Suiform Soundings

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Suiform Soundings

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IUCN
The World Conservation Union

SSC
Species Survival Commission

Photo front page: Christopher Sandom photographed this male wild boar *Sus scrofa* in Alladale Wilderness Reserve, in the northern Highlands of Scotland. Read more about Chris's research into the use of wild boar in woodland regeneration on page 22.

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Editorial

This issue of the newsletter may be a little later than usual, and I hope you'll excuse me for this. I've had to be particularly persistent (read nagging) with my requests for contributions! However, I'm sure you'll agree that the wait was worth it, as we've got some very interesting articles featured here.

As usual, the peccary researchers (who now have two new chairs heading their Specialist Group – read about them on page 4) provide us with news on their latest findings, including an article on the use of hair traps for collecting DNA samples. Rebecca Lewison, chair of the Hippo Specialist Group, updates us on the precarious state of hippos in the DRC, while we also learn about a study taking place in Scotland, where the use of wild boar in woodland regeneration is being investigated.

I hope you enjoy this latest edition of *Suiform Soundings*, and I look forward to receiving your submissions and articles for Volume 10(2). It is my hope that this newsletter will continue to serve as a forum for the three separate Specialist Groups to share their research, ideas and conservation concerns, but this relies on the continued involvement and contributions of you, the reader.

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It's a hog's life.

These two pictures were kindly supplied by Jean Pierre d'Huart, who also explains the story behind them.

The man in the photos is Fraser Smith, who was for many years the leader of a WWF project in Garamba National Park, north east DRC. Fraser now works in the Selous in Tanzania. His house in Langata/Nairobi is called 'Hog Heaven' and is situated near the Nairobi National Park.
For many years, his garden has been visited by friendly warthogs. With the help of regular bits of food, Fraser has managed to "habituate" some of these wild warthogs to the point where they now sit ("good hog") before getting food, beg for vigorous flank-scratching, and happily accept the close presence of the resident dog!

Introducing the new chairs for the Peccary Specialist Group

Nos complace anunciar que hemos aceptado el honor y desafio de liderar el grupo de especialistas en pecaries de UICN. Mariana a trabajado en ecologia y conservacion de pecaries en el bosque lluvioso de Costa Rica y el bosque seco de la region del Chaco en Argentina. Harald ha trabajado en interacciones troficas y no troficas entre pecaries y otras especies en la Amazonia de Peru.

Como nuevos leaders del grupo, esperamos poder organizar actividades, crear un forum para discusions e intercambio de informacion, coordinar esfuerzos de investigacion y conservacion de pecaries, y fortalecer las relaciones entre los investigadores y conservacionistas de pecaries.Otra meta a largo plazo es crear mas nexos con los medios de comunicacion, agencias governamentales, NGOs, y fundaciones privadas para asegurar suficientes recursos y soporte para desarrollar estrategias realistas de conservacion de pecaries, y por lo tanto, de biodiversidad.

Actualmente nuestro grupo cuenta con 40 miembros de 16 paises diferentes, incluyendo investigadores de varias disciplinas biologicas, veterinarios, expertos de zoologicos, y de organizaciones conservacionistas. Esta diversidad y experiencia da al grupo una base fuerte para avanzar con colaboraciones, avanzar nuestro entendimiento de la especie, y trabajar para su conservacion.

Nuestras metas a corto plazo son coordinar el trabajo entre los miembros para realizar actualizaciones regulares de la Lista Roja de UICN, crear una pagina web interactiva, y compilar una biblioteca virtual con toda la literatura publicada sobre pecaries. Ademas, queremos crear un nuevo documento de planeamiento de la conservacion de pecaries, para actualizar el existente plan de conservacion de 1993. Tambien pensamos que es importante expandir nuestro grupo para incluir mas colegas de paises latinoamericanos, de Estados Unidos, y de instituciones zoologicas.

Hay mucho trabajo por delante para hacer si realmente queremos compartir la diversidad tropical con las proximas generaciones. ¡Vamos Amigos!

We are glad to announce that we have accepted the honour and challenge of leading the IUCN Peccary Specialist Group. Mariana has worked on the ecology and conservation of peccaries in the rainforest of Costa Rica and the dry forest of the Chaco region in Argentina. Harald has worked on trophic (i.e. seed dispersal and predation) and non-trophic (ecosystem engineering) peccary-species interactions in the Peruvian Amazon.

As new chairs, we hope that we can help to organize activities, create a forum for discussions and sharing information, coordinate efforts for peccary research and conservation, and strengthen relationships among peccary researchers and conservationists. Another long-term goal is to develop and foster partnerships with the media, governmental agencies, NGOs, and private foundations to secure sufficient resources and develop realistic conservation strategies for peccaries and overall biodiversity.

Currently our group has approximately 40 members from 16 different countries, including researchers from many biological disciplines, veterinarians, zoo experts, and conservation organizations. This diversity and expertise gives the group a very strong base to advance collaborations, our understanding of peccaries and to work for their conservation.

Our short-term goals are to coordinate work among members for regular updating of the IUCN Red List, create an interactive web page for the group, and compile a "virtual library" with all published literature related to peccary research. We further need to create a new Species Conservation Planning to replace the existing 1993 Species Action Plan. We would also like to expand our group to include more colleagues from Latin American countries, from the US, and from the zoo community.

There is a lot of work ahead of us if we really want to share tropical diversity with the next generation. ¡Vamos Amigos!

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News from the field: Conservation status of the common hippopotamus (*Hippopotamus amphibius*) in the Democratic Republic of Congo

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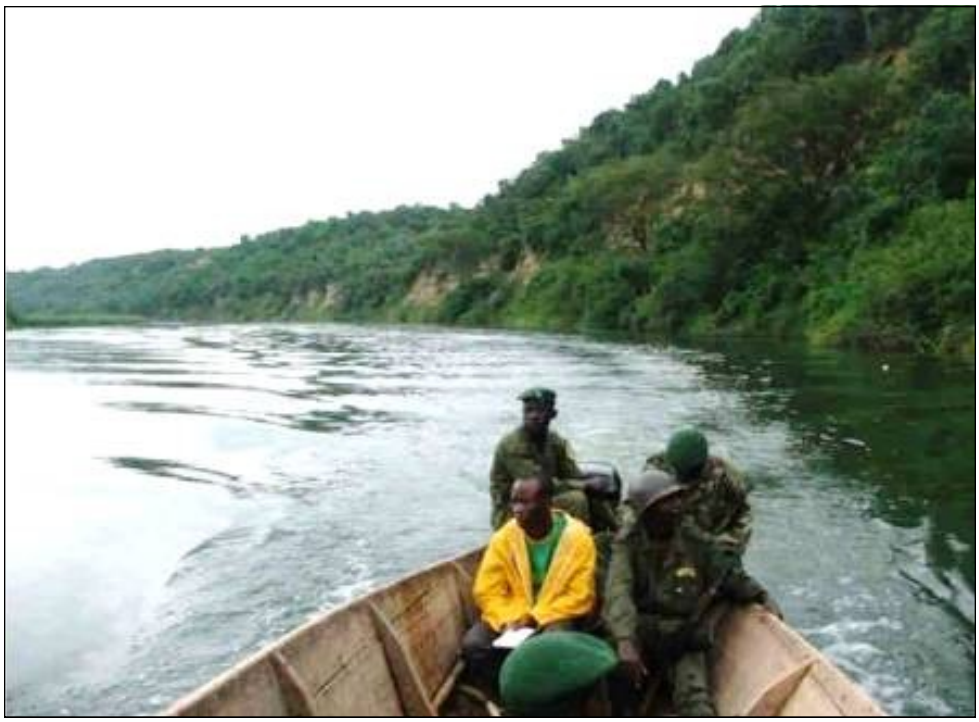
Reports from Virunga National Park, Democratic Republic of Congo (DRC) over the past 5 years have suggested dramatic declines in wildlife populations as civil unrest has reigned in the eastern part of the country. Once home to the world's largest common hippo populations, the reports of the declines in the DRC hippo populations were catastrophic. In the 1970's, DRC was home to as many as 30,000 hippos, the highest number in any African country. In 2006, a report by Zoological Society of London stated that perhaps as few as 900 hippos remained in the area as a result of rampant poaching in and around Virunga NP.

In Fall 2009, Mr. Deo Kujirakwinja conducted a survey to assess the abundance and persistence of hippos in Virunga NP and to understand the attitudes and perceptions from local communities related to the decline of hippos in Virunga NP. Conducting both a ground and aerial count along sections of the Ishasha, Rutshura and Semuliki River, as well as along the shoreline of Lake Edward, Mr. Kujirakwinja surveyed approximately 160 km and 550km with ground and aerial counts respectively and estimated a total of 1200 hippos. Overall, community members indicated they supported the presence of hippos, although survey results indicate that hippo meat is the major target for illegal hunting and mar-

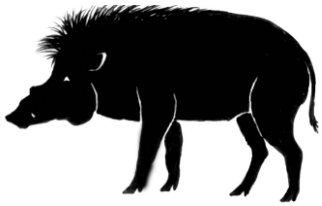
kets.

