Suiform Soundings

ISSN: 1446-991X

PPHSG Newsletter

Volume 7(2) December 2007

Suiform Soundings

is the newsletter of the IUCN/SSC Pigs, Peccaries, and Hippos Specialist Group (PPHSG). This newsletter is electronically available at: http://iucn.org/themes/ssc/sgs/pphsg/home.htm

IUCN
The World Conservation Union

SSC
Species Survival Commission

Photo front page: *Hippopotamus amphibious* photographed in the Kazinga channel, Queen Elizabeth National Park, Uganda. Photo courtesy of R.G. Gordon.

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PAPERS AND COMMUNICATIONS

Editorial: Communities and Conservation

I have recently started working for the Cheetah Conservation Fund, a conservation NGO based in north-central Namibia that is primarily concerned with ensuring the survival of the endangered cheetah. However, while pursuing the cause of the cheetah, we invariably affect the livelihoods of many other wildlife species living in the same habitat. Much of my work revolves around farmer training workshops, where the emphasis is placed on integrated livestock and predator management. In other words, advising farmers on ways in which they can farm in harmony with nature, instead of fighting daily battles with predators, wild herbivores and other creatures that roam though their farmlands. This is no easy task – most of Namibia's wildlife occurs not in national parks and reserves, but on communal and commercial farmlands, with farming being, at present, one of the top income generators for the country. Herbivores compete with livestock for grazing and browsing, predators eat cattle and goats, and other animals, like baboons, warthogs and porcupines, are just seen as pests in general, causing havoc with fences & water pipes. So why should farmers tolerate wildlife on their lands when it is seen as having no real value to them?

This situation is not unique to Namibia, nor is it only an issue when dealing with African species. In many ways, the same problems that face the farmers here affect rural communities across the rest of Africa, as well as South America and Asia, and the issues facing the cheetah – loss of suitable habitat, conflict with farmers – are applicable to many of the pigs, peccaries and hippos that this specialist group deals with. As the human population increases, our demand for space and resources increases, with the result being that human and wildlife populations come into increased contact, and conflict situations escalate. It is no use simply appealing to the farmers' sympathies and asking them not to kill wildlife, especially where there is a monetary loss involved. Viable solutions must be found that suit both the farmers and the conservationists. Our farmer courses follow a two-part approach. Firstly we discuss the value of the specific species in the ecosystem, be it rodents, warthogs or cheetahs, why these species are important to farmers, and what their removal from the ecosystem would mean. Secondly, we teach alternative methods of reducing losses to predators and ways in which farmers can live with wildlife, while discouraging the knee-jerk reaction of killing animals once the damage has been done and money has been lost. To put more of a suiform spin on things, many farmers complain that warthogs are pests as they dig holes under their game fences, allowing other game species to "escape" from their farms and predators to enter. One solution to this problem is the use of swing gates (Schumann *et al*., 2006), which allows warthogs and other burrowing animals to pass through game fences without damaging them, while keeping precious animals belonging to the farmer on the inside of the fences. As with many other wildlife species, warthogs also have a monetary value, and farmers come to realise that if they want sustainable populations from which they can harvest individuals, either for meat or for trophy hunting, they need to conserve the species.

Communities cannot be separated from conservation incentives. In the next issue of Suiform Soundings I would very much like to hear from you about practical conservation solutions to the problems facing suids around the world, as well as situations where solutions are yet to be found. And, as always, all feedback, articles and contributions relating to pigs, peccaries and hippos will be eagerly received.

I hope you enjoy this next issue, where, amongst other things, the discovery of a new peccary species is challenged, we follow the progress on the establishment of a breeding centre for Javan warty pigs, and we receive an updated reference list of peccary publications.

May 2008 be a happy and successful year for you all.

Anne-Marie Stewart, Otjiwarongo, Namibia

Refs: Schumann M, Schumann B, Dickman AJ, Watson LH and Marker LL. 2006. Assessing the use of swing gates in game fences as a potential non-lethal predator exclusion technique. *South African Journal of Wildlife Research* 36(2): 173-181.

Another word from our Afro-tropical co-ordinator . . .

Dear Members,

Following on from my plea in volume 7(1), I am trying to update the action plan for the Suidae of the Afro-tropical region. I still feel that the next step for the PPHSG is to re-write the Action Plan for all species in 2008. As a slightly-ambitious target, why don't we (the co-ordinators of all regions) aim to have this in place by October 2008? After all, we have the 1993 Action Plan as a blue print from which to update our current knowledge. Once the action plan is updated, we can reassess where we are and where best to focus our future efforts.

I would like to thank the two members who sent information to me regarding the two warthog species, and while I would welcome any further information any of you may have on these two species, I would like to extend my request to include all Afro-tropical Suidae. Could anyone who has worked with or even held an interest in these species send any relevant information to me (distribution, population size, local extinctions, increased pressures in particular regions on these species etc.)? Furthermore, should any of you have any updated information from 1993 on any Pig, Peccary, or Hippo species, I will forward it on to the relevant co-ordinator of that group. Thank you very much in advance to all those who are able to help in any way.

With best wishes, and in anticipation,

Chris Gordon
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Progress Report:

The establishment of a captive breeding facility for Javan warty pigs (*Sus verrucosus*)

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Progress in 2007 on the captive breeding of Javan warty pigs (*Sus verrucosus*) in Indonesia has been relatively slow due to some problems. First, being in a predominantly Moslem country, the presence of such a "pig breeding centre" faces social resistance due to the "haram" (prohibited) status in the religion. All wild pigs in Java are also considered to be pests, therefore the presence of captive breeding facilities is unacceptable to the majority of people for fear of pigs escaping. Lastly, to obtain live Warty pigs is a big job, as no hunters are willing to catch live pigs as the chances of getting "warty pigs" are very low. A pamphlet/poster has since been distributed requesting assistance should someone catch or know of the whereabouts of live warty pig.

We finally had success with the location of a breeding centre in Sukabumi, using the existing animal rescue facility, in August 2007. Thus far we have 3 heads on the premises: one confirmed adult male, *Sus verrucosus*, and two unconfirmed piglets (male and female, 2 months). At the piglet size it is difficult to identify the species positively as *verrucosus*. Only once the animals reach sub-adult age can this be done with any confidence. It has been proposed that the stripe type of *verrucosus* can be used as an external indicator to differentiate these animals from *Sus scrofa*. However thus far we are unable to verify the accuracy of this as an external indicator.

One old *verrucosus* male from Ragunan Zoo has been promised to our breeding program, should he still be capable of mating. This animal will soon be transported to our facility and observed for the possibility of natural mating or alternatively for use in the artificial insemination program.

In addition, we had three responses from "*verrucosus* habitat" in Banjar, Ciamis, West Java, where local hunters had caught piglets during their hunting. However, due to a lack of funding, this report has not yet been followed up.

As for the molecular profile of pure *verrucosus*, we are collaborating with Prof. Dr. Martien Groenen from Wageningen University, the Netherlands. Unfortunately the analysis is still ongoing, due to the fact that the DNA being isolated is small in volume. These samples will be tested for the presence of *scrofa* alleles through a 384 SNP set test.

As for publications, we have managed a short article on internal parasites of captive animals, published in a local journal.

Estructura organizativa del subgrupo pecaríes de la PPHSG/SSC/IUCN

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Durante el último congreso de manejo de fauna silvestre que se realizó en Bahía, Brasil, se organizó un taller sobre pecaríes que contó con la participación de unas 20 personas. Uno de los temas de discusión del taller fue el fortalecimiento del sub-grupo pecaríes. Estamos en un buen momento, en el que hay muchos jóvenes trabajando con estas especies, contamos con bastantes publicaciones, y reconocemos la necesidad de aumentar nuestro conocimiento sobre conservación y manejo de pecaríes. Una de las propuestas del taller fue formar una estructura organizativa del grupo pecaríes, creando diferentes comités de trabajos, en los cuales participarían tanto miembros oficiales del PPHSG como otros investigadores y estudiantes interesados en pecaríes. Finalmente logramos tener una estructura armada, y queremos publicarla para que todos puedan conocer los comités de trabajo y los roles auto-designados, además de los nombres de las personas que han ofrecido su tiempo para colaborar con el grupo. También queremos invitar a otras personas a unirse a esta estructura, ya que existen aun varios puestos vacantes. Los interesados en formar parte de comités pueden contactarse directamente con los coordinadores. Una vez que cada comité este formado los miembros del mismo se pondrán en contacto y determinarán sus propias metas a corto y largo plazo.

Objetivos del sub-grupo pecaríes

1. Contribuir a la conservación de los pecaries a través del manejo e investigación, tanto en cautiverio como en vida silvestre.
2. Consolidar el grupo de investigadores, gestores y otras personas interesadas en la biología, conservación y manejo de los pecaríes para que este grupo sea un foro de coordinación, comunicación e intercambio de lecciones aprendidas.
3. Fomentar y promover la formación de recursos humanos en pos de la conservación, manejo y promoción de los pecaries.

Estructura organizativa del subgrupo pecaries

Vice-director del PPHSG: Andrew Taber
Director del subgrupo pecaríes: Andrew Taber
Vice-director del subgrupo pecaríes: Richard Bodmer
Coordinador pare el uso sustentable de los pecaríes: Richard Bodmer
Coordinador para la conservación de los pecaríes: Mariana Altrichter

Coordinadores de especie

Tayassu tajacu: Harald Beck
Tayassu pecari: Rafael Reyna y Eduardo Naranjo
Catagonus wagneri: Mariana Altrichter

Coordinadores por pais

Argentina: Mariana Altrichter
Brasil: Alexine Keuroghlian
Peru: Harald Beck
Otros países: Vacantes

Comités de trabajo

Boletín: *Coordinadores*: Edsel Amorim y Mariana Altrichter
Educación: *Coordinador*: Vacante
Mercadeo y website: *Coordinador* Vacante:
Cría y manejo en cautiverio: *Coordinador*: Pedro Mayor. *Miembros*: Paulo Rogerio Mangini, Gonzalo Barquero, Hilma Lúcia Tavares Dias, Diva Anelie de Araujo Guimarães; Natália Inagaki de Albuquerque, Yvonnick Le Pendu.

Metodología para estudios de campo: *Coordinador*: Rafael Reyna. *Miembros*: Eduardo Martins Venticinque. Paulo Rogerio Mangini, Harald Beck. Gonzalo Barquero
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Estudios veterinarios: *Coordinador*: Pedro Mayor. *Miembros*: Paulo Rogerio Mangini, Gonzalo Barquero; Hilma Lúcia Tavares Dias, Diva Anelie de Araujo Guimarães; Natália Inagaki de Albuquerque, Yvonnick Le Pendu.

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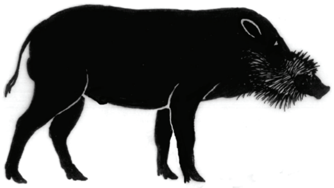
Papers and communications



Article reprinted from: van Roosmalen MGM, Frenz L, van Hooft P, de Iongh HH and Leirs H. 2007. A new species of living peccary (Mammalia: Tayassuidae) from the Brazilian Amazon. *Bonner Zoologische Beiträge* 55: 105-112.

A new species of living peccary (Mammalia: Tayassuidae) from the Brazilian Amazon.

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Abstract

Here we report on the existence of a new species of even-toed ungulate in the Brazilian Amazon, which we name *Pecari maximus*, the giant peccary. It represents the largest of living peccary species. One complete mitochondrial D-loop and two nuclear SINE PRE-1 DNA sequences of giant peccary compared with that of the sympatric and morphologically most similar collared peccary (*Pecari tajacu*) support full species status. The divergence time is estimated at 1.0–1.2 million years before present. In contrast to other peccaries, which are gregarious and range semi-nomadically in large home ranges, giant peccaries appear to live in family groups containing only a pair of adults, with or without 1–2 offspring. In view of recent developments in the interfluves where it lives and due to its limited distribution, we consider the giant peccary endangered.

Keywords: New species, Artiodactyla, Tayassuidae, Pecari maximus, giant peccary, Brazilian Amazon.

Introduction

Until recently only three extant species in the New World Artiodactyla family Tayassuidae (peccaries) were known to science, belonging to three genera (Grubb, 2005): the collared peccary *Pecari tajacu* (Linnaeus 1758), the whitelipped peccary *Tayassu pecari* (Link 1795), and the Chacoan peccary *Catagonus wagneri* (Rusconi 1930). A living population of the latter which was thought to have gone extinct was discovered in 1974 in the Chaco region on the borders of Bolivia, Paraguay and Argentina (Wetzel *et al*., 1975). During transect surveys of megafauna and fruits conducted in January 2000 in the Rio Aripuanã basin, the first author saw a group of three peccaries, not belonging to any of the known species. Since then, the first author has had several encounters with such peccaries and collected some basic ecological and behavioural data. In March 2003, the first two authors succeeded in filming a group of four such peccaries and collecting zoological material from game brought into the village of Arauazinho.

Description of Species

Class Mammalia; Order Artiodactyla; Family Tayassuidae Palmer, 1897; Genus *Pecari* Reichenbach, 1835

Pecari maximus sp. nov. (Figs. 1–3)

M**aterial.** Five skins in the possession of hunters along the lower Rio Aripuanã and a complete skull without exact locality data obtained from them (MR316); an incomplete skull with skin (MR315) from an adult specimen killed in December 2003 along the Rio Arauazinho; a complete skull (INPA4272) from an adult male killed by locals on March 12, 2003, along the left bank of the Rio Aripuanã near the settlement of Arauazinho. Several skulls and mandible parts of all three peccary species occurring in the area were examined as found in the kitchen middens of some local communities.

Diagnosis and discussion. A species of *Pecari* differing from the only other known species in this genus, *Pecari tajacu*, in being much larger but less robust, with much longer legs and a proportionally small head only slightly bigger than that of *Pecari tajacu*. Most of the body thinly bristle-haired, overall colour brown mixed with dirty white, a black mid-dorsal mane running from between the ears as far as the rudimentary tail. Ears small and whitish at distal surface. Nasal disc pinkish, relatively small and soft. Collar running over the shoulders very faint, dirty white, or absent (Figs. 1 and 2).

Fig. 1. Wild giant peccary *Pecari maximus* sp. nov. visiting a pond in the middle of continuous high rain forest; **a.** and **b.** show two different adult individuals belonging to the same family of four giant peccaries (Copyright NDR Naturfilm/Roland Gockel).

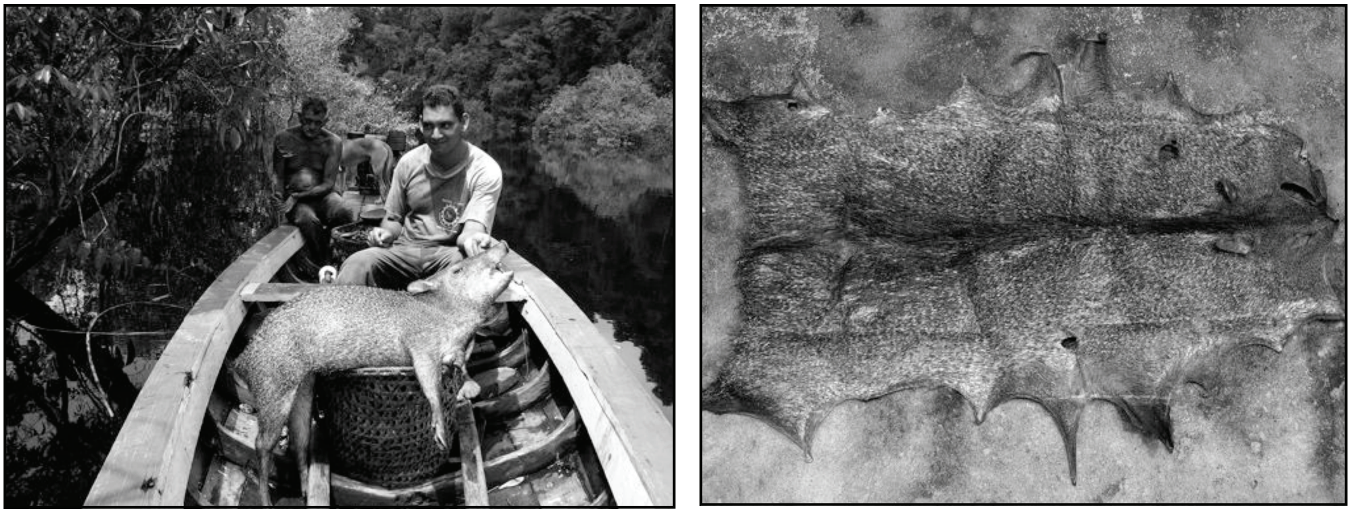

Fig. 2. a. (left) Hunters with freshly killed adult male specimen of *Pecari maximus.* The skull of this individual was saved and is here designated as the holotype (INPA4272). (Copyright by Frieder Salm); **b.** (right) Skin of *Pecari maximus* paratype specimen MR315, lacking even a faint collar.

