratic Republic of Congo to within a few months of extinction, wildlife experts say. Researchers from the Zoological Society of London (ZSL) say the population has halved in the last two weeks. They say the Mai Mai militia has set up camp in Virunga National Park and catches the animals for meat and ivory.

The hippo entered the Red List of Threatened Species this year, and is declining in many parts of Africa. ZSL says the militia killed hundreds of hippos in a two week period, and numbers now are below 400. Its scientists warn the entire population may disappear before the end of the year without urgent action. Twenty years ago there were about 22,000 hippos in Virunga Park, but the country's civil war brought numbers crashing down. Its location on the border with Uganda and Rwanda has made it prone to incursions. Rwandan rebels fled to the area after the 1994 genocide. The situation had stabilised after campaigns by Congolese and UN troops to oust the rebels and the establishment of an elite ranger corps within the park. Some of these rangers have reportedly been attacked by the Mai Mai group.

ZSL's Bushmeat and Forests Conservation Programme Coordinator, Lyndsay Gale, who spends about half of her time in Virunga, said: "This is one of the biggest challenges the park rangers have had to face since the war. "It comes as a devastating blow after recent surveys indicated wildlife populations were beginning to recover from over a decade of civil war." As well as hippos, the militia is also hunting buffalo and elephant, ZSL reports. Ivory taken from elephant tusks and hippo teeth is sold for profit. The society is appealing for more funds to go into its work with local conservation groups and rangers.

There are thought to be about 130,000 hippopotamus in Africa, with Zambia holding the biggest population. But a continent-wide decline of about 30% in 30 years brought its inclusion on this year's Red List as a species vulnerable to extinction.

New Literature on Suiformes

Ecology and conservation studies

1. Tierney, T. A. and J. H. Cushman (2006). "Temporal changes in native and exotic vegetation and soil characteristics following disturbances by feral pigs in a California grassland." Biological Invasions **8**(5): 1073-1089

Abstract: Invasive species that increase prevailing disturbance regimes can profoundly alter the composition and structure of ecosystems they invade. Using both comparative and manipulative approaches, we investigated how native and exotic vegetation and soil characteristics at a coastal grassland site in northern California changed through time following disturbances by feral pigs (Sus scrofa). We quantified these successional changes by comparing pig disturbances of varying ages (2, 14, 26+, and 60+ months) during the spring and early summer of 2001. Our results indicate that species richness of native plants increased slowly but steadily through time following disturbances, whereas richness of exotic species rebounded much more rapidly. Percent cover of native perennial grasses also increased steadily through time after pig disturbance, whereas the cover of exotic perennial grasses, annual grasses and forbs initially increased rapidly after disturbance and then remained the same or subsided slightly with time. The cover of native forbs and bulbs either increased weakly through time following disturbance or did not change substantially. Pools of ammonium and nitrate in the soil did not change greatly through time following pig disturbance. Net mineralization rates for ammonium and nitrate also varied little with age since disturbance, although we did find that nitrate mineralization was greater at intermediate ages in one study. Neither organic matter content or particle size varied significantly with disturbance age. In summary, we have shown that native and exotic plants from different functional groups vary greatly in how they recovered from pig disturbances. Exotic taxa were generally able to rapidly colonize and persist in pig disturbances, whereas native taxa usually exhibited a slow but steady rebounding following pig disturbance. Given our results, and those of others from nearby sites, we suggest that the health of coastal grasslands may be enhanced substantially by eliminating or greatly reducing the size of feral pig populations.