While DRC represents an extreme case, there are similar reports of common hippo poaching throughout their range in sub Saharan African countries. The Hippo Specialist Group is working closely with dedicated people like Mr. Kujirakwinja, and local and international wildlife agencies, to protect and conserve remaining hippo populations through research, education and enforcement.

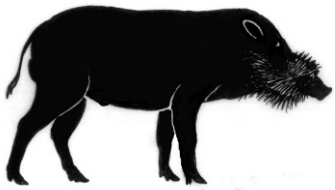
Mr. Deo Kujirakwinja is a student at the Percy FitzPatrick Institute, University of Cape Town. His work was supported by the Wildlife Conservation Society, the Congolese Wildlife Agency (ICCN), Frankfurt Zoological Society, and the International Hippo Foundation.



DRC Hippo survey team. Photo: D. Kujirakwinja



Papers and communications



Comparative reproductive biology of collared peccary (*Tayassu tajacu*) populations in the wild and in captivity under semi-extensive conditions in the Northeastern Peruvian Amazon.

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Abstract

The present study compares the reproductive performance of wild and captive populations of collared peccaries in the Northeastern Peruvian Amazon. The study of the reproductive performance of the collared peccary in the wild was based on the gross anatomic examination of genital organs from 193 females collected by rural hunters in the Tamshiyacu-Tahuayo Communal Reserve between 1996 and 2006. The wild collared peccary population presented a pregnancy rate of 42.5%. Estimations suggested that adult females produced 1.12 births/year, with a litter size of 1.77 embryos or foetuses. Parturition–conception and farrowing intervals were estimated on 187 and 325 days, respectively. Yearly reproductive production was 1.99 piglets per pregnant female, and gross productivity was 0.69 piglets per year and adult female. A phenomenon of embryo migration between the uterine horns was observed in the 31.8% of pregnant females. This study also analysed reproductive performance of a captive population of collared peccaries during a 56-month survey. Mean age at first parturition was 28.5 months; nevertheless, the earliest first parturition occurred at an age of 14.3 months. Mean parturition–conception and farrowing intervals were 143 and 283 days, respectively. Adult females produced 0.96 parturitions per year with a litter size of 1.58 piglets per parturition. Yearly reproductive production was 1.37 piglets per female. The captive population presented a high newborn mortality rate of 15.1% during the first month of life. Both populations of collared peccary bred year

round in the Northeastern Peruvian Amazon and presented inefficient reproductive factors. In the wild population, a low pregnancy rate was observed. In the captive collared peccary under semi-extensive conditions, a great effort should be made to improve the age at first parturition and reduce newborn mortality. The long estimated parturition–conception interval in both populations suggests that a large number of females do not present a fertile post-partum oestrus. This study provides reproductive information that should be taken into account in management plans.
Keywords: Reproductive biology, wild, captive, collared peccary, *Tayassu tajacu*.

1. Introduction

In the Amazon region, the collared peccary (*Tayassu tajacu*) is one of the most frequently hunted species (Redford & Robinson, 1991) and represents an important source of food and animal skins (Lavaigne *et al*., 1996; Fitz Gibbon, 1998). Since over-hunting could result in the local or even wide extinction of the species in forested habitats (Redford, 1993; Emmons, 1997), the development of conservative management strategies should be addressed towards the sustainable use of the collared peccary.

The reproductive biology of the peccary determines its ability to support high hunting pressures and is of paramount importance to optimize zootechnical performances of any species. The existing information on collared peccary reproduction in the Amazon region is based on outstanding long-term studies conducted in captivity in recent years (Mauget et al., 1997; Nogueira-Filho & Lavorenti, 1997; Mayor *et al*., 2005, 2006a, 2007). Nevertheless, the reproductive biology of the collared peccary in the wild is not sufficiently known (Gottdenker & Bodmer, 1998; Mayor *et al*., 2006a) and appropriate management practices have not yet been developed for this species.

In the Amazon, the collared peccary female is considered to be aseasonally polyoestrous in both the wild (Gottdenker & Bodmer, 1998; Mayor *et al*., 2006a), and in captivity (Mayor *et al*., 2007). This species shows an oestrous cycle length of 22.6–27.8 days (Sowls, 1997; Mauget *et al*., 1997), a mean gestation period of 138 days (Mayor *et al*., 2005), and a litter size of 1.7–1.9 foetuses or newborns (Gottdenker & Bodmer, 1998; Mayor *et al*., 2005 and 2007). Reproductive production of the species was estimated at 1.4–1.8 (Gottdenker & Bodmer, 1998) and 1.0-1.6 parturitions per female per year (Nogueira-Filho & Lavorenti, 1997; Mayor *et al*., 2007) in the wild and in captivity, respectively.

The reproductive biology could be fundamental to understanding the dynamics of wild populations and improving management of its breeding in the Amazon region. The objective of the present study is to compare the reproductive performance of collared peccary populations in the wild and those maintained in captivity under semi-extensive conditions in the Northeastern Peruvian Amazon.

2. Material and methods

2.1. Area of study

This study was conducted in the forests of Northeastern Peru in the state of Loreto. The climate in that region is typically equatorial with an annual temperature of 22-36ºC and a daily variation of 4ºC. The relative humidity varies between 80% and 100%. Annual rainfall ranges between 1500 mm and

3000 mm. Seasons are defined as short dry (January–February), long wet (March–June), long dry (July –September), and short wet (October–December) with inundation of the lowland forests occurring during the long wet season (Gottdenker & Bodmer, 1998).

2.2. Reproductive study of the collared peccary in the wild

The study area took place in the Tamshiyacu–Tahuayo Communal Reserve. The reserve spans 322,500 ha of continuous forest and is predominantly non-flooded terra firme forest (Bodmer *et al*., 1990). From 1996 to 2006, hunters living in the study area collected genital organs of 202 collared peccary females (193 adults and 9 pre-pubertal individuals), encompassing the wet and dry seasons. Hunters collected the samples as part of an ongoing participatory conservation programme that involves local hunters in the implementation of community-based wildlife management. Hunters labelled the genital organs by date and location where animals were killed. Whole body and genital organs weights were recorded, and tissues were maintained in buffered 4% formaldehyde solution (v/v) until analysis. All collected biological samples were stored at the Museo de Zoologia belonging to the Universidad Nacional de la Amazonía Peruana. During 2003 and 2006, hunters registered all species in order to determine most hunted preys in the area.

Animals were classified as pre-pubertals or adults according to body weight (Lochmiller *et al*., 1987; Dubost *et al*., 2003; Mayor *et al*., 2007), and gross anatomical and histological examination of genital organs (Gottdenker & Bodmer, 1998; Mayor *et al*., 2006a). Genital tracts of adult females were examined for evidence of embryos or foetuses. Non-pregnant adult animals with ovaries bearing large antral follicles and lacking CL were considered to be in the follicular phase of the oestrous cycle, while those with ovaries containing active luteal tissue were described to be in the luteal phase of the oestrous cycle (Mayor *et al*., 2006a). In the absence of either large antral follicles or corpora lutea (CL), the ovaries were considered inactive. Females with at least one embryo or foetus were considered to be pregnant, and the pregnancy stage was defined as embryonic or foetal (Nomina Embryologica Veterinaria, 1994). Since Mayor *et al*. (2005) determined first anatomical signs of pregnancy around the 15^{th} day of gestation in its conspecific, the collared peccary, we consider a possible underestimation of the 10% of pregnancies respect to non-pregnant females in luteal phase. Measurement of the crown-rump length was taken with a calliper (to the nearest 0.1 mm) and external features of the foetuses (vibrissae, eye, nose, dental development, sex and pelage) were also recorded.

We sectioned ovaries and recorded number of CL to determine ovulation rate, which was expressed as the number of CL per ovulating female. Fertilization rate was determined by counting the total number of embryos or foetuses per number of CL and pregnant females (Hellgren *et al*., 1995). The reproductive wastage was calculated as the difference between the number of true CL and the observed embryos or foetuses (van Aarde & Skinner, 1986).

Pregnancy rate was estimated by total number of pregnant females/total number of examined females. Litter size and sex ratio of each pregnancy were recorded. Foetal sex ratio was expressed as the number of male foetuses per number of female foetuses. Hunted adult sex ratio was expressed as the number of hunted males per hunted females. The comparison between foetal and adult hunted sex ratio was used as an indicator of hunting vulnerability according to the sex of the individual.

Monthly conceptions and births were determined by back-dating and fore-dating embryos or foetuses from the estimated age on the date when the collared peccary was collected. Embryo or foetus measurements were used to estimate conception and parturition dates. Gestation length used to backdate and foredate embryos or foetuses was 138 days (Mayor *et al*., 2005). Pregnant females were classified according to embryo or foetus age in pregnancy stages of 30 days, starting at day 15 of pregnancy. Percentages of hunted pregnant females were calculated in order to determine hunting vulnerability of pregnant females according to pregnancy stage.

Parturition-conception interval and farrowing interval were estimated using the number of pregnant and non-pregnant females (Gottdenker & Bodmer, 1998). Number of births per female per year was calculated based on the farrowing interval. Reproductive production was calculated by multiplying briths/year by average litter size per female. Gross productivity was defined as the number of embryos or foetuses per total number of adult pregnant and non-pregnant females, whereas gross fecundity was determined as the total number of female embryos or foetuses per total number of females in the sample (Caughley, 1977).