Whitish, thinly haired circumocular rings (Fig. 1). Distinguished from all other peccary species by its larger size; thin fur; proportionally longer legs giving it a more gracious general appearance; proportionally smaller head - skull length one fifth of total body length in *Pecari maximus*, one quarter in *Pecari tajacu* and *Tayassu pecari* (Woodburne, 1968), and nearly one third in *Catagonus wagneri* (Wetzel, 1977; Wright, 1989); less developed nasal disc; smaller ears. The new species is assigned to the genus *Pecari*, as it possesses a number of traits – in particular cranial features (Fig. 3 and Table 1) – in common with sympatric *Pecari tajacu*, from which it differs by its much larger size and weight (40–50 versus 22 kg), less stocky and longer-legged general appearance, thin, grizzled brown and white fur (instead of thick, dense, strongly speckled dark blackish-grey fur), blacker on the limbs and along the dorsal crest, and a very poorly expressed, sometimes absent, dirty white instead of strikingly contrasting bright white collar passing across the chest from shoulder to shoulder (Bodmer & Sowls, 1993; Grubb & Groves, 1993). Distinguished from *Tayassu pecari*, with which it is also sympatric, by its larger body size and weight (40–50 vs. 28 kg), and grizzled-brown thin fur instead of thick, long, evenly coloured blackish brown fur becoming grizzled or light-coloured only in the pectoral and inguinal regions. The forelimbs and legs are only distally black, while they are grizzled black and tan on the lateral and hind surfaces of the forelimbs in *Tayassu pecari* (Grubb & Groves, 1993; March, 1993). In contrast to the general blackish brown body colour, the chin, cheeks and sides of the muzzle are white or yellowish-white in white-lipped peccaries. Distinguished from *Catagonus wagneri*, with which it is allopatric, by its larger body size and weight (40–50 vs. 29–38 kg), grizzled-brown thin fur with or without a faint dirty white collar instead of brownish-grey thick fur with a distinct bright white collar (Wetzel, 1977; Wright, 1989; Grubb & Groves, 1993).

Overall, the cranium of *Pecari maximus* seems more related to that of *Pecari tajacu* than that of *Tayassu pecari* or *Catagonus wagneri*, but it differs in the following characters: it is clearly longer, wider and more robust; the frontal bone between the postorbital processes is wider; the rostrum behind the canines is wider, the dorsal surface is broader and flatter; the canine buttresses are larger; and the canines are more pointed with sharper edges. Comparing the cranial morphometrics of *Pecari maximus* with *Pecari tajacu* from Brazil (i.e., INPA283, MR317, MR318), where the species appears to grow bigger, especially where it is sympatric with *Pecari maximus*, it may be noted that breadth measurements in general differ more significantly between the species than length measurements.

For example, length of cranium, mandible, and mandibular diastema do not show much difference, whereas breadth across zygomatic arches and between postorbital processes of frontals are much greater in *Pecari maximus*. The width between alveoli of M3 is slightly greater in *Pecari maximus* implying a differently shaped palate. Whereas the depth below P2 is the same in the two species, the depth below rear of M3 is much greater in *Pecari maximus*, so that the lower jaw deepens posteriorly (for a more detailed comparison, see Table 1).

Fig. 3. a. Lateral view of the complete skulls of an adult male *Pecari tajacu* from Rio Demeni (INPA283) (left) and an adult male *Pecari maximus* from Rio Aripuanã (holotype INPA4272) (right). **b.** Dorsal view of the same skulls, *Pecari tajacu* (top), *Pecari maximus* (bottom). **c.** Ventral view of the crania of the same skulls (in same arrangement). **d**. Dorsal view of mandibles of the same skulls (in same arrangement).

Grubb (2005) lists the following 19 synonyms for *Pecari tajacu*: *angulatus*, *bangsi*, *caitetu, crassus, crusnigrum, humeralis*, *macrocephalus, minor, modestus, nanus*, *nelsoni*, *niger*, *nigrescens*, *patira*, *sonoriensis, tajassu, torquatus*, *torvus*, *yucatanensis*. Three subspecies groups have been differentiated in the past – the grey forms (‘*angulatus*’group) from Central America (Texas, Mexico and Honduras), the blackish forms with poorly expressed collar and dorsal stripe (‘*patira*’ group) from the Guianas, Colombia, Ecuador and Panama, and the buff forms with clearly marked pale collar and black dorsal stripe from South America (the nominate '*tajacu*' group). The synonyms of the South American forms apply to specimens collected in Colombia, Ecuador and the Guianas, areas north of the Amazon River, being geographically too distant from the range of the new taxon, *Pecari maximus*, for these synonyms to be taken into account. Linnaeus` name *Sus tajacu* is based on the tajacu of Marcgraf (Grubb, 2005), from the State of Pernambuco, Brazil, a region that is not considered part of Amazonia.

Table 1. Cranial and dental measurements [mm] of *Pecari maximus* sp. nov., *Pecari tajacu* and *Tayassu pecari*, following Woodburne (1968). *Pecari maximus* is represented by the holotype INPA4272 and the paratypes MR316 and MR315 (incomplete skull); *Pecari tajacu* is represented by INPA283, an adult male from Rio Demeni, MR317, an adult male (head-body length: 1100 mm) from Rio Arauazinho, and MR318, an adult female (head-body length: 1080 mm) from Rio Arauazinho. The second column of measurements of *Pecari tajacu* is of specimens collected outside Brazil in the northern part of the species' range where individuals are on average smaller than those from central Amazonia; these and the measurements for *Tayassu pecari* were taken from Woodburne (1968)

Cranium	***P. maximus* sp. nov. (N=3)**	***P. tajacu* (N=3)**	***P. tajacu* mean (N=71)**	***T. pecari* mean (N=41)**
Length of cranium (= length anterior tip of I^1 to rear of condyles)	262;260;---	230;255;258	202	235
Length of diastema from C to P^2 (distance from rear edge of alveolus of C)	31;30;---	21;25;26	18	26
Width between alveoli of P^2	18;20;---	14;17;16	18	21
Width between alveoli of M^3	20;19;19	18;18;18	18	20
Least width of rostrum behind canines	39,5;40;---	35;35;35	31	53
Height from condyles to nuchal crest	85;85;85	73;80;80	81	99
Breadth across zygomatic arches	119;120;119	104;110;95	101	118
Breadth between postorbital processes of frontals	88;88;89	78;78;71	73	92
Mandible				
Length of mandible (= length from I^1 to rear of condyles)	185;180;182	165;170;173	162	198
Length of diastema from C to P_2	40;35;36	31;37;37	25	34
Depth from tip of coronoid process to ventral angle	88;85;84	73;82;77	75	93
Depth below P_2	36;39;40	32;40;37	32	36
Depth below rear of M_3	45;45;45	32;33;35	34	41
Width between alveoli of P_2	20;25;24	20;22;21	22	26
Width between alveoli of M_3	25;25;24	26;27;26	27	31
Width between condyles	49;55;---	52;47;48	49	58
Length from P_2 to M_3	65;68;68	63;62;64	69	85

Measurements. Five skins from hunters along the lower Rio Aripuanã were measured, total length 120, 127, 133, 135 and 137 cm. Collar when present 35 cm. Nasal disc 5.3 x 4.0 cm. Mane bristles 10.5–12.0 cm, proximally with 2–3 white bands at the lower half and 3 brown bands, distally with 3 white and 4 brown bands, the white bands only on lower half of bristles. Bristles to the side of the mane 6–7 cm, the dorsal ones with 3 whitish bands, the more ventral ones 4.7 cm, with only 2 whitish bands. Collar bristles 3.6–4.3 cm, with or without 1–2 white bands on distal part. The upper legs have black, fine, non-annulated, 4.0 cm long hairs. Belly almost naked, the hairs vaguely banded or only with one whitish band at the base. Bristles on nape 8.5 cm, with one whitish band only. Proximal bristles 8.0 cm, with one whitish narrow band only. Based on film and photo material of wild animals we estimated the following average measurements for adults: total body length 127 cm; ear length 13 cm; shoulder height 85 cm. Body weight was not taken but according to local hunters ranges from 40–50 kg. Mean skull length 261 mm, mean mandible length 182 mm. For additional skull measurements of *Pecari maximus* n.sp., *P. tajacu* and *Tayassu pecari* and definitions of measurements see Table 1.

Type Material. Holotype: INPA4272 (Mammal Collection of the National Institute for Amazon Research, Manaus, Amazonas, Brazil): complete cranium and mandible of an adult male (Fig. 3), killed for food by a local hunter, Luís Corrêa Bastos, on March 12, 2003, along the left bank of the Rio Aripuanã near the settlement of Arauazinho. Figure 2a shows the freshly hunted animal from which only the skull could be saved that is here designed as the holotype.

Paratypes: MR315, an incomplete skull with skin (Fig. 2b), obtained from hunters who had killed the animal in December 2003 along the Rio Arauazinho; MR316, a complete cranium and mandible collected from hunters living along the lower Rio Aripuanã, but lacking exact locality data (both paratype specimens kept by the first author).

Type locality. Left bank of the Rio Aripuanã, close to the settlement of Arauazinho, situated at the mouth of the Rio Arauazinho, a left bank tributary of the lower Rio Aripuanã, State of Amazonas, Brazil (06°16´94´´S, 60°20´87´´W).

Etymology. The name is Latin meaning ‘the largest’, referring to the size of the new species that is the largest among living peccaries. The gender is masculine.

Vernacular name. *Pecari maximus* is locally known as ‘caitetú-mundè’. Locals claim that in the Tupi-Indian tongue (*lingua geral*) it means “the collared peccary that is bigger and goes in pairs”. This allows them to distinguish it from *Pecari tajacu* commonly known as ‘caitetúde-bando’ (“the collared peccary that goes in herds”).

Phylogeny

Mitochondrial cytochrome *b* (Theimer & Keim, 1998), control region and 12S r RNA sequences, and nuclear SINE PRE-1 sequences (Gongora & Moran, 2005) indicate that *Tayassu pecari* and *Catagonus wagneri* are more closely related to each other than to *Pecari tajacu*. Acomplete mitochondrial D-loop sequence (1383 bp) and two nuclear SINE PRE-1 sequences (P27, 322 bp and P642, 386 bp) [homologous sequences described in Sulandari *et al*. (1997) and Gongora & Moran, (2005)] from our skin sample (MR315) support the status of the new peccary species as belonging to the genus *Pecari*, closely related to *Pecari tajacu.* Sequences are deposited in GenBank under the accession numbers: DQ009006, DQ016371 and DQ016372. Net maximum likelihood (TN93) sequence divergence with

Pecari tajacu is 2.0 % (Colombia, GenBank accession numbers: AY546522, AF276938) and 1.1 % (GenBank accession numbers: AY26778-79, AY546529/32, AB000378-79), respectively. For the D-loop it is of the same order as observed between the European and Asian pig (1.7 %) (Kim *et al.*, 2002), for which the divergence time has been estimated at 860,000 years before present on account of near-complete mtDNA genome sequences (Kijas & Andersson, 2001). This indicates a divergence time between *Pecari tajacu* and *Pecari maximus* of 1.0 million years before present. The combined SINE PRE-1 sequences indicate a similar divergence time of 1.2 million years before present assuming a mutation rate of 4.6x10-9 per year per site (Sulandari *et al.*, 1997). Figure 4 shows a neighbour-joining tree including all known Tayassuidae species.

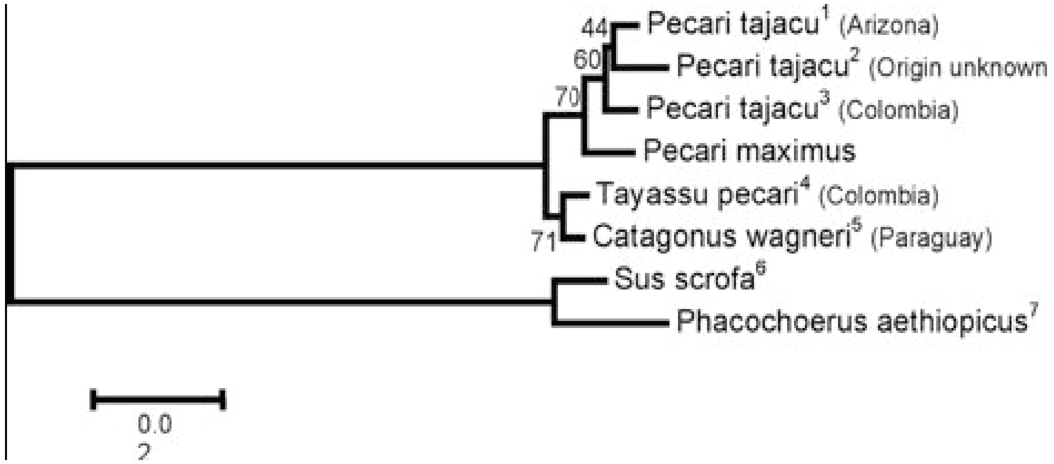

Fig. 4. Neighbour-joining tree of combined nuclear PRE-1 P27 and P642 sequences. The tree was co structed with MEGA3 (KUMAR et al. 2004), assuming the TN93 Gamma model (shape parameter a pha = 0.6). Bootstrap values (10,000 replicates) are indicated on branches. Geographic origins are mentioned between brackets. The superscripts refer to Genbank accession numbers. 1: AY546529 AY726778, 2: AB000378/379, 3: AY546532/AY726779, 4: AY546528/31, 5: AY546527/30, 6: AB000365/370, 7: AB000377/678.

Distribution, Ecology and Conservation Status

Distribution. The larger geographical distribution of the giant peccary is thought to be the interfluve delineated by the Rio Madeira in the west, the Rio Tapajós-Juruena in the east, the Rio Amazonas in the north and the Rio Guaporé in the south (Fig. 5). Since *Pecari maximus* appears to be confined to *terra firme* rainforest habitat we assume that its real distribution is much smaller and does not extend into the northern part of the Rios Madeira/Tapajós interfluve, where there are many open savannahs and extensive floodplains. We have observed the species in the wild only along both banks of the Rio Aripuanã (Fig. 6); it swims well (pers. obs.). The species might also occur in the upper Rio Madeira, State of Acre (Fig. 5). This assumption is based on the story of an American, John C. Yungjohann, who worked as a rubber cutter in the Rio Xapurí area from 1906–1919, written down in the book "White Gold" (Yungjohann, 2003). He describes three types of 'bush pigs'. The description of one of these closely resembles *Pecari maximus*: "there is a great, big one *porcão*, they travel in pairs, and are very lively. They will attack on sight – either you have to be swift and a sure shot or climb a tree". This behaviour – going in pairs and being really aggressive when attacked – is also reported by the hunters along the Rio Aripuanã.