2. Weckel, M., W. Giuliano, et al. (2006). "Jaguar (*Panthera onca*) feeding ecology: distribution of predator and prey through time and space." Journal of Zoology **270**(1): 25-30

Jaguars *Panthera onca* inhabiting tropical or subtropical evergreen moist forest have often been classified as opportunistic predators because they consume prey relative to its availability. However, these studies failed to address simultaneously the distribution of predator and prey through time and space, which may lead to an incomplete or erroneous understanding of jaguar foraging strategies. In this study, we reconstructed jaguar diet from scat, and used camera traps to investigate jaguar prey availability and the distribution of jaguar and its prey through space and time. We focused our examination of predator-prey temporal and spatial relations on forest infrastructure comprising man-made paths, small mammal trails, tapir *Tapirus bairdi* trail and trail-less, forested areas as they represent distinct habitats for prey selection. Overall, we observed high overlap between the prey used and available, suggestive of opportunistic foraging. However, jaguars exhibited selective tendencies in discriminating between larger prey. Jaguars used collared peccary *Tayassu tajacu* greater than its availability, while preying upon the equally abundant and similarly distributed white-lipped peccary *Tayassu pecari* and tapir less than predicted based upon availability. Armadillo *Dasypus novemcinctus* and paca *Agouti*

paca, 56.6% of total consumption, were consumed relative to availability but exhibited low spatial overlap with jaguar. Armadillo and paca used trail-less, forested areas and small mammal trails not used by jaguar and were photographed more frequently at greater distances from man-made paths, major thoroughfares for jaguars. This study suggests that although forest jaguars use prey relative to its abundance, jaguars may rely on foraging strategies other than chance encounters for exploiting prey.

3. Treydte, A. C., S. M. Bernasconi, et al. (2006). "Diet of the common warthog (*Phacochoerus africanus*) on former cattle grounds in a Tanzanian savanna." Journal of Mammalogy 87(5): 889-898

Abstract: In otherwise nutrient-poor savannas, fertile vegetation patches are particularly attractive to ungulates because of the higher-quality food they provide. We investigated forage plants and diet of the common warthog (*Phacochoerus africanus*) on an abandoned cattle ranch in coastal Tanzania. The forage grasses of highest nutritional quality occurred in former paddock enclosures (bomas) where cattle had been herded at night. In the dry season, grass samples from bomas contained approximately 4 times as much nitrogen and phosphorus as those of the surrounding vegetation. delta N-15 values of soil and plants also were highest in bomas and decreased significantly with distance, and high delta N-15 values in feces suggest that warthogs preferentially fed in the vicinity of the former bomas. delta C-13 values of warthog feces indicate that warthogs ingested on average 83% (77-98%) C-4 grasses, with this proportion varying regionally but not seasonally. We conclude that, for medium-sized selective grazers such as warthogs, bomas represent attractive feeding grounds. We also hypothesize that by promoting nutrient turnover in these patchily distributed areas, grazing animals help to maintain them as sources of high-quality forage.

4. Merli, E. and A. Meriggi (2006). "Using harvest data to predict habitat-population relationship of the wild boar *Sus scrofa* in Northern Italy." Acta Theriologica 51(4): 383-394

Abstract: The relationships between the wild boar *Sus scrofa*, Linnaeus 1758 density and the habitat characteristics were investigated by collecting bag records in 18 hunting areas during the 1995 and 1996 hunting seasons. The study areas were located in the Northern Apennines (N-Italy) from 470 to 1160 m a.s.l. In each study area a Density Index (DI) was calculated by weighting the number of wild boar culled in each hunting season on the number of hunting days and on the surface of the study areas. Moreover 16 habitat variables were measured in each study area. Correlation and regression analyses were performed considering the DI as a dependent variable. Mixed deciduous woods were positively correlated with wild boar density together with chestnuts woods and conifer reafforestations. No significant negative correlations were found. Twelve multiple regression models each including three habitat variables were ranked by the information-theoretic approach (modified Akaike's information criterion). The study stressed the importance of mixed woods for wild boar and the usefulness of hunting data as a mean to predict the habitat suitability for the species.