2.3. Reproductive study of the collared peccary in captivity

The animals belonging to the experimental farm of Biodiversidad Amazónica from Iquitos, the capital city in the Department of Loreto, were studied during a 56-month period (from March 2003 to December 2007). The experimental breeding stock was founded with 15 animals (7 males and 8 females) captured from the wild in 2000. In 2003, 6 individuals (2 males and 4 females) from another farm were introduced. During the experimental period, the total number of animals grew progressively from May 2003 (n=30) to December 2007 (n=96). Five animals (2 males and 3 females) from different localizations were also introduced intermittently throughout the study.

Animals were maintained under semi-extensive conditions and kept outdoors in large enclosures with natural soil, and divided into reproductive groups with an initial proportion of 1:1-2 (male: females). Available space per animal was from 100-125 m^2 (May 2003) to 20-25 m^2 (December 2007). Animals were classified as newborns, juveniles, sub-adults and adults according to age (Mayor *et al*., 2007). Animals less than 2 months old were considered newborns. Adult females were considered to be from 1 year old onwards. No reproductive or weaning program for piglets was implemented during the study period. Piglets were always in direct contact with their relatives. The experimental animals were fed in an effort to reproduce natural conditions in the wild, with plants, roots, tubers, grubs and caterpillars extracted from the Amazonian ecosystem supplied with cereal by-products. Water and food was freely available. No preventive medication was supplied.

The studied reproductive parameters were: yearly distribution of parturitions, age at first parturition, age at first conception (estimated by back-dating the 138-days of pregnancy length (Mayor *et al*. 2005) from the age at first parturition), litter size, newborn sex ratio, farrowing interval, parturition–conception interval, number of parturitions per female per year, production of piglets per year and per female, and production of alive 2-month old piglets per year and per female. Number of births per female and per year was expressed as the total parturitions of the captive population divided by the sum of individuals-time, expressed on an annual basis.

2.4. Statistical analysis

To estimate reproductive performance of the collared peccary in the wild, we assumed that the information collected from the hunted animals is representative of the population at large. To test the hypothesis of seasonal reproduction, we used the number of conceptions by season and applied an unpaired t-test, after testing for normality. Comparison between sex ratio of foetuses and adult hunted individuals, and hunting frequency according to the pregnancy stage were analyzed using chi-square tests. Comparison between weight of pregnant and non-pregnant females, and number of CL in right and left ovary was calculated using analysis of variance. Statistical differences on the recorded reproductive performances were estimated by analysis of variance. Mean differences were tested using the least-square means method. Statistical analyses were performed using GraphPad Instat (version 3.01 for Windows 95, GraphPad Software Inc., San Diego, CA, USA: www.graphpad.com). Differences with a probability value of 0.05 or less were considered significant. All values are expressed as the mean ± standard deviation (S.D.).

3. Results

3.1. Reproductive performance of the collared peccary in the wild

Table 1 presents the hunting registers of two communities of the study area (Diamante and Nueva Esperanza) during the experimental period 2003-06. Rodent species were the most hunted species (50.1%), followed by peccaries (14.1%) and primates (9.0%). The collared peccary was the third most hunted species (9.5%) in the experimental area.

Table 1. Hunting registers, both number and percentage (in brackets), of hunted animals in two communities of the study areas (Diamante and Nueva Esperanza) during part of the experimental period (2003-06).

Species	Diamante (2003-05)	Nueva Esperanza (2005-06)	Total area
Agouti paca	184 (39.6)	36 (22.4)	220 (34.9)
Dasyprocta spp.	76 (16.3)	20 (12.4)	96 (15.2)
Tayassu tajacu	30 (6.5)	30 (18.6)	60 (9.5)
Nasua nasua	41 (8.8)	15 (9.3)	56 (8.9)
Tayassu pecari	29 (6.2)	0 (0.0)	29 (4.6)
Primates	31 (6.8)	31 (19.3)	52 (9.0)
Birds	30 (6.5)	8 (5.0)	38 (6.0)
Other Arthiodactyla	17 (3.7)	13 (8.1)	30 (4.8)
Other species	40 (8.6)	8 (5.0)	48 (7.6)
Total hunted animals	**469 (100)**	**161 (100)**	**630 (100)**

Among the 193 adult sampled collared peccary females from 1996 to 2006, 82 (42.5%) were at different stages of pregnancy and 111 (57.5%) were non-pregnant females (Table 2). Non-pregnant females included 55 (49.6%) females in follicular phase and 56 (50.4%) females in luteal phase. All females presented large antral follicles or corpora lutea. Figure 1 shows monthly distribution of pregnancies (n=70), and estimated conceptions and parturitions. Females conceived in every month of the year (P=0.91), and there were no significant differences between the number of estimated parturitions during the wet and the dry season (42 and 28, respectively; P=0.86).

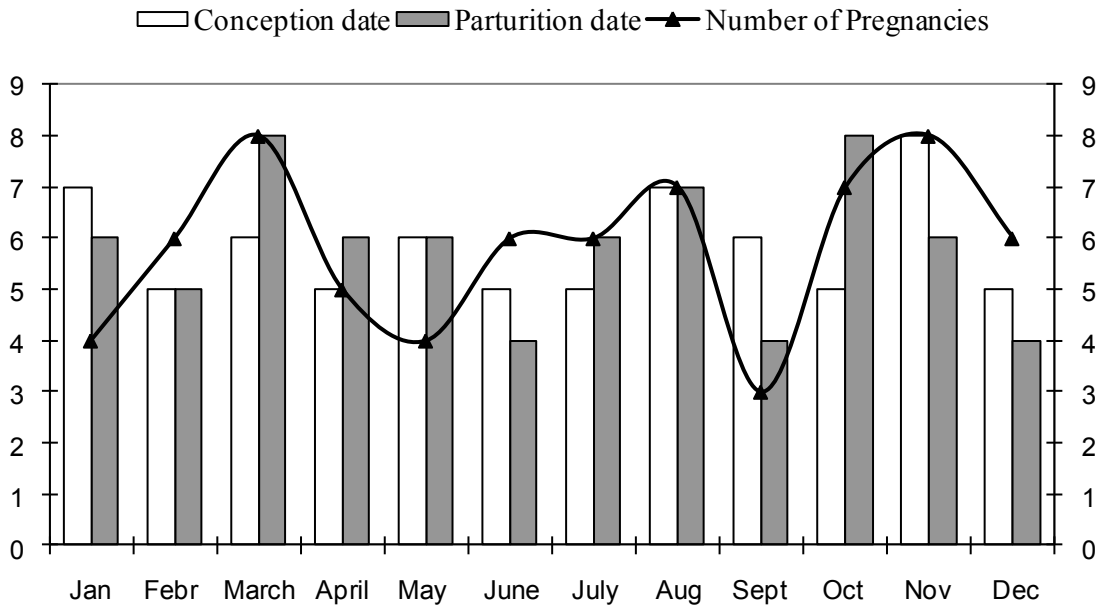

Figure 1. Monthly number of pregnancies, and estimation of conceptions and parturitions per month of the wild collared peccary female (n=70) in the study site. Conceptions and parturition dates were estimated by backdating or foredating of foetuses.

According to the number of CL, ovulation rate was not significantly different between pregnant and non-pregnant females in luteal phase of the sexual cycle (2.25 ± 0.58 vs. 2.03 ± 0.72 follicles per ovulating female, respectively; P=0.09). There was no significant difference in the number of CL in the left and right ovaries (1.03 ± 0.69 vs. 1.10 ± 0.75, respectively; P=0.44).

The observed 82 pregnant females showed 145 embryos or foetuses, resulting in a litter size of 1.77 ± 0.48 embryos or foetuses per pregnant female (Table 2). Collared peccary females presented a fertilization rate of 79.7%, and a mean ovum mortality of 0.45 ± 0.65 (21.3%) oocytes or embryos per pregnancy. Among all pregnancies studied, 21 (25.3%) were single, 59 (72%) double and 2 (2.7%) triple.

Right and left uterine horns presented a similar number of embryos or foetuses (49.6% and 51.4%, respectively). In 56 (68.2%) pregnancies, there was a correspondence between the number of embryos or foetuses and CL in the ipsilateral ovary. Contrary, in 26 (31.8%) females, the number of embryos or foetuses exceeded the number of CL in the ipsilateral ovary. Among females with embryo migration, 4 (4.5%) and 22 (27.3%) females presented a litter size of 1 and 2 foetuses, respectively (Figure 2).

Table 2. Reproductive performance of wild collared peccary females (n=193) in the Northeastern Peruvian Amazon (Blanco and Yavari Miri rivers) from June 1996 to August 2006.