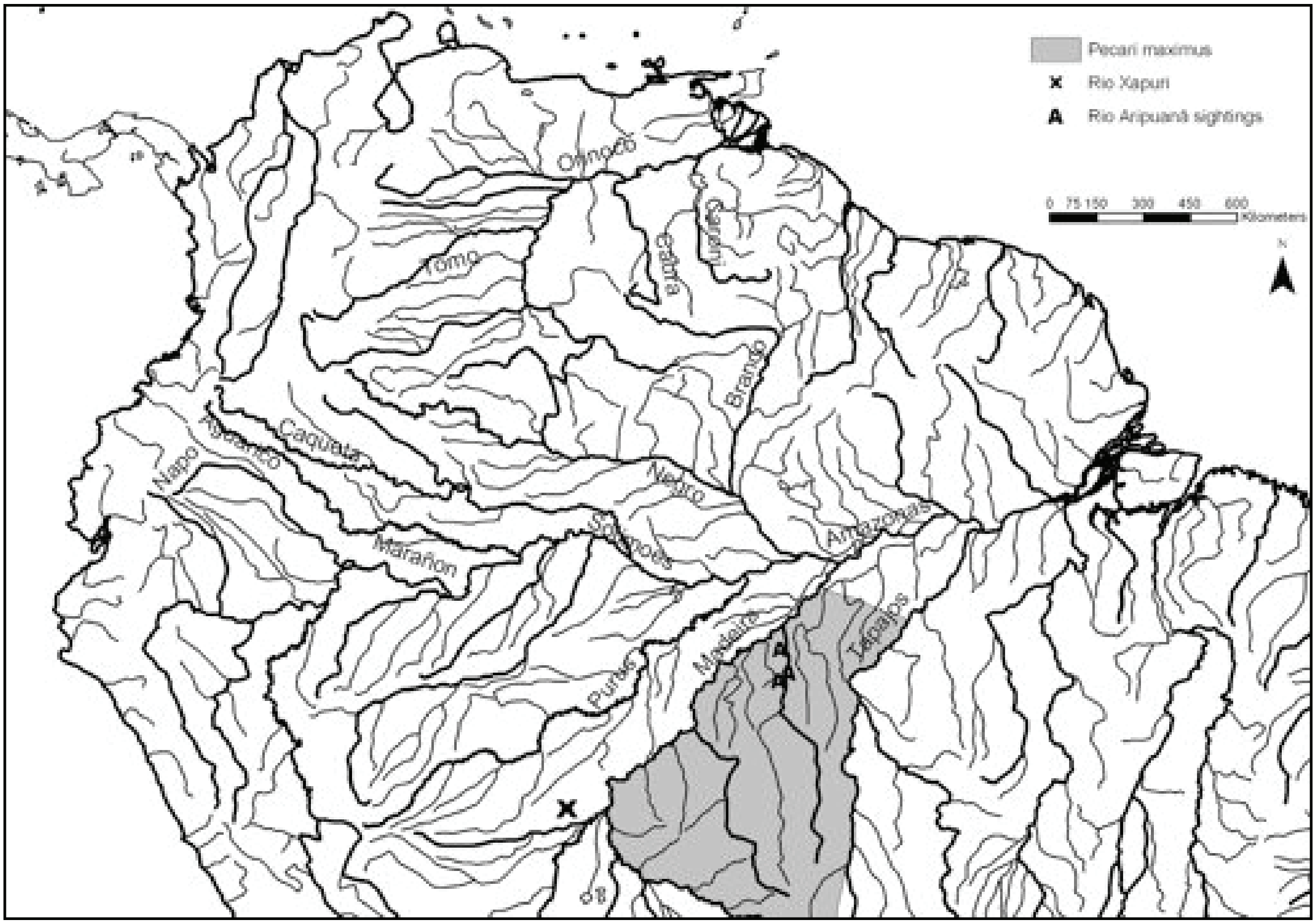

Fig. 5. Assumed distribution (shaded) of *Pecari maximus* sp. nov. in the Brazilian Amazon, based on sightings in the wild and interviews with locals. Aquestion-mark indicates the Rio Xapurí where an American rubber cutter working in the area from 1906–1916 described game that is similar to the giant peccary both in general appearance and behaviour (Yungjohann 2003).

Ecology. Both *Pecari tajacu* and *Tayassu pecari* roam semi-nomadically in a highly variable landscape in noisy, widely spread herds of up to 30, respectively 200 individuals, which stay in permanent contact by loud tooth-clicking. In strong contrast, *Pecari maximus* seems to walk silently through its preferred habitat – dense *terra firme* climax forest – in small family groups that contain only an adult pair with or without 1–2 offspring. *Pecari maximus* appears to perform little or no uprooting, whereas the gregarious peccary species largely forage for subsoil seed shadows, seedlings, roots and tubers. Instead, it has been seen feeding predominantly on freshly fallen fruits and seeds exposed on the forest floor. If this is its predominant foraging technique, its different dietary specialisation might well explain the fact that among the several skull and mandible parts of the three local species combined, the molars of *Pecari maximus* invariably showed a less dramatic wearing pattern. This could reflect its much smaller intake of sand and dirt during feeding. It appears that the larger *Pecari maximus* has abandoned social groupings, group defence and territorial scent marking. Its scent gland is thought to be rudimentary. None of the skins examined emitted the typical peccary scent, suggesting that if any secretory liquid is produced it is scentless, at least for the human nose.

Conservation status. All three peccary species occurring sympatrically in the Rio Aripuanã region are the favourite game of the locals, but only *Pecari maximus* is hunted with dogs since it does not go in herds like the other peccaries which are known to defend themselves fiercely. Although human occupation in this part of the Amazon is presently very low, this situation might soon change. In the Rio Aripuanã region unprecedented illegal extraction of timber and gravel is taking place. Recent road building through the area is intended to connect the town of Manicoré on the right bank of the Rio Madeira with the boomtown of Apuí at the border of the Tenharim Savannah and the State of Mato Grosso, areas of large-scale soybean agriculture. In view of these recent developments, we fear that commercial hunters using trained dogs will focus first on *Pecari maximus* to feed hungry settlers. Taking increasing hunting pressure and the species' limited distribution into account, we consider *Pecari maximus* endangered. We recommend inclusion of this new species in the IUCN Global Red List, based on criterion D (very small or restricted population). Besides the giant peccary, the Rio Aripuanã region is thought to harbour a number of floral and faunal elements new to science. The first author has identified so far a new species of dwarf porcupine, *Coendu roosmalenorum* (Voss & da Silva, 2001), and seven new primate species, four of which are already described (van Roosmalen *et al*., 1998; van Roosmalen *et al*., 2000; van Roosmalen *et al*., 2002; van Roosmalen & van Roosmalen, 2003). Among these primates, the dwarf marmoset *Callibella humilis,* represents a new genus never collected before. Most surprisingly, not a single area protected by Brazilian environmental law exists in the region. Given the uniqueness of the region in terms of biodiversity and its current status of biological *terra incognita*, we here encourage UNESCO to urge the Brazilian government to declare the entire region a World Heritage Site.

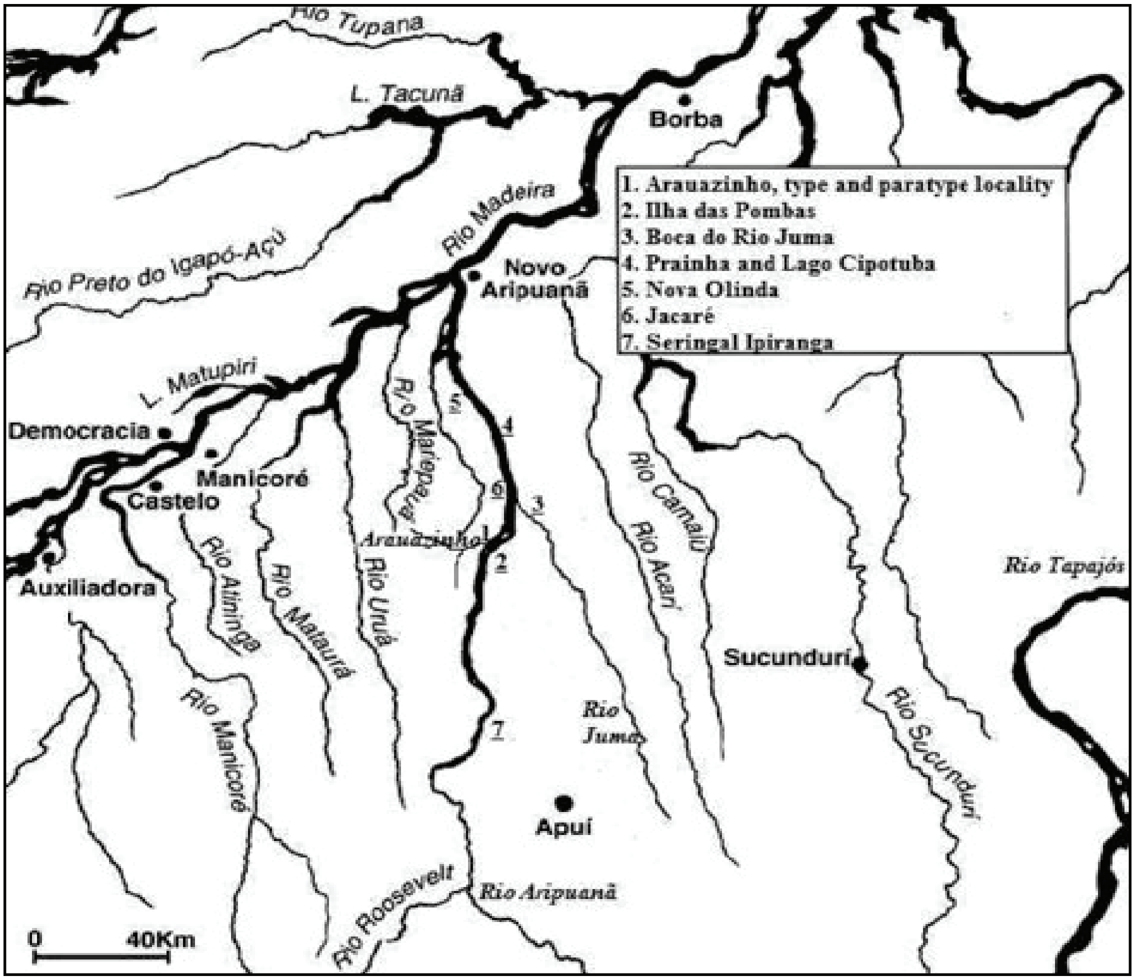

Fig. 6. Collecting and sighting localities for *Pecari maximus* sp. nov. along the Rio Aripuanã.

Acknowledgements

We thank Jörn Röver and Tom Synnatzschke from NDR (Norddeutscher Rundfunk) Naturfilm, Hamburg, Germany, who made two expeditions to the Aripuanã region possible in order to document new plant and animal species, and Roland Gockel and Frieder Salm, who accompanied the first two authors in the field for a total of three months and filmed and photographed giant peccaries in the wild for NDR.

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Re-examining the evidence for a ‘new’ peccary species, ‘*Pecari maximus’*, from the Brazilian Amazon

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The recent claim of a discovery of a ‘new’ peccary species in the Brazilian Amazon by van Roosmalen *et al*. (2007) underlines the urgent need to complete an ongoing modern taxonomic assessment of the family Tayassuidae. A revision of the peccaries is imperative to orient conservation management and planning as well as to increase understanding of the basic biology, ecology and evolution of this group (Taber, 1993). van Roosmalen’s claim also raises questions about what criteria to use to recognize the existence of a new species. In this paper we review challenges to species classification, discuss the current and commonly accepted taxonomic organization of the peccaries, assess the validity of the claim for *Pecari maximus*, and examine priorities for further research.

Species concepts- an old and a modern debate

There are more than 25 different definitions and practical applications of the species concept (Avise and Wollenberg, 1997; Bock, 2004; Bradley and Baker, 2001; Mayden, 1997; Mayr, 1969). The historical debate on whether shared morphological, reproductive, behavioural or ecological traits; or biological versus phylogenetic concepts; or monistic versus pluralistic approaches are the best bases on which to identify species is clearly as lively today as in the past (Balakrishnan, 2005; Hey, 2006; Horvath, 1997). Species concepts and recognition are sometimes confounded between the theoretical and conceptual understanding of species and the criteria or protocols used for species identification and delineation. Given the variety of definitions and applications, different taxonomic classifications can be made depending on the concepts and methodologies used (Agapow *et al*., 2004). This makes avoiding subjective species classification a complex endeavour, particularly when species have broad geographical distributions and phenotypic variation show unclear borders (Bock, 2004). For these reasons, it is critical to develop standardized criteria (Haig *et al*., 2006) to ensure that the most consistent information on the specific and/or subspecific diversity levels of taxa is obtained. Species recognition provides a critical baseline for biodiversity conservation planning and management (Mace, 2004) and needs to be undertaken on a strong theoretical basis to assure scientific robustness.

Identifying known species of peccaries

Three living species of peccaries are currently recognized: Collared, White-lipped and Chacoan peccaries (Wetzel *et al.* 1975; Woodburne, 1968; Wright, 1989, 1993), respectively *Pecari tajacu*, *Tayassu pecari*, and *Catagonus wagneri*. These species have been identified according to morphological and cytogenetic parameters and more recently using DNA sequences. Classification has generally relied on biological concepts of reproductive and genetic isolation. One confounding factor is that Collared and White-lipped peccaries are known to hybridize in captivity, (Sowls, 1997) and in the wild (Andrea *et al*., 2001), with the latter being reproductively sterile. Cytogenetic studies have confirmed the existence of three species, showing significant chromosomal differences in number and structure (Benirschke and Kumamoto, 1989; Bosma *et al*., 2004). Further DNA research has revealed that Chacoan and White-lipped peccaries clustered distinctly from Collared peccaries (Gongora and Moran, 2005; Theimer and Keim, 1998). These conclusions contrast with morphological studies which proposed two different scenarios of relationships: Collared and Chacoan peccaries are more closely related, while the White-lipped peccary was considered to be a member of a separate clade (Wright, 1989, 1993, 1998); and Collared and White-lipped peccaries are more closely related to each other than to the Chacoan peccary (Wetzel *et al*., 1975; Wetzel 1977). Other genetic studies have shown that Collared and White-lipped peccary populations cluster in separate clades based on five microsatellite marker loci (Silva, 2006) which were amplified using a cross-species PCR amplification approach (Gongora *et al*., 2002). However, the phylogenetic position of the Chacoan peccary using microsatellite markers still needs to be studied. Beyond this ongoing evolutionary debate, several studies have also addressed the reproductive, ecological, behavioural, retroviral and immunogenetic differences between these species (Fragoso, 1999; Gongora *et al*., 2004, 2007; Gottdenker and Bodmer, 1998; Grubb and Groves, 1993; Mayer and Brandt, 1982; Mayer and Wetzel, 1987; Santos *et al*., 2006; Sowls, 1997; Taber *et al*., 1993, 1994).

Highly relevant to van Roosmalen *et al*.'s claim for a fourth peccary species, in the genus *Pecari,* is that genetic variation within Collared peccary has been shown to be higher than that observed between Chacoan and White-lipped peccaries, and was also higher than that observed between recognised species of the Suidae family (Gongora and Moran, 2005; Gongora *et al*., 2006). Phenotypic, morphological, chromosomal and DNA data have been used to assess the levels of differentiation within the Collared peccary. This lineage has a broad distribution in the Americas spanning a wide variety of environments between the south-western United States of America and northern Argentina (Grubb and Groves, 1993). Its ancestry also seems to have an early divergence from the other peccary lineages in the Americas (Gongora *et al*., 2006). Early morphological studies provide the first evidence of cranial and dental variation among Collared peccaries from throughout the Americas (Kiltie, 1985; Woodburne, 1968), although specimens were ultimately grouped into a single species. Variations in size and pelage colour, coupled with distribution data, have been the basis for proposing the existence of 14 subspecies of Collared peccaries (Grubb and Groves, 1993; Hall, 1981). However, the inheritance of these traits has not been tested or substantiated by other methods.

More recently, conventional cytogenetic (Builes, *et al*., 2004; Gongora *et al*., 2000; Vasart *et al*., 1994) and cross-species chromosome painting (Adega *et al*., 2006; Bosma *et al*., 2004) studies, especially variation between North and South American specimens, provide preliminary evidence for differentiation within this species. A single captive specimen from Colombia, heterozygous for a balanced translocation may represent a hybrid between two different Collared peccary lineages (Builes *et al*., 2004). This may contrast with other cytogenetic studies (Adega et al., 2006) which propose a 'significant barier' for hybridization between major Collared peccary lineages/species.

However, germ line cytogenetic and/or reproductive studies are required to assess whether this possible hybrid is fertile before any conclusion can be made.