5. Fernandez, N., S. Kramer-Schadt, et al. (2006). "Viability and risk assessment in species restoration: Planning reintroductions for the wild boar, a potential disease reservoir." Ecology & Society 11(1): NIL_73-NIL_89

Abstract: The reintroduction of large mammals is often considered a priority conservation action in highly industrialized countries in which many of these species have been depleted. However, species reintroduction after decades of absence may involve important risks for human activities and ecological communities, such as favoring the spread of diseases. An example of a potentially troublesome reintroduction is the wild boar, which may act as a reservoir of diseases, e. g., classical swine fever, and cause high economic losses, and has become a species of concern in several European countries for both ecological and recreational reasons. Failure to prevent the disease consequences of species restoration can negate its conservation benefits. Here we evaluated the probability of both successfully reintroducing wild boar into Denmark and limiting their contact with domestic pig farms to which they

might spread disease. For this purpose, we developed a spatially explicit, individual-based population model that incorporates information on boar habitat and demography information from Central European populations. We then compared model predictions with the spatial distribution of farms to achieve a spatial assessment of the contact risk. The most restrictive model scenario predicted that nearly 6% of Denmark provides habitat conditions that would allow wild boar to reproduce. The best habitats for reintroduction were aggregated in seven different areas throughout the country in which the extinction probability was < 5%. However, the expected population expansion was very limited in most of these areas. Both the number of suitable areas and the potential for population expansion greatly increased when we relaxed our habitat assumptions about boar forest requirements; this provided a more conservative scenario for a cautious risk analysis. We additionally found that part of the risk of contact with piggeries was associated with the magnitude of the expansion, although the non-random spatial pattern of farm distribution also had a strong influence. The partitioning of risks into those related to population expansion and those related to farm distribution allowed us to identify trade-offs between restoring boar populations and minimizing risks in different potential areas and under different risk scenarios; as a result, we rejected some of the particularly high-risk areas for potential reintroduction of the species. Our approach illustrates how the joint quantification of anticipated reintroduction success and associated risks can guide efforts aimed at reconciling species recovery and the affected health and economic interests.

Taxonomic, morphological, biogeographic, and evolutionary studies

1. Gongora J, Morales S, Bernal JE, Moran C. 2006. Phylogenetic divisions among Collared peccaries (*Pecari tajacu*) detected using mitochondrial and nuclear sequences. Mol Phylogenet Evol. 41(1):1-11.

Abstract: The Collared peccary (*Pecari tajacu*) is one of the three extant recognised species of the family Tayassuidae, living in the Americas. To understand phylogenetic relationships among Collared peccaries, the entire mitochondrial DNA control region and cytochrome b as well as partial nuclear GPIP and PRE-1 P27, PRE-1 P642 and TYR sequences from specimens from Colombia, Argentina, Bolivia, Mexico, United States and Australian zoo animals of unknown origin were analysed. Separate and combined analyses of the mitochondrial sequences provided good resolution of Collared peccary relationships. Nuclear sequences were partially informative when combined sequence analyses were performed. Maximum Likelihood analyses of mitochondrial sequences showed that Collared peccaries clustered in two major clades, representing North-Central American and South American specimens. Collared peccaries from Colombia are paraphyletic. Statistical Parsimony analysis of combined nuclear sequences showed a distribution of DNA variants consistent with mitochondrial sequence analyses. However, there is an uncoupling of nuclear and mitochondrial sequence variation in two specimens from Colombia. The present study suggests the recent contact of isolated populations within Colombia and possible mitochondrial introgression between the North/Central clade and the South clade. Pairwise genetic distances comparison of mitochondrial sequences show that divergence between the two major clades of the Collared peccary was higher and comparable respectively with that within and between the other two recognised peccary species. Divergence between the two major clades of the Collared peccary was also higher than that observed within and even between recognised species of the Suidae family. The divergence within the major clades of the Collared peccary showed comparable values with those observed within the other two species of Tayassuidae and within six species of Suidae. The results show that the geographically widespread and phenotypically diverse Collared peccary consists of two species or at least subspecies with implications for management of wild, zoo and captive populations.