Reproductive parameters	Value
Number of females	193
Number of non-pregnant females	111
Number of pregnant females	82
Number of foetuses	145
Pregnancy rate (%)	42.5
Pregnant days/year (days)	155
Non-pregnant days/year (days)	210
Parturitions/year/female (piglets/year/adult female)	1.12
Farrowing interval (days)	325
Parturition-conception interval (days)	187
Litter size (piglets/parturition)	1.77
Foetal sexual ratio (F/M)	69/75
Yearly Reprod. Prod. (piglets/year/pregnant female)	1.99
Gross productivity (piglets/year/adult female)	0.689
Gross fecundity (female piglets/year/female)	0.326

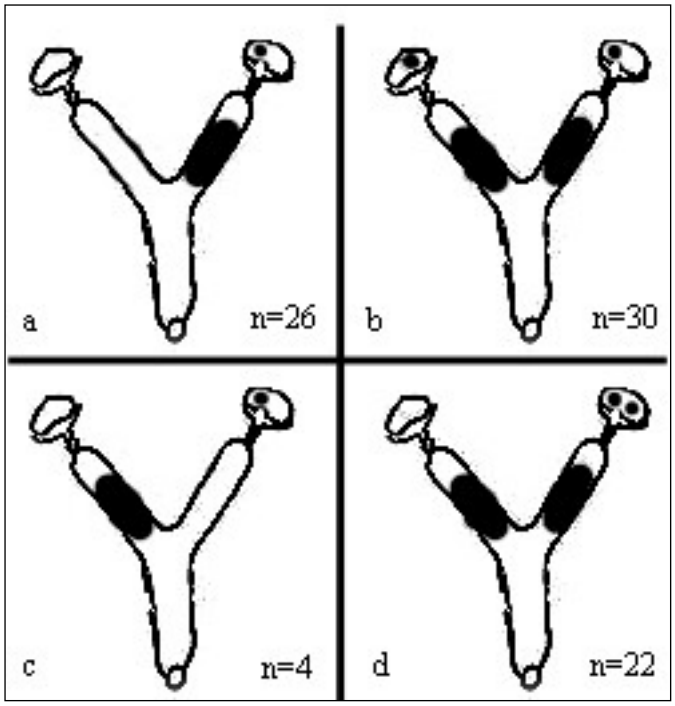

Figure 2. Distribution of CL and embryos or foetuses in the wild collared peccary pregnant female (n=80). a) Females with one embryo or foetus in the uterine horn and one CL in the ipsilateral ovary (independently of the side); b) females with one embryo or foetus in each uterine horn and one CL in each ovary; c) females with one embryo or foetus in the uterine horn and CL only in the contralateral ovary; d) females with one embryo or foetus in each uterine horn and 2 CL only in one ovary. A phenomenon of embryo migration was observed when the number of embryos or foetuses in the uterus exceeded the number of CL in the ipsilateral ovary (c and d).

The collared peccary presented a foetal sex ratio of 47.3% females and 52.7% males, which did not differ from a 1:1 sex ratio (P=0.67). Among the total 370 hunted and registered collared peccaries, the adult sex ratio was 45.4% females and 54.4% males. There was no significant difference between foetal and adult sex ratio (P=0.20).

The percentage of pregnant females (42.5%) implies that one average adult female was pregnant for 155 days and non-pregnant for 210 days per year, resulting in 1.12 parturitions per year and delivering at term 1.99 piglets per year and per adult female. Farrowing interval was 325 days, and parturition-conception interval was 187 days. There was no significant difference in hunted pregnant females according to the pregnancy stage (P=0.12).

3.2. Reproductive performance in the captive collared peccary

During the 56-month experimental period, 121 piglets were born from 77 parturitions. Figure 3 shows the distribution of females and the average adult life of females according to the number of parturitions. From the 28 adult females with an average of 39.4 months of adult life in the experimental farm, 2 (7.1%) and 6 (21.4%) females had no parturition or only one parturition, respectively. Parturitions occurred all year round (Figure 4). There were no significant differences between the number of parturitions during the wet and the dry season (45 and 32, respectively).

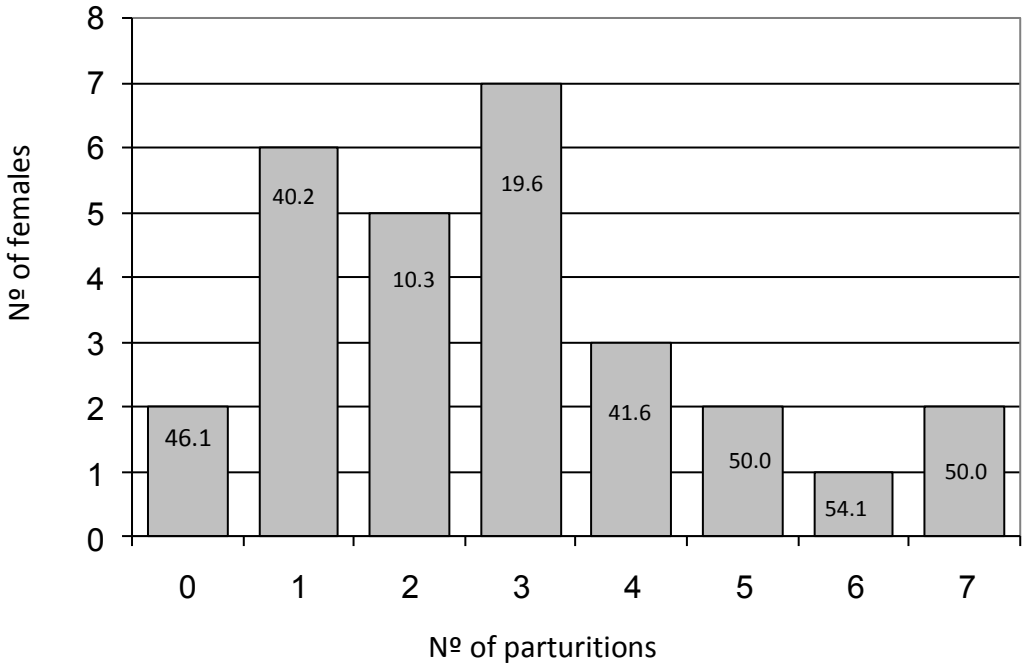

Figure 3. Distribution of females (n=28) in accordance to the number of parturitions in the captive collared peccary population. Averages of months of adult life in the experimental farm are shown into brackets.

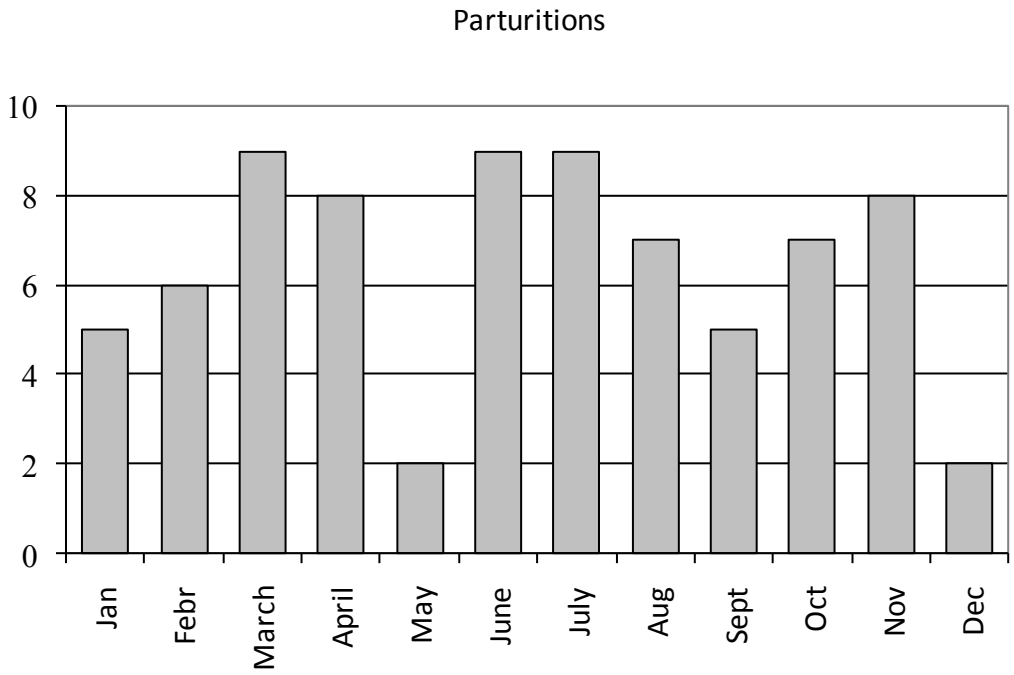

Figure 4. Distribution of cumulated parturitions (n=77) in the captive collared peccary population.

Table 3 shows the reproductive performance of the captive collared peccary population. Mean age at first parturition was 28.5±8.4 months, but the earliest first parturition occurred at 14.3 months old. Estimated farrowing and parturition–conception intervals were 282.8±121.6 and 144.8±121.6 days, respectively. In multiparous females, 8 (15.1%) estimated conceptions occurred less than 3 weeks after parturition, while 45 (84.9%) conceptions were estimated to occur more than 21 days after parturition.

Average litter size was 1.58±0.59 piglets per parturition, with a sex ratio of 57.1% females and 42.9% males. Among all parturitions, 36 (46.7%) were single, 38 (49.3%) double, and 3 (3.9%) triple. Litter size showed no significant differences (P = 0.54) in relation to the parturition number.