DNA sequence analyses (Gongora *et al*., 2006) revealed two major clades/lineages of Collared peccaries, based on 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 29 specimens from Argentina, Bolivia, Colombia, Mexico and the United States. Mitochondrial markers provided good resolution of Collared peccary relationships while concatenated nuclear sequences supported the conclusions drawn from mitochondrial sequences. These results suggest that the geographically widespread and phenotypically diverse Collared peccary may consist of at least two separate lineages deserving specific status. This study provides insights into peccary diversity, indicating that Collared peccaries underwent or are currently undergoing a process of speciation and diversification. More samples from throughout this species' distribution within the Americas will be required to provide further understanding of the levels of diversification within the Collared peccary.

'Peccary maximus': a new species or a representative of the South American Collared peccary clade/lineage?

The recent claim of a 'new' peccary species by van Roosmalen *et al*. (2007) raises questions about approaches and parameters in recognising new species. In that study the mitochondrial control region was sequenced to assess the genetic differentiation between species. Although there is not agreement as to which particular sequences accurately and universally reflect the species' boundaries (Vogler and Monaghan, 2007), other sequences, such as cytochrome *b* or cytochrome c oxidase I, rather than the control region are usually recommended as being more appropriate with genetic concepts of species and the use of DNA based taxonomy and barcoding (Blaxter, 2004; Blaxter *et al*., 2005; Bradley and Baker, 2001). van Roosmalen *et al*. (2007) used other DNA sequences, specifically SINE PRE-1 which is known to discriminate between species of suids and peccaries (Randi *et al*., 2002; Sulandari *et al*., 1997; Gongora and Moran, 2005). However, PRE-1 shows very poor resolution when specimens belong to the same or very closely related species (Gongora *et al*., 2006). In our view, it may have been better to choose different nuclear markers since the proposed 'new' species and the Collared peccary appear to be so closely related.

The data from van Roosmalen *et al*. (2007) were re-analysed in the context of the whole data set generated by Gongora *et al*. (2005, 2006) performing Maximum Likelihood and Maximum Parsimony methods and using the PAUP program (Swofford, 2002). This shows that the mitochondrial control region (Figure 1) and nuclear SINE PRE-1 sequences of the putative 'new' species cluster within the South American Collared peccary clade closely related to northern Argentinean samples, as recognized by van Roosmalen *et al*. (2007). Even when a less sophisticated method (Neighbour-Joining) was used, PRE-1 sequences of the putative 'new' species clustered in a separate clade within the Collared peccary lineage. The clustering of these DNA sequences implies that the peccary specimen studied by van Roosmalen *et al*. (2007) belong within the previously recognized South American Collared peccaries. It would have provided useful context to also analyse samples from animals attributed to *Pecari tajacu* by van Roosmalen *et al*. (2007) from the same area where the "new" peccary was collected.

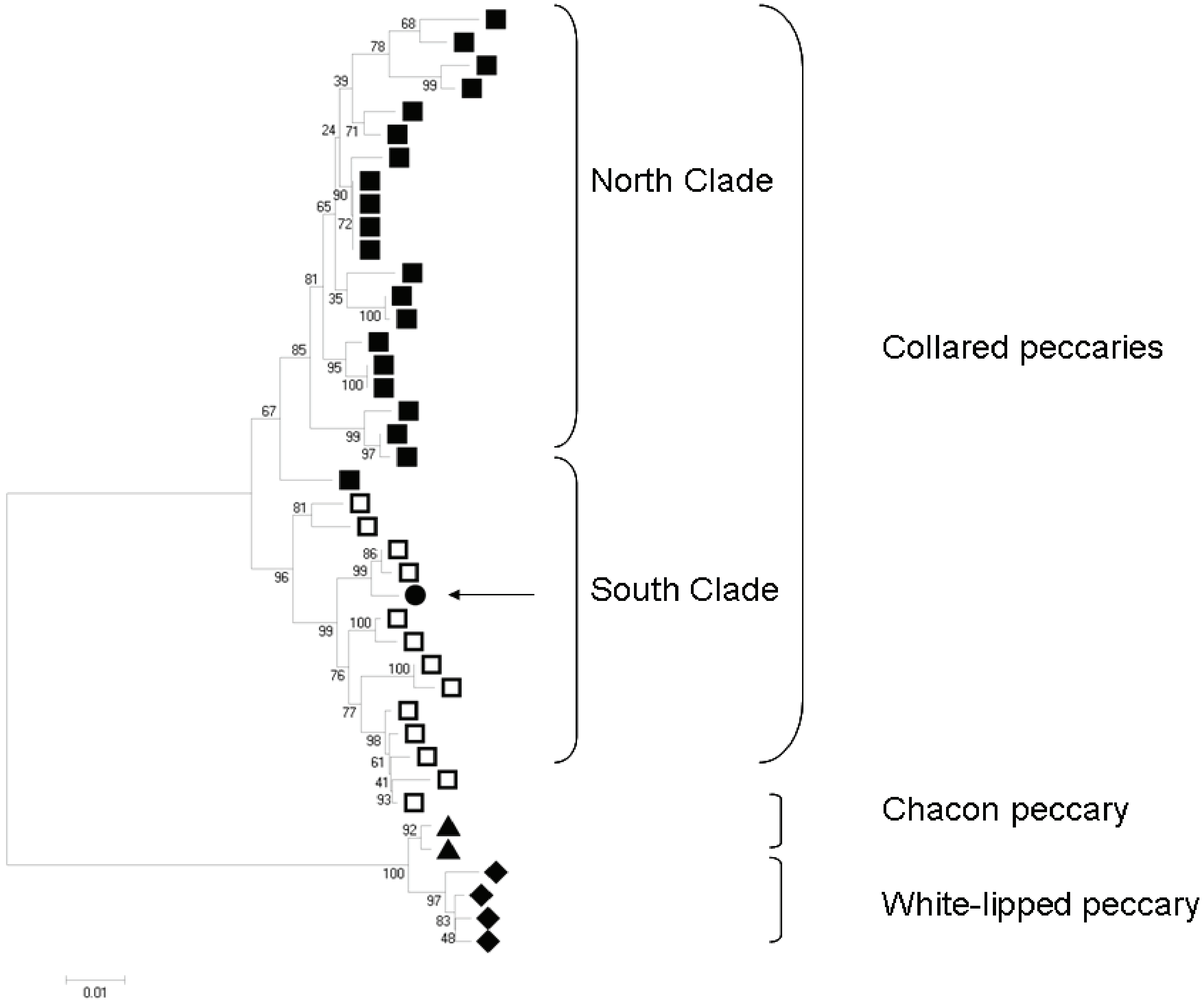

Fig. 1. Phylogenetic tree using mitochondrial control region DNA sequences from the three recognised species of peccary, including the putative 'new' peccary species. The clustering of this putative sequence is indicated with an arrow and a filled circle. Filled and unfilled squares correspond to the Collared peccary clades. Filled triangles and diamonds correspond to the Chacoan and White-lipped peccary species respectively. Bootstrap values (%; 1,000 replicates) are indicated on branches.

Similarly, morphological evidence used to support the claim for a new species of peccary by van Roosmalen *et al*. (2007) is problematic due to the small number of specimens obtained (five skins and three skulls, two of which were from adults), the use of local hunter reports to estimate body weight and size, morphometrics estimated from hide measurements, and a reliance on pelage analyses. The body weights for the proposed *Pecari maximus* are within the range reported for Collared peccaries, albeit at the large end. For instance, Sowls (1997) reports exceptional weights of wild Collared peccaries in Arizona in excess of 42 kg, and Bodmer (1989) reported weights close to 40 kg in Peru. Bodmer *et al*. (pers. obs.) have observed considerable variation in the skull sizes of both Collared and White-lipped peccaries from the Tahuayo, Yavari and Tamshiyacu regions of north-eastern Peru, well within the range reported by van Roosmalen. These preliminary observations are based on the collection held at the zoology museum of the Universidad Nacional de la Amazonía Peruana (UNAP), which consists of several thousand skulls collected by local subsistence hunters over a ten year period. In addition, Bodmer *et al*. (per. obs) have recorded body weights from both Collared and White-lipped peccaries hunted by local people in the Yavari river valley. Again, there is considerable variation, and the body weights are well within the range reported by van Roosmalen (Bodmer pers. obs.). It would be desirable that skull measurements of the proposed *Pecari maximus* be statistically compared with those from extremely large Collared peccaries found elsewhere in their range. Furthermore, using skin pelage characteristics to distinguish species can be problematic, since bristle colour may differ substantially within peccary species even in the same area (Gongora *et al*., 2006; Figure 2). In Collared peccaries, their lighter-haired collar pattern may vary from distinct in some individuals to barely noticeable in others. Comparing White-lipped peccaries with the proposed new species, the former may similarly reach head-body lengths over 120 cm and weights as high as 40 kg in the Brazilian Pantanal (Keuroghlian, 2006*)* and 50 kg in the northern Amazon (Fragoso, 1998). The most compelling morphological lines of evidence presented by van Roosmalen *et al*. (2007) are the photos of exceptionally long-legged peccaries which appear different from peccaries we are familiar with, but these are not backed up by measurements.

Fig. 2. Collared peccaries from Colombia showing distinct coat colour. Photographs taken by J Gongora.

Ecological and behavioural differences have also been used to characterize peccary species (Sowls, 1997). van Roosmalen *et al*. (2007) have attributed a number of differentiating traits for their peccary in line with this reasoning. However these claims are not based on intensive field observations, nor do they draw on recent literature concerning the ecology and behaviour of Collared and White-lipped peccaries to inform contrasts. For instance, while they claim that the new peccary uniquely lives in adult pair groups, sometimes with young, Collared peccaries are also known to forage alone or in small groups, even while belonging to herds typically of 6 to 12 individuals (Keuroghlian *et al*., 2004; Sowls, 1997; Taber et al. 1994), although larger groups have been reported from the Amazon (Fragoso, 1994). Furthermore, the number seen together may depend on the time of day. Radio telemetry studies have shown that White-lipped peccaries have distinct seasonal movements that are related to habitat and fruit availability within their large home ranges, and Collared peccaries have relatively small stable home ranges (Altrichter and Almeida, 2002; Fragoso, 1998; Keuroghlian *et al.,* 2004; Keuroghlian and Eaton, in press; Sowls, 1997). Neither species can be described as roaming semi-nomadically as suggested by van Roosmalen et al. (2007). Also, both White-lipped and Collared peccaries commonly forage on freshly fallen fruits (Altrichter et al. 2000, 2001; Beck, 2005; Keuroghlian and Eaton, in press), so this is not a unique behaviour of the new species. Whether peccaries need to dig with their noses during foraging depends on the type of habitat where fruits are available, i.e. buried within the sediments of a swamp or exposed on the forest floor (Keuroghlian and Eaton, in press). With only three skulls attributed to the new species, sample size is too low to comment on tooth wear patterns. Also, the lack of scent from the new peccary skins may be related to the skill of the hunters (that remove scent glands during butchering) (Keuroghlian pers. obs.). We note that subjectively there seems to be a considerable range between species and individuals with Chacoan peccaries having the least intense scent which may contribute to them being harder for the dogs of local hunters to track (Taber *et al*., 1993). Finally, observations are too limited, and overly dependent on local hunter hearsay, to draw conclusions that this possible new species has abandoned social groupings, group defence and territorial scent marking.

The possible discovery of a new peccary species from the Amazon basin is very exciting, and plausible, considering recent discoveries of new mammal species in this region mainly by van Roosmalen et al. (1998, 2000, 2002, and 2003). However, based on the information reported in the article by van Roosmalen *et al*. (2007), we consider that further research is necessary to claim discovery of a new species. Phylogenetic conclusions based on a single sample are inconclusive and uncertain; although this work does provide further evidence in support of previous DNA (Gongora *et al*., 2006) and chromosomal (Adega, *et al*., 2006; Builes, *et al*., 2004; Gongora *et al*., 2000; Vasart *et al*., 1994) studies which suggest northern and southern species/lineages of Collared peccaries. Studies of additional sequences and samples supplemented by cytogenetic analyses and possibly even breeding studies of reproductive isolation are highly desirable. Also, it would be important to incorporate new samples from all across the Amazon basin, particularly from Brazil. Within population genetic variation needs to be assessed along with between population studies. Finally, it is imperative that authors of 'new' species claims clarify what species concept (s) and criteria they are addressing for recognition and delimitation. We are sensitive to the first author of van Roosmalen *et al*.'s (2007) current legal plight (http://www.marcvanroosmalen.org/news.htm), and recognize his reputation as a skilled naturalist – one of the few working in what remains one of the world's most poorly surveyed regions for large terrestrial mammals. Nevertheless, we believe that biological, and conservation decision making must be based on the most rigorous science possible. In conclusion, we agree completely with his view that there is an urgent need for protection of the study region considering their recent discoveries of new primates…. and possibly a new peccary.

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Article reprinted from: Dewi K and Nugraha RTP. 2007. Endoparasit pada feses babi kutil (*Sus verrucosus)* dan prevalensinya yang berada di kebun binatang Surabaya. *Zoo Indonesia* 16(1): 13-19.

Endoparasit pada feses babi kutil (*Sus verrucosus)* dan prevalensinya yang berada di kebun binatang Surabaya.

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Abstrak

Babi kutil (*Sus verrucosus*) merupakan babi endemik untuk pulau Jawa, Madura dan Bawean. Dalam studi ini tujuh ekor babi kutil yang ada di Kebun Binatang Surabaya diperiksa kotorannya untuk dicaria ada tidaknya endoparasit. Hasil analisis menunjukkan adanya telur dari jenis *Oesophagostomum* sp. dan *Ascaris* sp., kista *Eimiria* sp., dan *Balantidium coli*, dengan tingkat prevalensi berturut-turut 28.57%, 14.28%, 57.14% and 85.71%.
Kata kunci: babi kutil, *Sus verrucosus*, endoparasit.

Abstract

The Javan warty pig (*Sus verrucosus)* is endemic to Java, Madura and Bawean islands. In this study, the faeces of seven captive Javan warty pigs from Surabaya Zoo were examined for endoparasites. The examination was conducted using native methods, replicated six times. The results of the study were that eggs were obtained of *Oesophagostomum* sp., *Ascaris* sp., cysts of *Eimiria* sp., and *Balantidium coli* with a prevalence of 28.57%, 14.28%, 57.14% and 85.71% respectively.
Keywords: Javan warty pig, *Sus verrucosus*, endoparasites, seroprevalence.

Pendahuluan

Babi kutil atau babi goteng, *Sus verrucosus,* merupakan babi liar yang endemik untuk P. Jawa dan P. Bawean. Populasinya yang dahulu pernah ada di P. Madura sekarang diyakini telah punah (Semiadi & Meijaard, 2006). Pada tahun 2000, The IUCN Species Survival Commission menempatkan *Sus verrucosus* dalam katagori '*Endangered*', atau sebagai jenis yang menghadapi kemungkinan kepunahan di alam yang cukup tinggi. Hal tersebut disebabkan karena penurunan populasi dalam kurun waktu 10 tahun terakhir, terfragmentasinya populasi yang demikian tinggi atau terjadinya penurunan sub-populasi serta jumlah individu dewasa (IUCN, 2000). Sampai saat ini Indonesia belum memasukkan babi kutil ke dalam satwa liar yang harus dilindungi.

Ancaman kepunahan babi kutil di Indonesia disebabkan karena hilangnya habitat babi ini untuk dijadikan permukiman dan daerah pertanian oleh penduduk. Selain itu babi ini sering diburu karena merusak area pertanian dan ada sebagian penduduk yang memanfaatkannya sebagai bahan makanan. Untuk itu diperlukan usaha dalam penyelamatan dan melestarikannya. Usaha yang dapat dilakukan antara lain adalah merehabilitasi kembali sebagian habitatnya untuk tempat tinggal alami babi (konservasi *in-situ*) atau dengan penangkaran (konservasi *ex-situ*).