2. Massolo, A. and R. M. della Stella (2006). "Population structure variations of wild boar *Sus scrofa* in central Italy." Italian Journal of Zoology 73(2): 137-144

Abstract: The study has been carried out on a wild boar *Sus scrofa* population in southern Tuscany (Italy). We aimed to estimate the trend in population structure and productivity of a harvested and high-density population. From 1990 to 1996 we examined 2773 harvested wild boars, assessing age, sex, and number of foetuses per females. We highlighted an increase of the proportions of yearling following a season with a peak of two-year individuals. Neither significant differences in mean foetus numbers among age classes nor among seasonal variations have been pointed out. Productivity peaks seemed to be related to peaks in sub-adult females in previous seasons, while food availability and harvest could have been responsible for fluctuations of sub-adult females. Fluctuations seemed more likely linked to an alternation of high and low frequency in the recruitment of females in the breeding pool than to individual differences in prolificity. Massive harvesting could bring sub-adult females and males to reproduction when adult individuals are scarce, incrementing the overall productivity, but young individuals are possibly more sensitive to environmental variations. We suggest that these studies should last longer and be strictly associated to a contemporary monitoring of trophic resources.

Veterinary studies

1. Wheaton, C. J., S. Joseph, et al. (2006). "Body weight as an effective tool for determination of onset of puberty in captive female Nile hippopotami (*Hippopotamus amphibious*)." Zoo Biology 25(1): 59-71

Abstract: Profiles of fecal progestogens and body weight from the early juvenile to the peripubertal period are presented for eight captive female Nile hippopotami housed at Disney's Animal Kingdom in Florida. Average growth rate in juveniles was 0.85 +/- 0.03 kg/day (r(2) = 0.913). Progestogen elevations were detectable as early as 16.8 months of age, and elevations indicative of ovulation and luteal activity were identified in seven of eight females by 30.3 +/- 1.6 months of age and body weight of 829.3 +/- 49.4 kg. Progestogen patterns before the Onset of puberty were highly variable within and between females. Some females remained at baseline concentrations, whereas in others the progestogen pattern was characterized by infrequent, transient elevations of low amplitude and shortened duration. Four females were monitored through Onset of puberty, conception, and first pregnancy. Onset of puberty was defined as the first luteal phase from the series of consecutive ovarian cycles culminating in conception and was observed at 34.9 +/- 2.2 months of age and 963.6 +/- 39.4 kg, however, the quality and number of cycles varied among females before conception. Females conceived between 2.7-3.9 years of age after attaining an approximate threshold body weight of 1,000 kg (1,070.5+/-39.5 kg). The age at first conception in captivity occurs at a younger age than has been reported for wild populations. Body weight may be an effective tool for approximating the state of reproductive maturity and facilitate collection management in zoos.

2. Mayor, P., Y. Le Pendu, et al. (2006). "A health evaluation in a colony of captive collared peccaries (*Tayassu tajacu*) in the eastern Amazon." Research in Veterinary Science 81(2): 246-253

Abstract: This study pretends to determine baseline data on the health and mortality of a colony of captive collared peccaries in the Eastern Amazon (Belem, State of Para, Brazil) during a 65-months survey. Thirty-nine out of 166 animals (23.5%) died and were examined postmortem. Monthly mortality averaged 1.2%. The highest mortality rate was observed in newborns (74.4%). Abandonment by the mother and aggression were responsible for 24.1% and 13.8% of the total newborn deaths, respectively. Most frequent causes of non-neonatal death were food poisoning (50.0%) due to an episode of accidental bitter cassava leaves ingestion and traumatism due to aggressions between animals (10.0%). Results from serology for different infectious diseases showed that 4.9% (2/41) collared peccaries had antibodies against Brucella spp. and 9.8% (4/41) animals had antibodies to two different Leptospira spp. serovars, butembo and auttannalis. This is the first survey of morbidity and mortality in captive collared peccaries in the Amazon region.

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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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