Yearly mean reproductive production was 0.96±0.47 litters and 1.37±0.76 piglets per female. Multiparous females produced 1.04±0.35 litters and 1.58±0.57 piglets per year.

From a total of 52 deaths, mortality of newborns less than 1 and 2 months old was 36.5% and 48.1%, respectively. Mortality rate in newborns less than 1-month old was 15.7% (19/121) of the total newborn population. Newborn mortality generally occurred during the first two days of life (36.8%; 7/19). Mortality rate in newborns during the second month of life was 5.9% (6/102), and cumulated mortality rate in newborns less than 2 months of age was 20.7% (25/121) of the total newborn population at risk. Taking into account newborn mortality, yearly reproductive production per female was 1.06±0.65 piglets alive at 2 months old. No clinical reproductive signs and no abortions were observed in the experimental females.

Table 3. Reproductive performance of the captive collared peccary population (number of females=28) in the Northeastern Peruvian Amazon from January 2003 to December 2007.

Reproductive parameters	n	Mean ± S.D.
Number of females		28
Number of parturitions		77
Number of piglets		121
Litter size (piglets per parturition)	77	1.58±0.59
Alive piglets per parturition [1]	77	1.18±0.38
Dead piglets per parturition [1]	77	0.38±0.34
Age at first conception (in months)	16	23.9±8.5
Age at first parturition (in months)	16	28.5±8.4
Farrowing interval (in days)[2]	49	282.8±121.6
Parturition–conception interval (in days)[2]	49	142.8±121.6
Parturitions per year per female	28	0.96±0.47
Parturitions per year per multiparous female	20	1.04±0.35
Newborns per year and female	28	1.37±0.76
Newborns per year and multiparous female	20	1.58±0.57
Alive piglets per year and female [1]	28	1.06±0.65

[1] Two months after parturition.
[2] Only multiparous females

4. Discussion

A precise knowledge of reproductive biology is critical for the development of wildlife management strategies as it determines the strategy of species to support high hunting pressures. In the Amazon region, the collared peccary is one of the most frequently hunted species (Lavaigne *et al*., 1996; Fitz-Gibbon, 1998), making it necessary to develop reproductive studies aimed at the establishment of sustainable harvest rates and the establishment of captive breeding systems. The present report aims to compare the reproductive performance of two collared peccary populations, in the wild and in captive conditions, in the Northeastern Peruvian Amazon region.

Hunting registers in the study area show that the collared peccary is one of the most hunted species, representing 9.5% of total hunted animals. This value agrees with hunting registers in other localities of the Amazon region (Bodmer *et al*., 1988; Redford & Robinson, 1991; Vickers, 1993; Redford, 1993; Moreira & MacDonald, 1997).

The presence of pregnant females in both wild and captive populations in all months of the year shows that pregnancies are evenly distributed year around. In agreement with the findings of Gottdenker & Bodmer (1998), this study suggests that the collared peccary breeds year round in the Northeastern Peruvian Amazon, probably due to the lack of huge seasonal differences in resources in

the tropical environment, resulting in a sufficient food supply for peccaries to sustain a pregnancy regardless of the month of the year.

Similarly to Nogueira-Filho and Lavorenti (1997) and Mayor *et al.* (2007), the earliest observed first parturition was at 429 days old, suggesting that collared peccary females could initiate their reproductive life at approximately 8-9 months old. However, our experimental population presented a considerable higher mean age at first conception of 23.5 months.

As reported by Gottdenker and Bodmer (1998), in this study the collared peccary females in the wild presented a pregnancy rate of 42.5% and had an estimated reproductive production of 1.12 litters per year. Taking into account that the normal reproductive state of an adult female in the wild should be pregnancy (Weir, 1974), this low pregnancy rate suggests that, although a high number of reproductive females are in reproduction, a larger number of females are apparently limiting the efficiency of the whole population. The collared peccary is highly social (Altrichter *et al*., 2001), and one restricting reproductive factor could be the social organization of the herd (Clutton-Borck *et al.,* 1985). Mayor *et al*. (2008) suggested that in captive conditions, the dominance rank could limit the reproductive functionality of the collared peccary female.

Infecto-contagious causes cannot be discarded as a potential cause of the low productivity of the captive collared peccaries. In recent studies on the captive collared peccary, the presence of Leptospirosis (Mayor *et al.* 2007; Mendoza *et al.* 2008; Jori *et al*. 2009) and Brucellosis (Mayor et al. 2007), was observed. Both diseases affect wild pigs, producing abortion and infertility (Fowler, 1996).

The farrowing interval of collared peccary in the wild was 325 days, resulting in a yearly production of 1.99 piglets per female. In the captive population, the farrowing interval of multiparous females (283 days) was higher than the observed in other captive systems (Nogueira-Filho & Lavorenti, 1997: 215 days; Mayor *et al.,* 2007: 196 days) and that estimated in the wild (Gottdenker & Bodmer, 1998: 228 days). These reproductive parameters suggest that, although there is a long delay in the start of the reproductive life, after first parturition the captive female increases its reproductive efficiency.

In captive conditions, Mayor *et al*. (2006b and 2007) reported the occurrence of a fertile oestrous cycle in the early post-partum period. Nevertheless, the presence of a long estimated parturition–conception interval of 187 days and 145 days in the wild and captive collared peccary, respectively, suggests that a large number of females do not present a fertile post-partum oestrus.

Mean ovulation rate of the collared peccary in the wild was 2.25 follicles per female, with a low rate of reproductive wastage of 0.45 oocytes or embryos per pregnancy. Similarly to other studies conducted in the wild (Gottdenker & Bodmer, 1998; Mayor *et al*., 2006a) and in captivity (Mayor el al., 2005 and 2007), mean litter size was 1.77 piglets per parturition, with a sexual ratio not different from 1:1. Mean litter size in the captive collared peccary was 1.58 piglets per parturition. Pregnancy stage did not influence vulnerability to human hunter, in contrast to the white-lipped peccary which is more vulnerable in the advanced stage of pregnancy (Mayor et al., submitted).

A phenomenon of embryo migration was observed in the 31.8% of pregnant females in the wild, and no pregnant female had two foetuses in the same uterine horn. This finding suggests the inability of

the uterine horn to support the development of more than 1 foetus, limiting the prolificacy of this Suiform.

Yearly production of the collared peccary in the wild was 1.99 piglets per female. In captive conditions, yearly production per adult female and multiparous female was 1.37 and 1.58 newborns, respectively. The difference between these populations could be due to the high delay of the start of the reproductive life and the high number of females with a low efficiency in their reproduction. During the experimental period, 8 (28.5%) of the 28 experimental females of this study had no (n = 2) or one parturition (n = 6). As suggested by Mayor *et al.* (2008), the social structure of the group could affect the reproductive efficiency of some females.

The newborn mortality rate (15.1% from total newborns during the first month of life and 36.5% newborn mortality from total deaths) constitute another important restrictive factor for the reproductive efficiency of the herd and suggests the necessity in giving maximum attention to newborns.

Mayor *et al.* (2007) studied the reproductive performance of a captive population in semi-intensive conditions in the Eastern Amazon, with animals enclosed at high densities and fed with commercial sow food. In the present study, the captive collared peccaries were kept at low densities and were fed with natural products extracted from the Amazon. Both studies show that the captive collared peccary is capable of reproducing in different captive conditions. Nevertheless, both studies showed that a great effort should be focused to improve the age at first parturition and reduce the newborn mortality, suggesting that this species is still in the early stages of domestication. Nevertheless, a process of reproductive selection and the establishment of suitable management practices may improve the reproductive performance of the captive collared peccary populations.
The collared peccary in the wild presented a slightly higher reproductive performance than our captive population. The influence of the diet may have a strong impact on the reproductive efficiency of the species. In our semi-extensive captive collared peccaries, animals were fed by trying to reproduce natural conditions in the wild. They received mainly fruits of palms and other tropical plants, as well as roots, tubers, grubs and caterpillars (Sowls, 1984) extracted from the Amazon ecosystem, and only supplied with cereal by-products. Due to the variable availability of these products we could not determine the calorific and protein level supply. Nevertheless, we can not discard that diet could play a part in influencing the differences encountered between the studies in the wild and captive populations.

The collared peccary is one of the most frequently hunted species in the Amazon region and represents an important source of meat for the subsistence economy, making it necessary to consider management based primarily on the establishment of sustainable harvest rates. The captive breeding of this species could also play an interesting role in reducing the effects of intensive hunting in areas where this activity is no longer sustainable (Jori *et al.,* 1998).

This comparative study allows a current evaluation of the reproductive efficiency of the collared peccary in the wild and in captivity in the Northeastern Peruvian Amazon region. The study shows that captive collared peccaries maintained in semi-extensive conditions can reproduce successfully with a similar reproductive performance to that in the wild. Both populations show inefficient reproductive factors. In the wild population, the low pregnancy rate may act as an important restrictive factor for

the reproductive efficiency of the whole population. In the captive collared peccary, a great effort should be focused to improve the age at first parturition and reduce newborn mortality. This study provides relevant information that should be taken into account in both *in situ* and *ex situ* management programmes.