Mengetahui status kesehatan babi yang dipelihara merupakan hal yang penting untuk mencapai keefektifan manajemen pemeliharaannya pada tingkat penangkaran, khususnya, selain untuk mencegah kemungkinan penyebaran penyakit yang diakibatkan oleh babi lebih luas. Meskipun telah terdapat banyak data mengenai keberadaan endoparasit pada jenis babi liar, namun data tersebut umumnya hanya mengacu pada jenis *Sus scrofa.* Sedangkan untuk jenis *Sus verrucosus* masih sedikit yang diketahui. Untuk itu penelitian ini diharapkan dapat memberikan informasi tambahan mengenai endoparasit yang terdapat pada babi kutil.

Materi dan Metode

Sampel feses pada kondisi segar (< 1 jam defekasi) diambil sekitar 20 gram dari babi kutil yang dipelihara di Kebun Binatang Surabaya (KBS). Jumlah babi yang diperiksa berjumlah tujuh ekor, yang terdiri dari lima ekor dewasa (3 jantan dan 2 betina) dan dua ekor anakan (1 betina dan 1 jantan). Sampel kemudian disimpan dalam larutan formalin 4% untuk kemudian diperiksa ada tidaknya endoparasitnya. Pemeriksaan endoparasit dilakukan di Bidang Zoologi, Pusat Penelitian Biologi-LIPI, Cibinong.

Pemeriksaan dilakukan menggunakan metode natif (Neva & Brown, 1994) dengan enam kali ulangan untuk setiap sampel. Identifikasi jenis dilakukan berdasarkan temuan telur atau endoparasit pada feses. Untuk memudahkan identifikasi, hasil temuan positif di foto dengan menggunakan kamera Nikon Optiphot-2 yang dilengkapi dengan kamera Nikon FDX 35. Hasil foto kemudian dipindai mempergunakan *scanner* Canon 3000 F dengan resolusi 600 dpi. Citra hasil pemindaian selanjutnya dianalisa menggunakan perangkat lunak ImageJ ver 3.7. Untuk perhitungan unit metrik pada perangkat lunak, satuan pixel yang dihasilkan pada program Image J ver. 3.7 dikalibrasi terlebih dahulu dengan menggunakan foto micrometer yang diambil pada perbesaran yang sama, sehingga menghasilkan resolusi 9.3 pixel/mikrometer. Hasil dijabarkan secara deskripitif dengan sifat-sifat biologinya yang telah diketahui.

Hasil dan Pembahasan

Hasil dari pemeriksaan feses tujuh ekor babi kutil yang terdapat di KBS ditemukan telur *Ascaris* sp., *Oesophagostomum* sp., oosit dari *Eimiria* sp. dan bentuk trofosoit dan kista dari *Balantidium coli* (Tabel 1). Dari ketujuh ekor babi kutil yang diperiksa hanya terdapat satu ekor yang bebas dari endoparasit pada pemeriksaan fesesnya.

Ascaris sp.

Telur yang ditemukan dalam keadaan belum berkembang, berukuran 64,52 µm x 81,14 µm dan 56,22 µm x 63,26 µm. Bentuk telur oval, mempunyai dinding yang tebal, mempunyai lapisan albumin dan berwarna coklat kekuningan (Gambar 1A). Menurut Anderson (2000) dan Soulsby (1982) ukuran telur *A. suum* adalah 40 - 60 µm x 50 – 75 µm, Jenis *Ascaris* yang kosmopolitan dijumpai pada babi liar dan domestik adalah *A. suum* (Fernandes-de-Mera *et al*. 2002; 2003; Eslami &Farsad-Hamdi, 1992; Coombs & Springer, 1974; Ineson, 1953). Pada pemeriksaan ini telur *Ascaris* sp. ditemukan pada feses seekor anakan babi kutil (14,28%).

Telur *A. suum* di lingkungan yang kering dapat bertahan selama 2–4 minggu, sedangkan di lingkungan yang lembab dan dingin bisa bertahan selama delapan minggu (Olson & Geselle, 2000).

Secara perkembangan, telur belum infektif ketika dikeluarkan inang melalui feses dan akan berkembang menjadi infektif jika menemukan lingkungan yang menguntungkan. Tingkat prevalensi *Ascaris* pada babi sangat dipengaruhi tercemarnya pakan oleh telur infektif tersebut. Selain hal tersebut pada babi liar yang hidup dalam kelompok kecil dengan area jelajah yang luas akan memiliki prevalensi *Ascaris* yang lebih kecil dibandingkan kelompok besar dengan kepadatan yang tinggi (Coombs & Springer, 1974).

Tabel 1. Jenis endoparasit yang ditemukan pada pemeriksaan feses babi dan prevalensinya

Parasit	Prevalensi (%)		
	Dewasa (n = 5)	Anakan (n = 2)	Total (n = 7)
Nemotoda			
Oesophagostomum sp.	40	0	28,57
Ascaris sp.	0	50	14,28
Protozoa			
Emiria sp.	40	100	57,14
Balantidium coli	80	100	85,71

Telur infektif yang tertelan dalam tubuh inang akan menetas di usus halus menjadi larva. Larva tersebut tidak akan langsung menjadi dewasa melainkan melakukan migrasi di dalam tubuh inangnya. Selama perjalanan migrasinya larva akan menembus dinding usus dan masuk ke dalam vena kecil atau pembuluh limfe, melalui sirkulasi darah portal masuk ke hati. Larva ditemukan di dalam hati tiga hari setelah terinfeksinya babi, kemudian menuju jantung untuk melanjutkan perjalanannya ke paru-paru pada hari yang ketujuh dan setelah itu keluar dengan pecahnya kapiler dan akan menuju alveoli, untuk kemudian bersama aliran darah masuk ke dalam bronchiolus. Dari bronchiolus larva akan naik ke trachea sampai epiglotis, dan turun melalui oesophagus ke usus halus dan mengalami perubahan terakhir dalam waktu 21–29 hari setelah infeksi. Cacing menjadi dewasa dan melakukan perkawinan untuk melengkapi siklus hidupnya dalam waktu 50–55 hari dan telur ada pada feses babi pada hari ke 60–62 (Anderson, 2000).

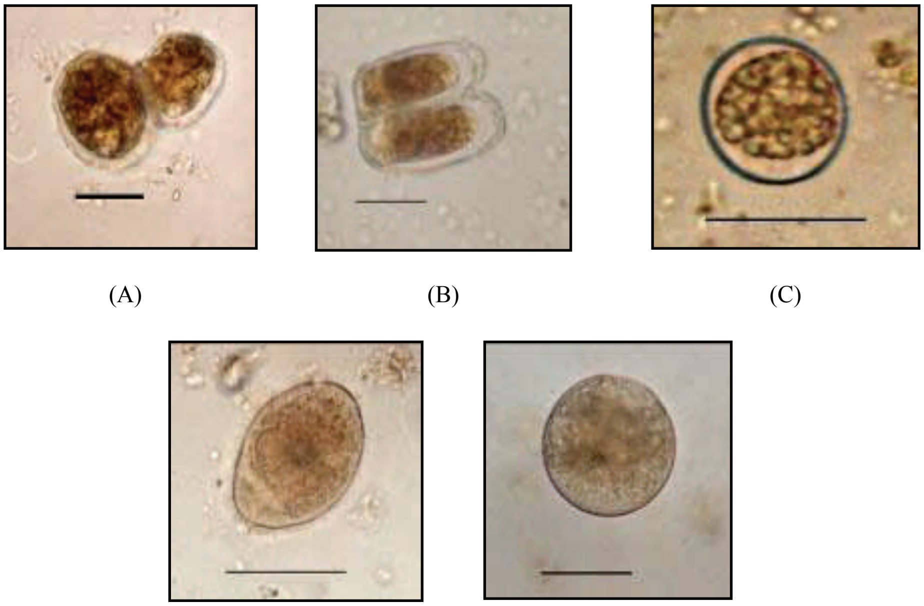
Infeksi dari cacing ini pada babi sering tidak menunjukkan gejala klinis yang nyata. Cacing dewasa hidup di dalam rongga usus dan mendapat makanan berupa makanan yang setengah dicernakan dan dari sel-sel mukosa usus. Cacing ini juga mempunyai kemampuan menghambat pencernaan protein dengan mengeluarkan zat penghambat tripsin. Akibatnya babi akan mengalami kelesuan dan menjadi lebih rentan terinfeksi penyakit lain. Pada infeksi yang berat cacing ini dapat menyebabkan penyumbatan pada usus.

Oesophagostomum sp.

Telur *Oesophagostomum* sp. Ditemukan pada dua ekor babi kutil dewasa (28,57%). Sedangkan pada anakan tidak ditemukan. Eijck & Borgsteede (2005) menyebutkan bahwa angka prevalensi cacing ini akan meningkat seiring pertambahan umur babi yang mengindikasikan kurangnya tingkat kekebalan inang yang didapatkan.

Telur berbentuk oval berdinding tipis, terdiri dari dua lapis dan berukuran 63,18 µm x 36,75 µm dan 67,20 µm x 38,79 µm (Gambar 1C). Menurut Olsen (1967) telur *Oesophagostomum* berukuran 74–88 µm x 45– 54 µm. Telur dikeluarkan bersama feses inangnya dalam keadaan belum infektif, kemudian di luar tubuh akan berkembang menjadi larva *rhabditiform* yang pertama yang akan menetas kurang lebih 24 jam pada suhu yang optimum. Larva hidup dengan memakan bakteri yang terdapat di lingkungan dan berkembang menjadi larva tahap kedua yang akan menjadi larva *filariform* yang infektif dalam waktu 3–5 hari setelah menetas. Inang menjadi terinfeksi dengan menelan larva tahap ketiga yang infektif atau dengan masuknya larva tersebut melalui kulit (perkutan) (Anderson, 2000).

Anggota dari marga *Oesophagostomum* dikenal sebagai cacing pembentuk nodul pada bagian usus. Cacing tersebut merupakan parasit yang umum dijumpai pada usus besar babi, hewan ruminansia, primata dan tikus. Cacing dari marga ini yang kosmopolitan dijumpai pada babi adalah *O. dentatum* (Fernandes-de-Mera *et al*., 2002; 2003). Pada babi keberadaan *O. dentatum* juga ditemukan di Belanda (Eijck & Borgsteede, 2005), New Zealand (Ineson, 1954) dan Iran (Eslami & Farsad-Hamdi, 1992). Sedangkan di Amerika ditemukan jenis *Oesophagostomum quadrispinulatum* pada babi liar (Pence *et al*., 1988).



Gambar 1. (A) telur *Ascaris* sp., (B) telur *Oesophagostomum* sp., (C) oosit *Eimeria,* (D) trofozoit *Balantidium coli,* (E) kista *Balantidium coli*. A, B & C skala: 40 µm, D & E skala 50 µm (Foto: Nugraha RTP & Dewi K).

Eimeria sp.

Bentuk oosit dari *Eimeria* ditemukan pada feses empat ekor babi (57,14%), yang terdiri dari dua ekor dewasa dan dua ekor anakan. *Eimeria* yang ditemukan pada pemeriksaan feses adalah stadium ookista, berbentuk ovoid, berukuran 32,88 µm x 38,82 µm dengan dinding ookista yang tebal dan halus (Gambar 1D). Menurut Olsen *Eimeria* yang ditemukan pada babi berukuran 12–40 µm.

Marga *Eimeria* merupakan parasit yang tergolong dalam filum Protozoa yang menyebabkan penyakit koksidosis. Infeksi koksidia merupakan hal yang umum ditemui pada babi anakan (Eijck & Borgsteede, 2005). Jenis *Eimeria* yang tercatat ditemukan pada babi adalah *E. cerdonis, E. neodebliecki* dan *E. porci*, yang ditemukan pada feses babi di Amerika Utara dan India, *E. guevarai* di Spanyol, *E. scrofae* ditemukan di Swiss, *E. spinosa* yang ditemukan pada babi yang didomestikasi di Amerika dan negara bekas bagian Uni Soviet serta *E. debliecki, E. scraba* dan *E. perminuta* yang mempunyai distribusi pada babi di seluruh dunia (Soulsby, 1982)

Penularannya melalui ookista yang sudah bersporulasi. Hewan yang terserang koksidosis sering tidak menunjukkan gejala klinis yang nyata, kecuali pada infeksi yang berat. *Eimeria* umumnya mengalami perkembangan siklus hidup secara lengkap di dalam dan di luar tubuh inangnya, dan dapat dibagi menjadi siklus aseksual dan seksual. Siklus hidup ini lebih dikenal dengan tiga stadium, yaitu skizogoni, gametogoni dan sporogoni. Siklus aseksual merupakan stadium skizogoni, siklus seksual meliputi gametogami, sedangkan sporogoni adalah pembentukan spora (Tampubolon, 1996).

Siklus hidup terjadi dengan tertelannya ookista yang bersporula oleh babi, setelah tiga hari akan membentuk skison di jejenum. Skison generasi kedua dan ketiga matang dalam waktu lima dan tujuh hari setelah infeksi di ileum. Generasi kedua skison menghasilkan 14–22 merosoit, sedangkan generasi ketiga menghasilkan 14–28 merozoit. Gamon, yang akan membentuk dua jenis kelamin, terbentuk pada hari ke delapan, mikrogamet dan makrogamet masak pada hari kesembilan setelah infeksi. Makrogamet tersebut akan difertilisasi oleh mikrogamet dan membentuk zigot yang berkembang menjadi oosit. Oosit keluar dari sekum atau usus kecil dan keluar bersama feses (Olsen, 1982).

Balantidium coli

Balantidium coli merupakan protozoa yang termasuk dalam kelas Kinetofragminophora yang mempergunakan silia sebagai alat gerak. Organisme ini berbentuk oval sampai elips, di dalamnya terdapat makroukleus dan mikronukleus. Silia tersusun berbaris di seluruh tubuh. Mulut atau peristome terletak dekat dengan ujung anterior. Bentuk trofozoit rata-rata berukuran 50–60 µm panjangnya, beberapa diantaranya dapat mencapai 150 µm (Olsen, 1982). Pada penelitian ini trofosoit *B. coli* yang ditemukan berukuran 66,52 µm panjangnya dan dengan lebar 47,90 µm (Gambar 1D). Kista berbentuk bulat atau sedikit lonjong dan berukuran 40–60 mikron (Tampubolon, 1996). Kista yang ditemukan pada penelitian ini berukuran 70,93 µm (Gambar 1E).

B. coli biasanya bersifat komensal dalam lumen sekum babi. Infeksi *B. coli* yang berat pada babi menyebabkan terjadinya diare. Babi yang terinfeksi *B. coli* dapat menularkannya pada manusia jika pengolahan air limbah kotoran tidak ditangani dengan baik. Jenis ini tinggal di dalam mukosa usus dan dapat menyebabkan diare pada manusia. Diare tersebut dapat ditularkan dari manusia ke manusia yang lain lewat air (*water born diseases*). Babi liar diduga memegang peranan pada balantidiasi yang terjadi pada manusia di Iran (Solaymani-Mohammadi *et al*., 2004).

Infeksi *B. coli* pada babi liar dan babi domestik diketahui memiliki sebaran yang mendunia, diantaranya di Amerika Tengah dan Utara, Filipina, New Guinea, Iran, Asia Tenggara dan beberapa pulau di Kepulauan Pasifik (Solaymani-Mohammadi *et al*., 2004). Nakauchi (1999) dalam Solaymani-Mohammadi *et al*. (2004) melakukan studi prevalensi *B. coli* pada jenis mamalia dan menemukan bahwa 100 % babi liar terinfeksi oleh *B. coli*.

Ucapan Terima Kasih

Penulis mengucapkan terima kasih kepada Dr. Gono Semiadi APU atas sampel feses yang diberikan untuk penelitian ini, serta Rosita Sulis Tanty SSi. yang membantu dalam proses koleksi di lapang. Penulis juga mengucapkan terimakasih kepada Dr. Isabel Gracia fernadez-de-Mera dari National Research Institute on Game Biology (REC, CSIC-UCLM), Spanyol atas bantuannya dalam identifikasi foto spesimen.

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Vestiges of seeds *Araucaria angustifolia* (Parana pine) consumed by white-lipped peccaries *Tayassu pecari*, in Parana, Brazil.