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A brief summary of findings from an exploration into the use of wild boar to promote woodland regeneration and control bracken in Northern Scotland.

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In ecological restoration, increasing consideration is being given to species reintroduction as a tool to re-establish ecosystem function (Soulé *et al*., 2003). A recurrent disturbance regime can be an important process for maintaining ecological function (White, 1979). Some species have a disproportionate effect on ecosystem function and are often termed keystone species or ecosystem engineers (Byers *et al*., 2006). Wild boar (*Sus scrofa*) are a good example of such a species as their industrious rooting activity can make an important contribution to the ground flora disturbance regime at the patch scale.

The Scottish Highlands is a denuded landscape that has suffered habitat loss (e.g. Caledonian Pine Forest) and species extirpation (e.g. wolf (*Canis lupus)*, brown bear (*Ursus arctos*), European lynx (*Lynx lynx*), European elk (*Alces alces*) and wild boar) over recent millennia (Yalden, 1999; Smout *et al*., 2005). The altered conditions and resources available within the Highland ecosystem have shifted the vegetation community from woodland to open heath. Although some of this shift has been the result of a changing climate, anthropogenic effects have also played a role (Smout *et al*., 2005). A lack of woodland regeneration is now threatening the limited woodland that remains (Warren, 2002). One method to promote woodland regeneration has been the construction of fenced deer exclusion areas, as high browsing pressure has been identified as a primary cause of the lack of woodland regeneration. Their success has been mixed and one reason for the lack of regeneration is the lack of disturbance to the ground flora (Bruinderink and Hazebroek, 1996; SNH, 2000; Welander, 2000).

Wild boar were extirpated from Scotland at least 300 years ago as a result of habitat destruction and direct persecution (Yalden, 1999). Wild boar are still farmed in Scotland where their rooting behaviour can be a nuisance. It is proposed that stocking farmed boar in regeneration exclusion areas could provide a novel opportunity to meet multifunctional forestry objectives and re-establish a disturbance regime to promote woodland regeneration.

To determine whether wild boar could be effective in this capacity I've attempted to address a number of questions:

- What foraging strategy do wild boar employ in the Scottish Highlands and is it compatible with promoting woodland regeneration and the control of bracken?
- Do these behaviours and their spatial distribution vary seasonally with implications for recommended stocking periods?
- Can behaviour be manipulated with supplementary feed to meet regeneration objectives?

- How does stocking density affect their rate of rooting?
- What are the wider environmental implications of using wild boar?
- Is the use of wild boar cost-effective?

The experiments were carried out in fenced regeneration areas on the Alladale Reserve, Sutherland. The initial investigation used a 175ha area with a population of 5 wild boar. Their foraging strategy indicated a preference for wooded areas with a ground vegetation of grass throughout the year and bracken in the autumn and winter. Rooting accounted for nearly double their foraging activity in the autumn and winter compared to spring and summer. Deep rooting behaviour was specifically associated with bracken dominated vegetation and there was evidence to suggest that deep rooting could reduce bracken density and increase forb species richness.

Within a heather moorland environment I identified that rooting rate was proportional to the number of boar stocked. The per capita rooting rate per week was consistent between separate enclosures although with temporal variation. The temporal variation was possibly related to environmental and weather conditions. It may be possible to predict the rate of rooting if boar abundance and rooting conditions are known. This information could be useful in predicting the completion rates of stocked areas for woodland regeneration and identifying the importance of a boar population to the local disturbance regime.

The wider environmental impacts of using boar are complex. Boar can promote woodland regeneration of seedlings while also threatening saplings and mature trees through bark stripping and uprooting, which was evident from a survey of Scots pine (*Pinus sylvestris*) present in the enclosure. Species richness can initially be reduced by rooting behaviour but with colonisation over time species richness can be re-established and potentially exceed previous levels. It is as yet unclear whether it is cost effective to use boar within woodland regeneration schemes compared to other methods and will largely be determined by whether a successful agro-forestry business model can be established. This may be most effective if farmers are willing to rent boar to forestry schemes during the autumn and winter, keeping them within farms in the spring and summer to farrow and raise piglets. The cost of renting the boar could potentially be borne by forest grant payments but it is yet to be seen whether this might be viable.

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A female *Sus scofa* and her piglet, Alladale Wilderness Reserve. Photo: Chris Sandom

Hair trap efficacy to sample white-lipped peccaries (*Tayassu pecari*)

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Introduction

Several forest-dwelling species of mammals are elusive and hard to sample. However, recent advances in genetic technology allow us to identify the species, sex and specific individuals without capturing the animals in question, via DNA extracts from faeces, carcasses, and hairs (Taberlet *et al.*, 1999). Faeces, which mark territory boundaries or lodges have been used in carnivore studies (Ernest

et al., 2000; Palomares *et al.*, 2002; Miotto *et al.*, 2007). Hair traps have been efficiently used to sample carnivores, such as bears (*Ursus arctos* and *U. americanus*; Woods *et al.*, 1999; Kendal *et al.*, 2009), lynx (*Lynx canadensis*; McDaniel *et al.*, 2000), martens (*Martes americana*; Foran *et al.*, 1997; Mowat, 2006), and ocelots (*Leopardus pardalis*; Weaver *et al.*, 2005), but not to sample other mammals in tropical forests.

White-lipped peccaries (*Tayassu pecari*) are neotropical ungulates that forage in thick vegetation in large herds that can exceed 100 individuals (Peres & Palacios, 2007; Galetti *et al.*, 2009). White lipped peccary populations have been declining and many local extinctions have occurred (Peres, 1996). In order to protect them via appropriate management and conservation programs, genetic parameters (such as genetic diversity, population structure, levels of gene flow, inbreeding coefficients, etc) need to be estimated. Our aims were to investigate the efficiency of barbed wire hair traps in a tropical rainforest and how white-lipped peccaries respond to these traps, in order to evaluate its application for future genetic studies.

Material and Methods

This work was conducted in Cardoso Island (Parque Estadual Ilha do Cardoso), Cananéia, São Paulo State, Brazil (25°03'05" – 25°18'18" S and 48°53'48" – 48°05'42" W). The Cardoso Island is a 15,100 ha protected land-bridge island encompassing several types of Atlantic rainforest, including lowland and montane tropical rain forests, mangroves, dune vegetation and restinga forest (Barros *et al.*, 1991). No reliable information exists on the white-lipped peccary population status in Cardoso Island (see Bernardo, 2004).

We constructed hair traps which consisted of an enclosure of barbed wire of approximately 16 m^2 wrapped around four trees (*Fig. 1*). We used one strand of wire positioned at a height of 40 cm above the ground, which is approximately 15 cm lower than the mean height of an adult white-lipped peccary. We positioned the wire at this height because many genetic parameters are estimated based on adult population (effective population), but juveniles can be sampled using the wire at lower height. Each trap was baited weekly with approximately 0.5 kg of corn and 0.25 kg of salt placed in the centre of the enclosure. We placed four traps in the "Poço das Antas" area, using a spacing distance of ≥ 100 m. Traps were set up in places known to be used by white-lipped peccaries such as foraging trails and rest sites. Traps were checked regularly twice a week, from 30 June to 27 October 2009. Hairs were collected from each trap separately during each checking occasion. When we checked hair traps, we also looked for and collected faeces in the same area where traps were placed. We compared the number of faeces collected with the number of hairs obtained with roots attached, to estimate the success of hair traps to sample white-lipped peccaries. In addition, we utilised one camera trap (ReconyxÒ) at one of the hair traps during two full days in November 2009 and recorded the number of peccaries and other mammal species that visited the trap.

Results and Discussion

Ten white-lipped peccaries and one agouti (*Dasyprocta aguti*) visited one hair trap during two hours of camera recording. On 25 occasions peccaries crossed the hair trap, leaving their hairs in the barbed wire (*Fig. 1*). We collected a total of 795 hairs from the four traps during the whole study period, of

which 80 (10.1%) had follicles. In contrast, we collected only 17 faecal samples in the same period and in the same area. In two traps we also found hairs from two other unidentified species, which show the potential of this type of trap to obtain samples from other species of mammals.

Our results demonstrated that barbed-wire hair traps are efficient in sampling white-lipped peccaries and probably other mammals in rainforests. This noninvasive method permitted us to collect samples with low costs and without obvious injury to the animals, which could be determined from the camera trap photos. We had a higher success rate sampling hairs than faeces. Faecal samples usually contain low and highly fragmented DNA and high concentrations of PCR inhibitors (Waits & Paetkau, 2005), and to purify the target DNA it is necessary to use expensive purification kits which increase the final costs of the analyses. Therefore, a barbed-wire hair trap is a good alternative to sample white-lipped peccaries and, with some adaptations, other rainforest mammals at low costs and easy handling. This makes this technique valuable to conservation genetic studies.

Figure 1. White-lipped peccary entering barbed-wire enclosure hair trap. Four of these traps were used to collect hair samples from white-lipped peccaries in Cardoso Island, Southeastern Brazil, from June to October, 2009. (Photo: D. Norris)

Acknowledgements

We would like to thank Darren Norris for letting us use the camera trap information. Permission to work in Parque Estadual Ilha do Cardoso and logistical support was provided by Instituto Florestal do Estado de São Paulo. Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA) allowed us to collect hair samples. Our project was funded by Coordenadoria de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) and Programa BIOTA of the Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP). MG receives a CNPq fellowship.

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News in Brief

Warthog befriends huge hornbill

By Jody Bourton , Earth News reporter
http://news.bbc.co.uk/go/pr/fr/-/earth/hi/earth_news/newsid_8534000/8534844.stm 2010/02/26

A warthog has been pictured being groomed by a huge bird known as a ground hornbill.

The warthog approached the southern ground hornbill seeking the favour, and the bird obliged by removing parasites from the warthog's body.

Similar interactions occur between warthogs and other animals such as banded mongooses. But hornbills are not known to groom in this way, say scientists who photographed the incident. Details of the behaviour are reported in the African Journal of Ecology.

Southern ground hornbills groom warthog. Photo: Hendri Coetzee

"The warthogs approached the hornbills and then lay down on their sides to be cleaned," explains Mr Hendri Coetzee of North West University, Potchefstroom, South Africa. "The warthogs were very nervous, because this behaviour most probably makes them more vulnerable to predation."

Mr Coetzee says he repeatedly observed similar interactions between common warthogs (*Phacochoerus africanus*) and southern ground hornbills (*Bucorvus leadbeateri*) in the Mabula Game Reserve

in South Africa's Limpopo Province. The arrangement is mutually beneficial: the warthog gets a cleaning service and the ground hornbill a nutritious and easily obtainable food source.

Other animals will also groom warthogs, picking off parasites from the wild pig's body. For example, banded mongooses remove ticks from warthogs, in what is believed by scientists to be the only symbiotic relationship between two mammal species.

Oxpecker birds also regularly clean the skins of a number of African mammals, including zebra and hippos.

But the interactions with the hornbills stood out because the warthogs usually initiated the grooming. Southern ground hornbills are large black plumaged birds, with powerful beaks that can kill tortoises and large snakes.

"What surprised me was how delicately they were removing parasites from the warthogs," says Mr Coetzee. "Adult warthogs even tolerated the ground hornbills probing their ears and around their more delicate areas under their tails."

Mr Coetzee speculates that the animals might be behaving this way in part because they are living on a game reserve, where they might be less threatened and more relaxed.

"It is most likely the result of learned behaviour and regular contact between the same individuals living under somewhat artificial circumstances, where the risk of predation is reduced," he explains.

(*Suiform Soundings first reported on these observations of Mr Coetzee's in Vol 6(1) of July 2006)*

Congo Soldiers Caught Poaching in Virunga National Park

By Heidi Marshall, Greenfudge.org Blog at ***http://www.greenfudge.org*** *8 April 2010*

About a month ago it was reported that Congo soldiers based in Virunga National Park were suspected of poaching a number of animals, including: 7 hippos, 5 elephants, 5 antelopes, 4 baboons, 3 chimpanzees, and 2 buffalo.
Those suspicions were correct.

According to the commander of the army's 15th Brigade (which is behind most of the killings), the soldiers have resorted to poaching because of the inadequacy of their food rations. On top of the poaching for food, soldiers have also developed an illegal ivory business in Nord-Kivu province, where the National Park is located. Traders purchase ivory from the troops in Goma and Butembo and then they ship the ivory to either China or Dubai.

IDPE (Innovation for the Development and Protection of the Environment) have been involved in the case. They claim that soldiers "use their wives and cousins to sell the meat" in villages near the park.

Virunga National Park is the oldest in Africa and also a UNESCO World Heritage Site. Hunting and fishing is completely banned in the park, though what punishment lies ahead for the soldiers remains to be seen.

At the very least, the military may be removed from the park altogether, as proposed by IDPE. More updates will be posted as they happen.

Three little pigs hog the limelight at Edinburgh Zoo

Zoo News http://www.edinburghzoo.org.uk/news-and-events/news/articles/news_111.html

30 June 2010 - Keepers at Edinburgh Zoo are celebrating the birth of three male red river hog piglets. Born on 6 June 2010, red river hogs have been at Edinburgh Zoo since 2004 and this is the second year they have bred successfully.

The piglets named Ellis, Moses and Nelson after stadiums in South Africa featured in the FIFA World Cup 2010 (Ellis Park, Moses Mabhida and Nelson Mandela), were born to proud parents Belle and Hamish. Currently the piglets have yellow and brown stripy coats but when they mature they will look very different. Adult red river hogs have a shaggy red coat, with a tufted white stripe running the length of their back. They also have long black and white tassels of hair hanging from each ear.

Sue Gaffing, Head Keeper of Hoofstock at Edinburgh Zoo, said: "We are delighted that for a second year our adult pair has produced piglets. At almost a month old they are really playful and have been chasing each other around their enclosure. At this age they are particularly cute so it's a really good to see them."

Red river hog *Potamochoerus porcus* piglets and an adult of the species
http://www.edinburghzoo.org.uk/news-and-events/news/articles/news_111.html

Red river hogs can be found throughout western and central Africa, living in wet habitats like swamps and marshes. In the wild, they are hunted by leopards, lions, hyenas and pythons. Humans also hunt them for bush meat, leading to a declining population.

Zebra puts head in hippo's mouth

BBC NEWS: http://news.bbc.co.uk/go/pr/fr/-/1/hi/world/europe/8564834.stm 2010/03/12

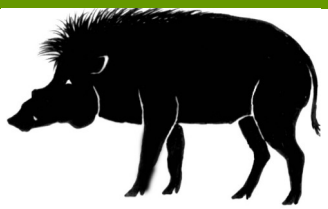
A zebra at Zurich Zoo appeared to be staring into the jaws of death when visitors saw it nose to nose with an open-mouthed hippopotamus.

But the hippo had no intention of having the zebra for lunch - it was having its teeth cleaned.
The extraordinary sight was captured by photographer Jill Sonsteby, from Jacksonville, Florida.
She said the teeth-cleaning session lasted 15 minutes and the zebra came to no harm.

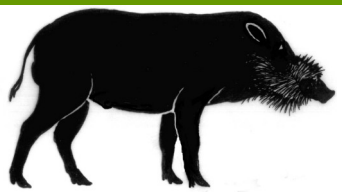
"The zebra was in the same enclosure as the hippo and its baby," said Ms Sonsteby, 34. "The hippo opened its mouth and let the zebra in there to clean. Everybody was snapping pictures. It was so great to be there at that moment."

The hippopotamus is regarded as one of the most aggressive creatures in the world and has a bite that can cut a small boat in half. Hippos can weigh up to three tonnes and are the third largest land mammal in the world. Although they rarely kill each other, hundreds of fatal attacks on people in Africa have been recorded. Despite its bulky frame, the hippo can outrun a human on land over short distances.

Photo: Jill Sonsteby/Solent News)



New Literature on Suiformes



Veterinary, Genetic and Physiological Studies

Booyse DG, Boomker EA and Dehority BA. 2010. Protozoa in the digestive tract of wild herbivores in South Africa. I: Warthogs (*Phacochoerus aethiopicus*). Zootaxa 2492: 63-68.

Seventeen warthogs were harvested from their natural habitat during the winter hunting seasons of May to July 2001 and May to June 2002. Samples (200ml each) were collected and weighed from the stomach, cecum and colon of each animal for protozoal counts. *Telamodinium onyx* was the only protozoa present in seven animals and the predominant species in all others. *Megadinium aethiopicum* was observed in eight animals, while *Teratodinium sphaeredon* was present in two warthogs. Several different species of protozoa were seen in a few animals, two of which belong to the family *Ophryoscolecidae* and are considered to be normal inhabitants in the rumen (*Diplodinium dentatum* and *Ophryoscolex purkynjei*).

Cohen M, Costantino SN, Calcagno MA, Blanco GA, Pozio E and Venturiello SM. 2010. Trichinella infection in wild boars (*Sus scrofa*) from a protected area of Argentina and its relationship with the presence of humans. Veterinary Parasitology 169(3-4): 362-366.

In Argentina, Trichinella infection has been documented in humans and animals of several provinces since 1930. This zoonotic parasite infection has been recently detected in humans and pigs of a region historically considered as Trichinella-free, suggesting the spread of these pathogens. The aim of the present work was to investigate the presence of Trichinella infection in wild boars (*Sus scrofa*) and in the human population living in a protected area. Trichinella infection has been investigated by serology (in humans and wild boars) and by artificial digestion of wild boar muscles. The isolated Trichinella larvae have been identified at the species level by multiplex PCR. A geographical information system has been used to collect environmental data. The results showed the circulation of Trichinella spiralis in wild boars with a low parasite burden, and suggest the influence of human behavior on the transmission. The transplacental passage of parasite is postulated. It follows that the declaration of region as Trichinella-free should be carefully established by means of extensive monitoring programs, not only in humans and domestic animals but also in wildlife.

Cooper SM, Scott HM, de la Garza GR, Deck AL and Cathey JC. 2010. Distribution and interspecies contact of feral swine and cattle on rangeland in south Texas: implications for disease transmission. Journal of Wildlife Diseases 46(1): 152-164.