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Introduction

The main characteristic of the majority of mammals are discrete behaviours. So, visualizing them in their natural environment is, sometimes, very difficult. However, the fact that these animals are not easily seen does not mean that they are not present in such environments.

Therefore, studies involving mammals are commonly based on indirect observations, made through tracks, hair, scat and food remnants. In relation to the analysis of food remains, the prints resulting from attempts to open fruits and seeds, could indicate a pattern of consumption, which can provide information about species occurrence and about seed and fruit predation. The white-lipped peccary (*Tayassu pecari*) may be considered as a predator (when a seed is chewed completely), or as a seed disperser (when the ingested seed does not suffer alteration in the digestive system; or yet, when it returns to the soil during the chewing process).

The aim of this study was to identify the consumed vestiges of *pinhão* (Parana pine seed) left by white-lipped peccaries, through experiments with captive animals at the Zoological gardens in Curitiba, Paraná, Brazil. These vestiges can be used as an indication of the presence of this species in the natural environment, in addition to fruit-eating and dispersal behaviours.

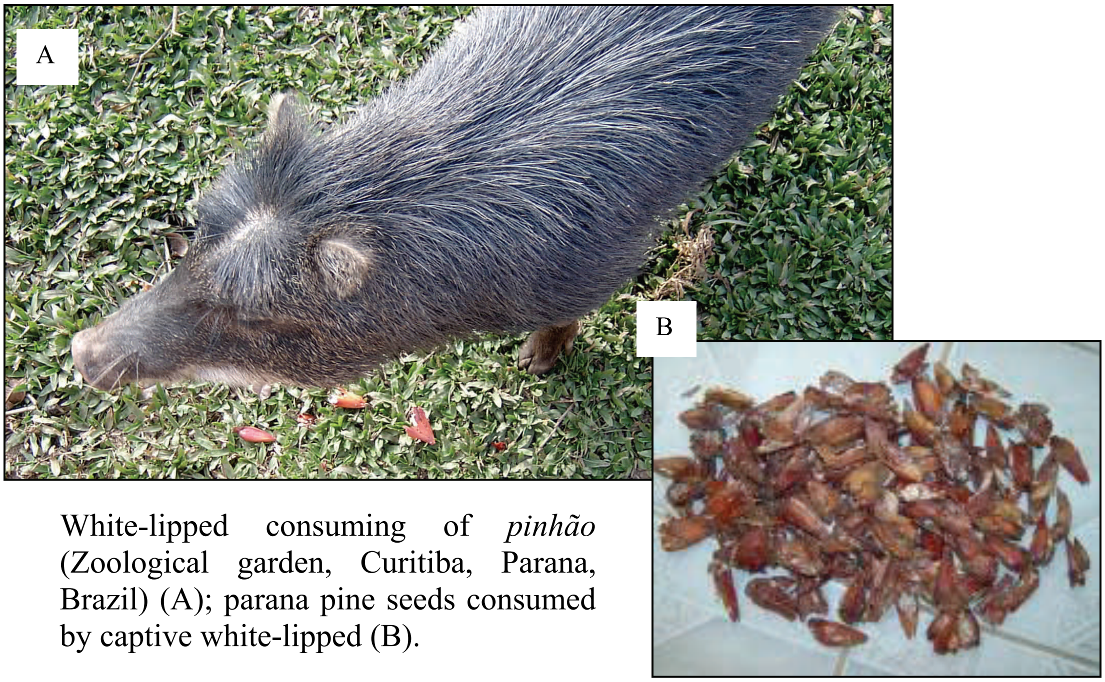
Materials and Methods

Pinhões were available to captive animals in the Zoological gardens on different occasions, when feeding behaviour was observed. The *pinhões* remnants, left by the peccaries, were collected, analyzed, photographed and later compared to the waste found in natural environments (Lageado Grande Farm, Paraná, Brazil).

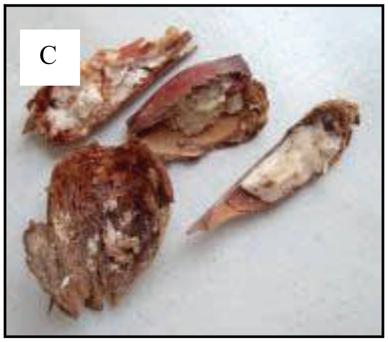
Results

1) In Zoological Gardens

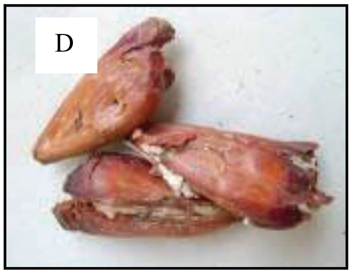
The white-lipped peccary showed several behaviours of predation of *pinhão* seeds (Figure B). The following situations were observed: (a) completely eaten seeds; (b) forefoot used to open the *pinhão*, pressing the seed against the ground and pulling the endosperm, using the tooth; (c) endosperm and shell not completely consumed (Figure C); (d) prints of tooth on the shell, prior to dropping on the ground (Figure D); (e) shell completely destroyed by tearing (Figure E); (f) shell with cuts (Figure F); and (g) signs of mashing and tearing on the shell (Figure G).



White-lipped consuming of *pinhão* (Zoological garden, Curitiba, Parana, Brazil) (A); parana pine seeds consumed by captive white-lipped (B).

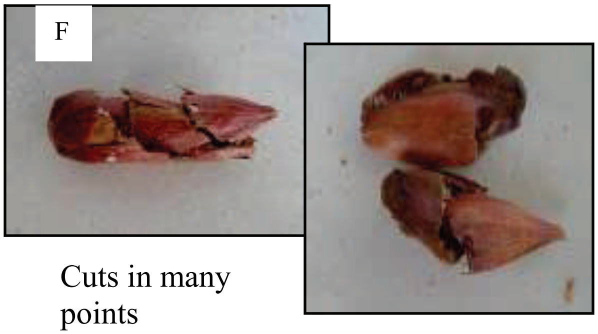


Endosperm and shell not completely consumed



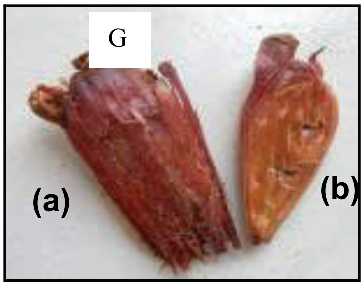
Signs of *pinhões* torn and returned to the ground

Shell completely destroyed



Cuts in many points

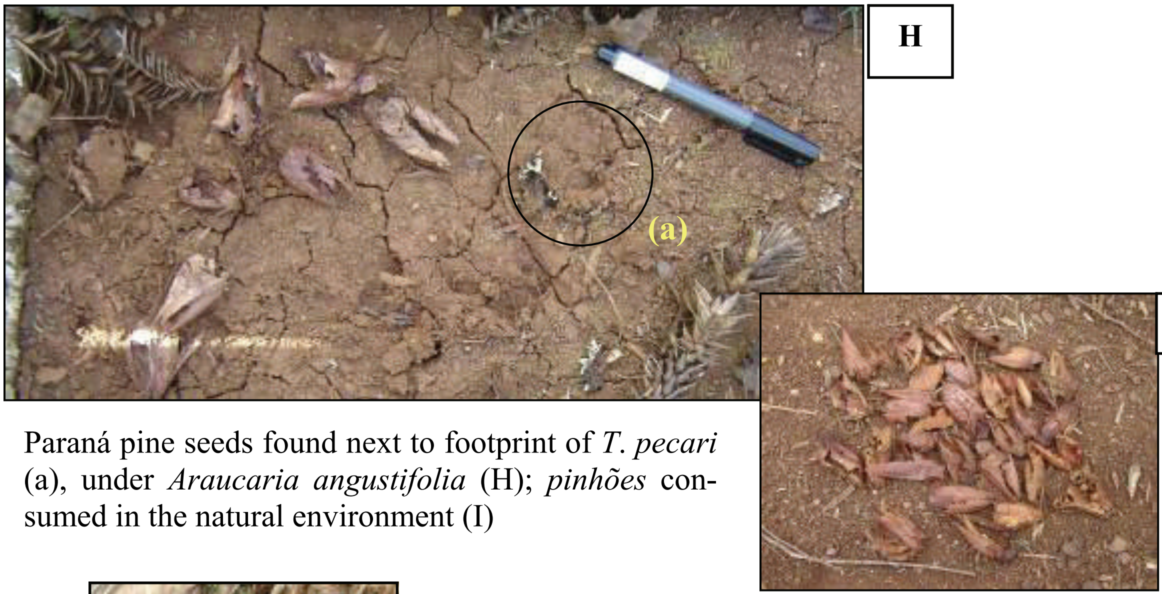
Cut in one



Shell mashed (a), shell tearing with tooth prints (b)

2) In Lageado Grande Farm

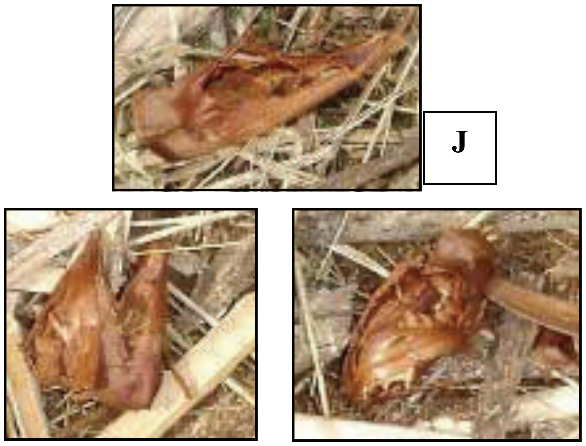
Several Parana pine seeds were found in the area of Araucaria forest between June and August (Figures H and I). A lot of these seeds showed characteristics of seed vestiges consumed by white-lipped peccaries, such as: shell destroyed by tearing (Figure J) and shell with tooth prints (Figure K), shell with signs of mashing (Figure L) and tearing (Figure M), similar to those observed in the captive environment.



H

I

Paraná pine seeds found next to footprint of *T. pecari* (a), under *Araucaria angustifolia* (H); *pinhões* consumed in the natural environment (I)



J

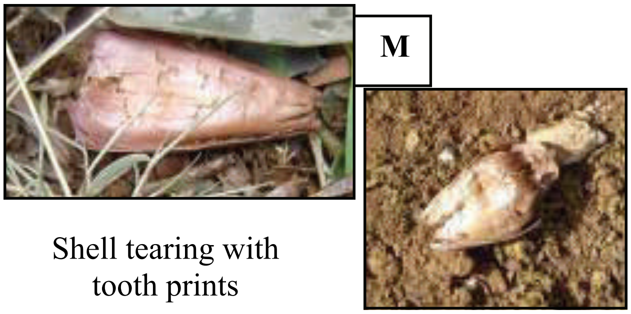
Shell destroyed by tearing

K

Shell destroyed by tearing with tooth print

L

Shell mashed



M

Shell tearing with tooth prints

Conclusion

The patterns of the vestiges left by the white-lipped peccaries was very similar to the Parana pine seeds consumed in Lageado Grande farm, which is the environment of *T. pecari.*

The consumed form of *pinhão* (partial or complete destruction) by this ungulate, suggests that it acts as a seed predator of *Araucaria angustifolia* (parana pine). It is important to say that *pinhão* (rich in energy reserves and amino acids) is considered the basic food for this species during the fall in the area of Araucaria forest. At this time of the year, there is less production of angiosperm animal-dispersed fruits (Paise e Vieira, 2005).

Acknowledgements

Thanks to Carolina Sens Abuázar, for invaluable help with the English revision of this manuscript.

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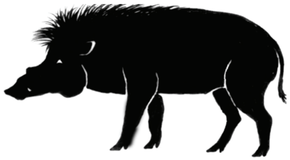
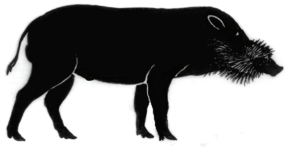


Some new literature on peccaries



Provided by M. Altrichter and E. Moraes

Beck H. 2006. A review of peccary-palm interactions and their ecological ramifications across the neotropics. Journal of Mammalogy 87(3): 519–530.

Abstract: Palms (Arecaceae) are a dominant element within the neotropical plant community and because they substantially contribute to the overall and year-round fruit availability they are considered a key resource for frugivores, particularly for peccaries. Similarly, peccaries (Tayassuidae) are a dominant element within the neotropical mammal community. Their evolution of a strong mastication apparatus, unique interlocking canines, patterns of movement, and foraging ecology are viewed as adaptations to exploit hard seeds, particularly palm seeds. But how strong are the interactions between peccaries and palms, and what are the ecological ramifications? This review synthesizes over 76 papers, published between 1917 and 2004, which revealed that peccaries consumed fruits from 46 palm species, 73% of whose seeds were destroyed after ingestion. Furthermore, peccaries disperse palm seeds; eat flowers, seedlings, and roots; and trample seedlings. Thus, peccaries affect the spatiotemporal distribution and demography of palms. Local extinction of peccaries resulted in dramatic changes in the forest ecology. New conservation strategies are required to protect peccaries and prevent negative cascading effects.

Beck H. 2007. Synergistic impacts of ungulates and falling palm fronds on saplings in the Amazon. Journal of Tropical Ecology 23: 599–602.

Gama Nogueira-Filho SLG, Oliveira Santos D, Mendes A and Siqueira da Cunha Nogueira S. 2006. Developing diets for collared peccary (*Tayassu tajacu*) from locally available food resources in Bahia, Brazil. Rev. Electrónica Manejo de Fauna Silvestre en Latinoamérica 1: 1-6.

Abstract: The collared peccary has the ability to handle a large amount of roughage in its diet. Such a characteristic represents an attractive asset since the species could utilize byproducts of human food and farm production that have little current outlet. In order to improve the economic viability of collared peccary farming, this study concentrated on the reduction of costs through the establishment of diets based on locally available foodstuff resources. We identified 20 foodstuffs potentially useful for feeding collared peccaries, and their specific nutritional content and digestibility coefficients were determined by chemical and in vivo digestibility analysis, respectively. We determined the preference order and voluntary consumption of some of these foods. We used six pen-raised adult collared peccaries and six metabolism chambers. With the data on voluntary intake and digestibility, and the nutritional requirements found in the literature we established four experimental diets for collared peccary, two for reproductive animals and two for growing individuals.

Keuroghlian A and Eaton DP. In Press. Fruit Availability and Peccary Frugivory in an Isolated Atlantic Forest Fragment: Effects on Peccary Ranging Behavior and Habitat Use. Biotropica In Press (Available online).

Abstract: The goal of this study was to examine seasonal frugivory by two sympatric peccary species (*Tayassu pecari* and *T. tajacu*) in a small (2178 ha), Atlantic Forest fragment on the inland plateau region of S˜ao Paulo State, Brazil. Fruit availability was determined with systematic ground surveys conducted over a 5-yr period. Examining fruit availability trends for dry and wet seasons, we found that species diversity was greater in the wet season, but the total number and dry mass of fruits were higher in the dry season. Fruit abundance in the dry season was due to one palm, 'jeriva' (*Syagrus romanzoffiana*), which could be considered a keystone species at Caetetus Ecological Station as it also supported a diverse array of mammals, birds, reptiles, and insects. White-lipped peccaries were the only ungulates that ate palmito fruits (*Euterpe edulis*) at Caetetus. They consumed ripe and unripe fruits and predated the seeds by chewing the pulp and seed. This occurred primarily during the dry season and was associated with a seasonal range shift and a preference for palmito habitat by the white-lipped peccaries. The dominance of fruits in peccary diets (80% fruit items in scat) has management implications for other plateau forest fragments. Forest fragments with diminished fruit abundance or diversity, or lacking key species such as *S. romanzoffiana* or *E. edulis*, will not support the energetic requirements of the characteristically large and highly mobile white-lipped peccary populations.

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Mendoza P, Mayor P, Cespedes M, Gálvez H and Jori F. 2007. Serologic survey for Antibodies against *Leptospira* spp. in the Collared Peccary (*Tayassu tajacu*) from the Peruvian Amazon. Emerging Infectious Diseases 13: 793-794.

Naranjo EJ and Bodmer RE. 2007. Source–sink systems and conservation of hunted ungulates in the Lacandon Forest, Mexico. Biological Conservation 138: 412-420.

Abstract: Native ungulate species constitute an important source of protein for Mesoamerican subsistence hunters. In this study, we (1) provide evidence supporting the hypothesis that source–sink systems help maintain some of the ungulate populations in the Lacandon Forest, Mexico; and (2) test the assumptions that density, age structure, and sex ratios are different in slightly hunted (potential sources) and persistently hunted (potential sinks) populations. From May 1998 to March 2001 we observed 1144 individuals and 1153 tracks of five ungulate species (Baird's tapir, collared peccary, white-lipped peccary, red brocket deer, and white-tailed deer) along 1908 km of line transects in slightly and persistently hunted sites of Montes Azules Biosphere Reserve (MABR) and adjacent community lands. Densities of Baird's tapir and white-lipped peccary were lower in persistently hunted sites, where there were higher proportions of young tapirs and white-tailed deer. The sustainability of hunting was evaluated in five communities using information on harvest rates, production rates, and density of each population. Our results suggest that persistently hunted populations of Baird's tapir and white-lipped peccary are at risk of local extinction, while collared peccary hunting appears to be sustainable. The red brocket deer, although locally overhunted, maintains a relatively safe status probably through a source–sink system in which MABR functions as the source of individuals which are readily hunted in adjacent community lands. Source–sink systems may be also important in maintaining Baird's tapir and white-lipped peccary populations outside protected areas of the Lacandon Forest, from evidence of migration observed during this study.

Dissertations

Reyna R. 2007. Social Ecology of the White-Lipped Peccary (*Tayassu pecari*) on the Calakmul Forest, Mexico. Ph.D. Dissertation, University of Florida, USA.

Neri FM. 2004. Ecologia e conservação de catetos, *Tayassu tajacu*, (Linnaeus, 1758) (Artiodactyla, Tayassuidae) em áreas de cerrado do estado de São Paulo. Dissertação de Doutorado. Universidade de São Carlos, Brasil.

Abstract: Among the present mammals in the units of conservation Estação Ecológica de Jataí (EEJ) and Parque Estadual de Vassununga (PEV) and in the unit of production, Estação Experimental de Luiz Antônio (EELA), located in the northeast of the State of São Paulo, are the peccaries, *Tayassu tajacu*. Between March of 2000 and January of 2004, the home range of them, the use of the space, diet and the impacts on the populations in these areas were studied. For obtaining the data, the radiotelemetry technique was used as tool and methods of terrestrial tracking. Seven peccaries received radio-collars for monitoring. It was established four home ranges being three referring to each one of the peccaries

of the Estação Ecológica de Jataí (EEJ) and Estação Experimental de Luiz Antônio with 161, 930 and 1.387 hectares and one regarding of the Parque Estadual de Vassununga (PEV), with 350 hectares. It were identified 22 species of plants used by the peccaries and 16 of wich were of confirmed use in the diet, five were considered as of probable use and one species was used as shelter.

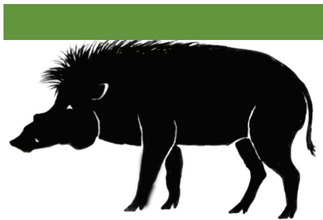
The diet also included ingested fruits of two palm trees (Família Arecaceae), other native species and five exotic species cultivated at orchards of EELA. It was identified some in this study factors that can be interfering negatively on the populations of peccaries and of other animals as weed killer application, hunts and activities of collection of exotic wood. Indirect impacts were also identified showing the need to improve the system of administration of units of conservation, including the definition of Management Plans that prioritize the regional biodiversity.

Keywords*: Tayassu tajacu*, radiotelemetry, diet, home range, São Paulo.

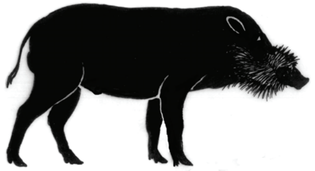
New literature on conservation of habitat

Desbiez ALJ. 2007. Wildlife Conservation in the Pantanal: Habitat Alteration, Invasive Species and Bushmeat Hunting. Ph.D. Dissertation, University of Kent, Canterbury, USA.

Abstract: Habitat alteration, invasive species introductions and bushmeat hunting dominate the conservation agendas of tropical habitats worldwide. These three key biodiversity conservation issues are examined in the centre of the South American continent in the Nhecolândia region of the Brazilian Pantanal. The Brazilian Pantanal is still a rather pristine freshwater wetland that has recently become increasingly threatened. In this thesis I use the community of medium to large sized mammals to evaluate the impact of habitat alteration and use the introduced feral pig and the native peccaries to examine the consequences of an invasive introduction and the impact of hunting in the region. The general methods used include line transects, collections of faecal samples, skulls, plants and fruits for the baited tracking stations, semi-structured interviews and hunting registers as well as laboratory work for the macro and micro analysis of faecal samples. Species assemblages were not distributed uniformly across the landscape mosaic. Forested landscapes supported higher densities of native species than the other landscapes. They were also more important in terms of energy consumption by native mammals. Generally, forested landscapes and habitats were the most selected by native mammals and should be considered key to wildlife conservation. Most of the changes in land use practices are affecting forested landscapes.. The impact of the introduced feral pig on native peccaries is probably not as high as previously suspected. Using different methodologies, habitat and dietary overlap between the feral pig and the peccaries were found to be low. Instead of a negative impact, I show that the presence of this exotic species may be beneficial to wildlife conservation. The Pantanal is one of the few non-protected areas in the Neotropics where native wildlife is not hunted, because feral pigs act as a replacement species for native wildlife hunting. According to the VORTEX model, feral pig populations will experience visible fluctuations in size and structure due to natural disturbances. In addition traditional hunting may regulate feral pig populations not through harvest rates, but rather through the act of hunting with horses and dogs, which reduces piglet survival. This thesis demonstrates that forested habitats and landscapes are key to maintaining biodiversity in the Pantanal. It also explains how an unusual combination of two major threats, invasive species introductions and bushmeat hunting, can have a positive outcome for biodiversity conservation. In turn, this study suggests new strategies for dealing with the bushmeat trade.



New Literature on Suiformes



Veterinary and Physiological Studies

Gethoffer F, Sodeikat G and Pohlmeyer K. 2007. Reproductive parameters of wild boar (*Sus scrofa*) in three different parts of Germany. European Journal of Wildlife Research 53(4): 287-297.

Abstract: Recent increases in wild boar populations in central Europe necessitated an evaluation of the current reproductive performance of this species. During a 2-year study, samples of ovaries and uteri were taken from wild boars from areas in the (northern) state of Lower Saxony and the (more southern) Rhineland-Palatinate, Germany, in which wild boar have been vaccinated against classical swine fever (CSF) after several outbreaks of the disease. Serum samples were also analyzed to determine the prevalence of diseases that may influence pig reproduction and fertility. While there was a striking seasonality of reproductive performance, especially among older animals, mating was delayed in up to 15% of piglets and yearlings, leading to a second peak of farrowing from June to August. Depending on the area, between 60 and 70% of the piglets were most likely to become pregnant during the main period of reproduction, while another two thirds of the remaining individuals farrowed by the summer, which was the case in the mountainous areas. The arithmetic mean number of fetuses were 6.29 per piglet, 6.67 per yearling, and 7.64 per adult for wild boar in Eastern Lower Saxony; 4.58 per piglet and 4.63 per yearling and 6.56 per adult for wild boar in the Western Eifel and 4.77 per yearling and 6.50 per adult in the Palatine Forest, as the number of pregnant piglets has been too low to calculate an arithmetic mean in this area. The numbers of Lower Saxony wild boar fetuses per individual exceed previously known values. The results indicate that exogenous factors have a strong impact on both reproductive seasonality and the percentage of reproducing individuals in an age group. Ovulation rates, numbers of fetuses, and prevalence of pregnancies were found to be high among all age groups, while early onset of puberty and high pregnancy rates were typical of young animals (yearlings). The influence of some important reproductive diseases like Aujeszky's disease, Brucellosis, porcine reproductive and respiratory syndrome, porcine parvovirosis, and CSF on wild boar reproduction and fertility was tested and found to be at least of minor interest for the reproductive outcome of the species.

Pena N, Morales J, Morales-Montor J, Vargas-Villavicencio A, Fleury A, Zarco L, de Aluja AS, Larralde C, Fragoso G and Sciutto E. 2007. Impact of naturally acquired *Taenia solium cysticercosis* on the hormonal levels of free ranging boars. Veterinary Parasitology 149 (1-2 Special Issue SI): 134-137.

Abstract: In chronically infected BALBc/AnN male mice, *Taenia crassiceps cysticercosis* induces changes in the host's sex steroids hormone that lead to their estrogenization and deandrogenization, with possible repercussions on their susceptibility to infections. Here reported are the serum steroid levels in free range cysticercotic male boars. Therefore, the possible effects of *Taenia solium cysticerci* over the pig steroid levels were evaluated. Herein are described the sex steroids and cortisol levels of non-cysticercotic (n = 25) and cysticercotic (n = 22) adult boars, as diagnosed by tongue inspection, all free-ranging in a typical village of an endemic rural area in Mexico. A significant reduction of testosterone (P = 0.022) and a likely one of 17 beta-estradiol (P = 0.08) levels were found in the cysticercotic boars in comparison with those non-cysticercotic, whilst no significant differences in the cortisol and DHEA levels were detected. Serum levels of specific antibodies did not correlate with infection nor with the levels of any of the hormones measured. Results suggest that *T. solium cysticercosis* significantly affects the hormonal status of its porcine host independently of their antibody response.

Jo SK, Kim HS, Cho SW and Seo SH. 2007. Pathogenesis and inflammatory responses of swine H1N2 influenza viruses in pigs. Virus Research 129(1): 64-70.

Abstract: Swine influenza viruses are an important pathogen in pig industry. In this study, we wanted to know whether swine H1N2 influenza viruses circulating in Korean pigs would cause clinical signs in pigs when experimentally infected. When pigs were infected with swine H1N2 viruses isolated from Korean pigs, pigs suffered from severe clinical signs of coughing, nasal discharge, labored breathing, facial edema, anorexia, and diarrhea. When the level of cytokine induction was measured using lung tissues, pro-inflammatory cytokines such as TNF-alpha, IL-1, and IL-8 were induced higher in lungs of infected pigs than in lungs of uninfected pigs. However, no increased induction of the anti-inflammatory cytokines such as IL-4 and IL-10 was observed in lungs of infected pigs. These results suggest that the pathogenesis induced in pigs by H1N2 influenza viruses may be induced by pro-inflammatory cytokines instead of anti-inflammatory cytokines.

Mise KM, de Almelda LM and Moura MO. 2007. A study of the Coleoptera (Insecta) fauna that inhabits *Sus scrofa* L carcass in Curitiba, Parana [Portuguese]. Revista Brasileira de Entomologia 51(3): 358-368.

Abstract: A study of the Coleoptera (Insecta) fauna that inhabits *Sus scrofa* L. carcass in Curitiba, Parand. This paper sought to assess the Coleoptera fauna associated with carcasses of *Sus scrofa* L., 1758, which is usually used as model in Forensic Entomology. The addition and sequential substitution of insect species could be used to estimate the post mortem interval (PMI). The present study took place in Centro Politecnico (UFPR), between september 2005 to september 2006. A pig weighting 15 kg was sacrificed each season and put inside a cage. Sampling is made daily in a tray placed below the carcass and in a Shannon modified trap, and each 14 days in five pit-fall traps. 4,360 beetles were collected, belonging to 112 species of 26 families, 12 were considered of forensic potential. The active collecting made in the tray was responsible for the largest number of beetles (2,023 specimens), followed by the modified Shannon trap (2,016 specimens) and by the pit-fall traps (324 specimens). Staphylinidae was more abundant in the modified Shannon trap, while Silphidae was more abundant in pit-fall traps. The main habits found are predator/parasite (55%) and omnivorous (38,05%), with only a few species considered necrophagous (1,31%).

Gomes L, Gomes G, Oliveira HG, Morlin JJ, Desuo IC, Quelroz MMC, Giannotti E and von Zuben CJ. 2007. Occurrence of Hymenoptera on *Sus scrofa* carcasses during summer and winter seasons in southeastern Brazil. Revista Brasileira de Entomologia 51(3): 394-396.

Abstract: Occurrence of Hymenoptera on *Sus scrofa* carcasses during summer and winter seasons in southeastern Brazil. Considerable importance has been given to nest construction and larval food transport to the nest as a precondition for the eusociality of insects. Most adult hymenopterans feed on liquids, although bees and a few wasps may also feed on pollen. Carrion represents an additional source of protein for some species and they will scavenge for dead animals in the wild. This paper aims at analyzing Hymenoptera visitors on a pig carcass during the process of decomposition, in the summer of 2005 and the winter of 2006 in Brazil, and comparing the results with other studies in the Neotropical region. To our knowledge, this is the first study which described the occurence of *Agelaia pallipes*, *Polybia paulista* and *Scaptotrigona depilis* on decomposing carcasses in southeastern Brazil. It also raises the hypothesis of possible applications of Hymenoptera to achieve more precise PMI estimations, apart from other insects already known as having great importance in such estimates.

Ducos A, Berland HM, Bonnet N, Calgaro A, Billoux S, Garnier-Bonnet N, Darre R and Pinton A. 2007. Chromosomal control of pig populations in France: 2002-2006 survey. Genetics Selection Evolution 39(5): 583-597.

Abstract: The chromosomal control of pig populations has been widely developed in France over the last ten years. By December 31st, 2006, 13,765 individuals had been karyotyped in our laboratory, 62% of these since 2002. Ninety percent were young purebred boars controlled before service in artificial insemination centres, and 3% were hypoprolific boars. So far, 102 constitutional structural chromosomal rearrangements (67 since 2002) have been described. Fifty-six were reciprocal translocations and 8 peri- or para-centric inversions. For the first time since the beginning of the programme and after more than 11,000 pigs had been karyotyped, one Robertsonian translocation was identified in 2005 and two others in 2006. The estimated prevalence of balanced structural chromosomal rearrangements in a sample of more than 7,700 young boars controlled before service was 0.47%. Twenty-one of the 67 rearrangements described since 2002 were identified in hypoprolific boars. All were reciprocal translocations. Twelve mosaics (XX/ XY in 11 individuals, XY/ XXY in one individual) were also diagnosed. Two corresponded to hypoprolific boars, and three to intersexed animals. The results presented in this communication would justify an intensification of the chromosomal control of French and, on a broader scale, European and North-American pig populations.

Agungpriyono S, Kurohmaru M, Presetyaningtyas WE, Kaspe L, Leus KYG, Sasaki, M, Kitamura N, Yamada J and Macdonald AA. 2007. A lectin histochemical study on the testis of the babirusa, *Babyroussa babyrussa* (Suidae). Anatomia, Histologia, Embryologia: Veterinary Medicine Series C 36(5): 343-348.

The distribution of lectin bindings in the testis of babirusa, *Babyrousa babyrussa* (Suidae) was studied histochemically using 10 biotinylated lectins, Peanut agglutinin (PNA), Ricinus communis agglutinin (RCA I), Dolichos biflorus agglutinin (DBA), Vicia villosa agglutinin (VVA), Soybean agglutinin (SBA), Wheat germ agglutinin (WGA), Lens culinaris agglutinin (LCA), Pisum sativum agglutinin (PSA), Concanavalin A (Con A) and Ulex europaeus agglutinin (UEA I). Nine of 10 lectins showed a variety of staining patterns in the seminiferous epithelium and interstitial cells. The acrosome of Golgi-, cap- and acrosome-phase spermatids displayed various PNA, RCA I, VVA, SBA and WGA bindings, indicating the presence of glycoconjugates with D-galactose, N-acetyl-D-galactosamine and N-acetyl-D-glucosamine sugar residues respectively. No affinity was detected in the acrosome of late spermatids. LCA, PSA and Con A which have affinity for D-mannose and D-glucose sugar residues were positive in the cytoplasm of spermatids and spermatocytes. DBA was positive only in spermatogonia. In addition to DBA, positive binding in spermatogonia was found for VVA, WGA and Con A, suggesting the distribution of glycoconjugates with N-acetyldgalactosamine, N-acetyl-D-glucosamine, D-mannose and D-glucose sugar residues. Sertoli cells were stained intensely with RCA I, WGA and Con A. In Leydig cells, RCA I and Con A were strongly positive, while WGA, LCA and PSA reactions were weak to moderate. The present findings showed that the distribution pattern of lectin binding in the testis of babirusa is somewhat different from that of pig or other mammals reported previously.

Ramlachan N, Anderson RC, Andrews K, Laban G and Nisbet DJ. 2007. Characterization of an antibiotic resistant *Clostridium hathewayi* strain from a continuous-flow exclusion chemostat culture derived from the cecal contents of a feral pig. Anaerobe 13(3-4): 153-160.

Abstract: The chemostat model has been an important tool in studying intestinal microflora. To date, several competitive exclusion products have been developed from Such studies as prophylactic treatment against pathogenic bacteria. A continuous-flow chemostat model of a feral pig was developed using inocula from the cecal contents of a wild boar caught in East Texas. Several strains of antibiotic-sensitive bacteria were isolated including *Bacteroides*, *Lactobacillus*, *Enterococcus* and *Clostridium sp*. This study reports on the characterization of a multidrug-resistant *Clostridum hathewayi* strain that was isolated from this feral pig's cecal contents maintained in a continuous-flow chemostat system showing high resistance to carbapenems and macrolides (including the growth promoter tylosin). *Clostridium hathewayi* has been documented to be pathogenic to both humans and animals. Feral pigs may be an important source of pathogenic and antibiotic resistant bacteria and may pose potential risk to domestic species. Further work is needed to elucidate the prevalence of these reservoirs and assess the contribution these may play in the spread of disease and resistance.

Penrith ML, Pereira CL, da Silva MMRL, Quembo C, Nhamusso A and Banze J. 2007. African swine fever in Mozambique: Review, risk factors and considerations for control. Onderstepoort Journal of Veterinary Research 74(2): 149-160.

African swine fever (ASF) is the most important disease that constrains pig production in Mozambique. Until 1994 it was apparently restricted to the central and northern provinces, but since 1994 outbreaks have been experienced throughout the country. ASF causes severe economic losses both in the small commercial sector and among the large numbers of small-scale producers in the family sector in rural and peri-urban areas. The history of ASF in Mozambique since its first confirmation in 1960 is briefly reviewed, recent outbreaks are reported, and the available information on the virus genotypes that have been responsible for some of the outbreaks is presented. Epidemiological factors that contribute to ASF outbreaks and strategies for limiting the negative effects of the disease in the different pig farming sectors in Mozambique, including raising farmer and community awareness, are discussed.

Wheaton CJ, Joseph S, Reid K, Webster T, Richards M, Forde HM and Savage A. 2007. Suppression of ovulation in nile hippopotamus (*Hippopotamus amphibius*) using melengestrol acetate-treated feed or high dose depo-provera injection. Zoo Biology 26(4): 259-274.

Analysis of fecal progestogen profiles during Depo-Provera injection (1,200 mg; DEPO, Pfizer Inc., New York, NY), melengestrol acetate (MGA) in feed (2 or 3 mg/head/day), and a combination treatment (DEPO + MGA) are presented for nine captive female Nile hippos housed at Disney's Animal Kingdom in Florida. All tested treatments reduced fecal progestogen elevations successfully to durations consistent with prevention of ovulation for a portion of the treatment period. Percentage of treatment months with suppression of luteal phases indicative of ovulation was maximal for high-dose MGA (91.7 +/- 13.9%) and DEPO+MGA (91.7 +/- 20.4%), followed by DEPO injection alone (69.2 +/- 13.9%) and low-dose MGA (57.6 +/- 33.2%). Both 1,200mg DEPO and low-dose MGA (2.0 mg/day) treatments were insufficient to prevent an apparent seasonal breakthrough of ovarian activity from

June-August 2002. Although luteal phases were observed, no females conceived during those months. Overall, in 133.5 treatment months with females housed with an adult male, one female conceived during the transition period between treatments. After cessation of contraceptive treatment, average latency to first normal ovarian cycle was 80.6 +/- 19.5 days (range = 22-179 days). Up to 12 months post-treatment, however, successive cycles were often irregular with evidence of short periods of anovulation and shortened luteal phases in all females monitored. In conclusion, high dose and combination treatments were most successful in preventing progestogen increases indicative of ovulation in hippos.

Taxonomic, Morphological, Biogeographic and Evolutionary Studies:

Larson G, Albarella U, Dobney K, Rowley-Conwy P, Schibler J, Tresset A, Vigne JD, Edwards CJ, Schlumbaum A, Dinu A, Balacsescu A, Dolman G, Tagliacozzo A, Manaseryan N, Miracle P, van Wijngaarden-Bakker L, Masseti M, Bradley DG and Cooper A. 2007. Ancient DNA, pig domestication, and the spread of the Neolithic into Europe. Proceedings of the National Academy of Sciences of the United States of America 104(39): 15276-15281.

Abstract: The Neolithic Revolution began 11,000 years ago in the Near East and preceded a westward migration into Europe of distinctive cultural groups and their agricultural economies, including domesticated animals and plants. Despite decades of research, no consensus has emerged about the extent of admixture between the indigenous and exotic populations or the degree to which the appearance of specific components of the "Neolithic cultural package" in Europe reflects truly independent development. Here, through the use of mitochondrial DNA from 323 modern and 221 ancient pig specimens sampled across western Eurasia, we demonstrate that domestic pigs of Near Eastern ancestry were definitely introduced into Europe during the Neolithic (potentially along two separate routes), reaching the Paris Basin by at least the early 4th millennium B.C. Local European wild boar were also domesticated by this time, possibly as a direct consequence of the introduction of Near Eastern domestic pigs. Once domesticated, European pigs rapidly replaced the introduced domestic pigs of Near Eastern origin throughout Europe. Domestic pigs formed a key component of the Neolithic Revolution, and this detailed genetic record of their origins reveals a complex set of interactions and processes during the spread of early farmers into Europe.

Wu CY, Jiang YN, Chu HP, Li SH, Wang Y, Li YH, Chang Y and Ju YT. 2007. The type I Lanyu pig has a maternal genetic lineage distinct from Asian and European pigs. Animal Genetics 38(5): 499-505.
Abstract: The Lanyu pig is an indigenous breed from Lanyu Islet, located south-east of Taiwan, with phenotypic characteristics distinctive from other pig breeds in Asia and Europe. Based on geographic considerations, the Lanyu pig may have originated from mainland China, Austronesia or the Ryukyu Islands. In the present study, polymorphism of the mitochondrial DNA control region sequence was used to clarify phylogenetic relationships among two herds of Lanyu pigs imported before 1980 from Lanyu Islet into Taiwan and reared in isolation on two different farms. Two distinct mitochondrial control region haplotypes were found. The type I Lanyu sequence appeared independently as a unique clade different from Asian and European pig sequences, while the type II Lanyu sequence was clustered within the major Asian clade. The pairwise distances between the major Asian clade vs. the type I Lanyu and European clades were 0.01726 +/- 0.00275 and 0.01975 +/- 0.00212 changes per site respectively. Estimates of divergence time suggest that the type I Lanyu sequence split from the major

Asian pig clade in prehistoric times. The type II Lanyu mtDNA shares a close genetic lineage with Japanese Satsuma and New Zealand Kune Kune mtDNA with pairwise distances of 0.00095 +/- 0.00000 and 0.00192 +/- 0.00000 respectively, indicating gene flow between Lanyu Islet, Japan and Oceania in recent times. Together these results indicate that the type I Lanyu pig has a genetic lineage separate from Asian-type pigs, while the type II Lanyu sequence may represent a more recent introgression of modern Asian pigs.

Habicht M and Struwe R. 2007. Investigations of the attitude and use of pigs from ancient times until modern times [German]. Tieraerztliche Umschau 62(7): 383.

Abstract: Pig husbandry and their exploitation play a significant role in the modern agricultural animal husbandry. However, the husbandry conditions of the animals are often not appropriate to the species and man's basic relationship with pigs is remote, and more lost. This study focuses on the question of the living conditions of pigs in the history of agricultural animal husbandry. It introduces and discusses essential aspects of pig husbandry, and exploitation in ancient times, Middle Ages and modern times using documents of leading agricultural authors. It also illustrates man's relationship to animals in the various eras. The respect for pigs was low especially as expressed by many of the authors of Middle Ages and modern times. However, the production of meat and fat were most important in all of these eras. Many of the authors from ancient to modern times discussed the importance of health and well-being of the animals but these aspects were still secondary, in comparison to the exploitation of pigs. In the 19th century, ever more authors criticized the husbandry conditions of pigs that were developed during the industrialization period. These authors called for a return to natural husbandry methods.

Fisher RE, Scott KM and Naples VL. 2007. Forelimb myology of the pygmy hippopotamus (*Choeropsis liberiensis*). Anatomical Record (Hoboken, N.J.: 2007). 290(6): 673-693.

Based on morphological analyses, hippos have traditionally been classified as Suiformes, along with pigs and peccaries. However, molecular data indicate hippos and cetaceans are sister taxa (see review in Uhen, 2007, this issue). This study analyzes soft tissue characters of the pygmy hippo forelimb to elucidate the functional anatomy and evolutionary relationships of hippos within Artiodactyla. Two specimens from the National Zoological Park in Washington, D.C. were dissected, revealing several adaptations to an aquatic lifestyle. However, these adaptations differ functionally from most aquatic mammals as hippos walk along river or lake bottoms, rather than swim. Several findings highlight a robust mechanism for propelling the trunk forward through the water. For example, mm. pectoralis superficialis and profundus demonstrate broad sites of origin, while the long flexor tendons serve each of the digits, reflecting the fact that all toes are weight-bearing. Pygmy hippos also have eight mm. interossei and a well-developed m. lumbricalis IV. Retention of intrinsic adductors functions to prevent splaying of the toes, an advantageous arrangement in an animal walking on muddy substrates. Published descriptions indicate common hippos share all of these features. Hippo and ruminant forelimbs share several traits; however, hippos are unique among artiodactyls in retaining several primitive muscles (e.g., mm. palmaris longus and flexor digitorum brevis). These findings are consistent with the hypothesis that hippos diverged from other Artiodactyla early in the history of this group. Additional analyses of hindlimb and axial muscles may help determine whether this trajectory was closely allied to that of Cetacea.

Ecology and Conservation Studies

Fordham DA, Georges A and Brook BW. 2007. Demographic response of snake-necked turtles correlates with indigenous harvest and feral pig predation in tropical northern Australia. Journal of Animal Ecology 76(6): 1231-1243.

Abstract: Species that mature late, experience high levels of survival and have long generation times are more vulnerable to chronic increases in mortality than species with higher fecundity and more rapid turnover of generations.
Many chelonians have low hatchling survival, slow growth, delayed sexual maturity and high sub-adult and adult survival. This constrains their ability to respond quickly to increases in adult mortality from harvesting or habitat alteration. In contrast, the northern snake-necked turtle *Chelodina rugosa* (Ogilby 1890) is fast-growing, early maturing and highly fecund relative to other turtles, and may be resilient to increased mortality.
Here we provide correlative evidence spanning six study sites and three field seasons, indicating that *C. rugosa* is able to compensate demographically to conditions of relatively low subadult and adult survival, caused by pig *Sus scrofa* (Linnaeus 1758) predation and customary harvesting by humans.
Recruitment and age specific fecundity tended to be greater in sites with low adult and sub-adult survival (and thus reduced densities of large turtles), owing to higher juvenile survival, a smaller size at onset of maturity and faster post-maturity growth.
These patterns are consistent with compensatory density-dependent responses, and as such challenge the generality that high sub-adult and adult survival is crucial for achieving long-term population stability in long-lived vertebrates such as chelonians. We posit that long-lived species with 'fast' recruitment and a capacity for a compensatory demographic response, similar to *C. rugosa*, may be able to persist in the face of occasional or sustained adult harvest without inevitably threatening population viability.

Pattison J, Drucker AG and Anderson S. 2007. The cost of conserving livestock diversity? Incentive measures and conservation options for maintaining indigenous Pelon pigs in Yucatan, Mexico. Tropical Animal Health and Production 39(5): 339-353.

Abstract: In the Mexican state of Yucatan the Pelon pig breed has been identified as being endangered. The gradual disappearance of this indigenous breed that is able to survive well in an extreme environment and under low-input conditions undermines food and livestock security for Yucatan's rural poor. This study uses contingent valuation to identify those backyard pig producers who require least compensation to conserve the Pelon breed. Understanding the conditions under which livestock keepers most committed to the use of the indigenous breed would be willing to participate in different conservation scenarios allows for a comparative analysis of alternate conservation schemes, in terms of cost and breed population growth. The findings suggest that establishing a community-based conservation scheme could be sufficient to ensure that the Pelon pig reaches a 'not at risk' extinction status. Alternatively, establishing open-nucleus breeding schemes would result in a higher effective population size, but at relatively greater cost. We conclude that for the specific case of the Pelon pig in Yucatan, Mexico, if effectively designed, the cost of conservation and sustainable use strategies may be little more than the cost of facilitating access to the animal genetic resource for those most reliant upon it.

Pushkina D. 2007. The Pleistocene eastern-most distribution in Eurasia of the species associated with the Eemian *Palaeoloxodon antiquus* assemblage. Mammal Review 37(3): 224.

The *Palaeoloxodon antiquus* large-mammal assemblage was typical of the late middle and late Pleistocene interglacials in Europe. This review examines the assemblage's origins, dispersal and cohesiveness in Eurasia.
During the more climatically equable middle-Pleistocene periods, the Palaeoloxodon assemblage (or closely related) species occurred across central Eurasia almost simultaneously. In Central and Western Europe, these species responded to climatic changes together as an unvarying interglacial assemblage, whereas in Eastern Europe and Siberia, they occurred in diverging assemblages. The boundary of the Palaeoloxodon assemblage can be drawn roughly from Poland to Romania
In Central and Western Europe this interglacial assemblage last occurred during the Eemian. During this period many of the Palaeoloxodon assemblage species may also have co-occurred in south-eastern Europe and, except for *Bubalus murrensis* and *Hippopotamus amphibius*, further eastwards. The extinct species of the Palaeoloxodon assemblage disappeared in Siberia and Central Asia prior to Europe and the Caucasus whereas the extant species were already present in their modern distribution areas.
A quantitative study of faunal associations across Eurasia, following much-needed comprehensive systematic reviews, would further elucidate the patterns of faunal change associated with local and global climatic changes during the middle to late Pleistocene.

Lewison R. 2007. Population responses to natural and human-mediated disturbances: assessing the vulnerability of the common hippopotamus (*Hippopotamus amphibius*). African Journal of Ecology 45(3): 407-415.

Vulnerable wildlife populations can face a suite of anthropogenic activities that may threaten their persistence. However, human-mediated disturbances are likely to be coincident with natural disturbances that also influence a population. This synergism is often neglected in population projection models. Here I evaluate the effects of natural (rainfall fluctuation) and human disturbances (habitat loss and unregulated hunting) using a multi-matrix environmental state population model for the common hippopotamus (*Hippopotamus amphibius*). By evaluating each disturbance type (natural and human) alone and then together, I explicitly consider the importance of incorporating realistic environmental variability into population projection models. The model population was most strongly affected by moderate habitat loss, which yielded the highest probability of crossing the risk thresholds over the 60 year time period, although these probabilities were relatively low (<= 0.31). However, the likelihood of crossing the risk thresholds were two to five times as high when human-mediated and natural disturbances were considered together. When these probabilities were calculated per year of the simulation, the results suggested that even relatively mild human disturbances, when considered in conjunction with realistic natural disturbance, resulted in a high probability (> 0.50) of substantial declines within decades. The model highlights the importance of integrating realistic natural disturbances into population models, and suggests that, despite locally abundant populations, protected hippopotamus populations may decline over the next 60 years in response to a combination of environmental fluctuations and human-mediated threats.

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.

This newsletter is electronically available at: http://iucn.org/themes/ssc/sgs/pphsg/home.htm