The last outbreak of foot-and-mouth disease (FMD) in the United States occurred in 1929. Since that time, numbers and distribution of feral swine (*Sus scrofa*) have increased greatly especially in the southern states. This creates a potential risk to livestock production because swine are susceptible to, and can be carriers of, several economically harmful diseases of livestock. Most importantly, swine are potent amplifiers of FMD virus. In this study, global positioning system (GPS) collars were placed on rangeland cattle (*Bos indicus* x *taurus*) and feral swine to determine shared habitat use by these species on a large ranch in south Texas from 2004 to 2006. The aim was to identify locations and rates of interspecies contact that may result in effective transfer of FMD virus, should an outbreak occur. In shrubland and riparian areas, animals were dispersed, so contacts within and between species were relatively infrequent. Indirect contacts, whereby cattle and feral swine used the same location (within 20 m) within a 360-min period, occurred primarily at water sources, and seasonally in irrigated forage fields and along ranch roads. Direct contacts between species (animals <20 in apart and within 15 min) were rare and occurred primarily at water sources. Changes in ranch management practices are suggested to reduce interspecies contact should an FMD disease outbreak occur. This information can also be used to improve current epidemiologic models to better fit free-ranging animal populations.

Costa GMJ, Leal MC, Silva JV, Ferreira ACS, Guimaraes DA and Franca LR. 2010. Spermatogenic Cycle Length and Sperm Production in a Feral Pig Species (Collared Peccary, *Tayassu tajacu*). Journal of Andrology 31(2): 221-230.

Although the collared peccary (*Tayassu tajacu*) is found throughout the Americas, with a high potential for domestication and commercial exploitation, there are few data on the reproductive biology of this mammalian species. The aim of the present study was to investigate testis structure, spermatogenic cycle length, Sertoli cell efficiency, and spermatogenic efficiency. Twelve adult peccaries were used for biometrical, histological, and stereological analyses; 3 of these peccaries received intratesticular injections of H-3-thymidine for the determination of the duration of spermatogenesis. Testis weight and gonadosomatic index were 23.7 +/- 1.8 g and 0.2% +/- 0.1%, respectively. Seminiferous tubule volume density was 77.4% +/- 1.7%. Leydig cells occupied 12.8% +/- 1.8% of the testis parenchyma and presented a peculiar cytoarchitecture in the periphery of the seminiferous tubule lobes. The premeiotic, meiotic, and postmeiotic stage frequencies were very similar to those found for wild and domestic boars. The spermatogenic cycle and entire spermatogenic process (based on 4.5 cycles) lasted approximately 12.3 +/- 0.2 and 55.1 +/- 0.7 days, respectively. Daily sperm production per gram of testis in the collared peccary was approximately 23.4 +/- 2 x 10(6), which is similar to that of domestic and wild boars. The knowledge generated in the present study could be used in reproduction and animal improvement programs and provides important information that may be used for comparative reproductive biology with previously investigated mammalian species.

de Villiers EP, Gallardo C, Arias M, da Silva M, Upton C, Martin R and Bishop RP. 2010. Phylogenomic analysis of 11 complete African swine fever virus genome sequences. Virology 400(1): 128-136.

Viral molecular epidemiology has traditionally analyzed variation in single genes. Whole genome phylogenetic analysis of 123 concatenated genes from 11 ASFV genomes, including E75, a newly sequenced virulent isolate from Spain, identified two clusters. One contained South African isolates

from ticks and warthog, suggesting derivation from a sylvatic transmission cycle. The second contained isolates from West Africa and the Iberian Peninsula. Two isolates, from Kenya and Malawi, were outliers. Of the nine genomes within the clusters, seven were within p72 genotype 1. The 11 genomes sequenced comprised only 5 of the 22 p72 genotypes. Comparison of synonymous and non-synonymous mutations at the genome level identified 20 genes subject to selection pressure for diversification. A novel gene of the E75 virus evolved by the fusion of two genes within the 360 multicopy family. Comparative genomics reveals high diversity within a limited sample of the ASFV viral gene pool.

Garrido JM, Vicente J, Carrasco-Garcia R, Galindo RC, Minguijon E, Ballesteros C, Aranaz A, Romero B, Sevilla I, Juste R, de la Fuente J and Gortazar C. 2010. Experimental infection of Eurasian wild boar with *Mycobacterium avium avium*. Veterinary Microbiology 144(1-2): 240-245.

The Eurasian wild boar (*Sus scrofa*) is increasingly relevant as a host for several pathogenic mycobacteria. We aimed to characterize the first experimental *Mycobacterium avium avium* (MAA) infection in wild boar in order to describe the lesions and the immune response as compared to uninfected controls. Twelve 1-4-month-old wild boar piglets were housed in class Ill bio-containment facilities. Four concentrations of MAA suspension were used: 10, 10(2) and 10(4) mycobacteria (2 animals each, oropharyngeal route) and 2.5 x 10(6) mycobacteria (2 animals each by the oropharyngeal and nasal routes). No clinical signs were observed and pathology evidenced a low pathogenicity of this MAA strain for this particular host. Bacteriological and pathological evidence of successful infection after experimental inoculation was found for the group challenged with 2.5 x 10(6) mycobacteria. These four wild boar showed a positive IFN-gamma response to the avian PPD and the real-time RT-PCR data revealed that three genes, complement component C3, IFN-gamma and RANTES, were significantly down regulated in infected animals. These results were similar to those found in naturally and experimentally *M. bovis*-infected wild boar and may constitute biomarkers of mycobacterial infection in this species.

Hoelzle K, Engels M, Kramer MM, Wittenbrink MM, Dieckmann SM and Hoelzle LE. 2010. Occurrence of *Mycoplasma suis* in wild boars (*Sus scrofa* L.). Veterinary Microbiology 143(2-4): 405-409.

Porcine infectious anemia is a well-known disease that occurs worldwide and is caused by the uncultivable hemotrophic bacterium *Mycoplasma suis*. In this study the occurrence of *M. suis* in wild boars was investigated by employing a quantitative real-time LightCycler PCR. M. suis infections were detected in 36 out of 359 wild boars (10.03%). Sequencing of the 165 rRNA gene and subsequent phylogenetic analysis revealed the existence of two genetically distinct *M. suis* subtypes in the wild boar population: one subtype was >99.0% identical to known American and European *M. suis* isolates, and the second subtype showed the highest homology to known Chinese isolates. In summary, this is the first detection of *M. suis* in wild boars. The role of *M. suis* as pathogen in wild boars has yet to be established, but the present findings revealed a possible wildlife reservoir for these bacteria.

Macchi E, Cucuzza AS, Badino P, Odore R, Re F, Bevilacqua L and Malfatti A. 2010. Seasonality of re-

production in wild boar (Sus scrofa) assessed by fecal and plasmatic steroids. Theriogenology 73(9): 1230-1237.

The collection of biological samples through non-invasive techniques represents one way of monitoring in vivo physiological changes associated with reproductive activity Such techniques are particularly important for the study of animal species in the wild. The goals of this study were 1) to evaluate fecal progestogen (P), estrogen (E), and androgen (A) by means of radio-immunoassays, in male and female wild boars culled in the Piedmont, Italy area. 2) to compare them with plasmatic concentrations and the animals' reproductive status. and 3) to assess variations in reproductive seasonality between two populations of wild boars living in a mountainous vs a plain habitat in Piedmont The results demonstrate a positive correlation between fecal and plasmatic steroid concentrations (r = 0 46, 0 58, and 0 45 for plasma P-4 and P, E-2, and E, and T and A, P < 0 05) Moreover, high fecal levels of both P and E (>170 ng/g and >100 pg/g respectively) were found in 70 6% of pregnant sows and in none of the non-pregnant animals, thus supporting the use of this technique for detecting pregnancy status in wild boar Similar birth patterns were displayed by the mountain and plain populations. but births peaked significantly only in the mountain population, in the spring (46%, P < 0 05. vs other seasons) A corresponding autumnal peak of plasma testosterone concentrations in males was displayed only by the mountain population (7 4 vs < 2 0 ng/mL in the other seasons, P < 0 05). The correlation between fecal and plasmatic steroid concentrations obtained in this study supports the applicability of this non-invasive sampling technique for monitoring reproductive status in wild boar, thus enabling a more informed and correct management of the species.

Massei G, Coats J, Quy R, Storer K and Cowan DP. 2010. The Boar-Operated-System: a Novel Method to Deliver Baits to Wild Pigs. Journal of Wildlife Management 74(2): 333-336.

Bait-delivered pharmaceuticals, increasingly used to manage populations of wild boar (*Sus scrofa*) and feral pigs, may be ingested by nontarget species. Species-specificity could be achieved through a delivery system. We designed the BOS (TM) (Boar-Operated-System) as a device to deliver baits to wild pigs. The BOS (TM) consists of a metal pole onto which a round perforated base is attached. A metal cone with a wide rim slides up and down the pole and fully encloses the base onto which the baits are placed. We conducted a pilot, captive trial and found that captive wild boar fed from the BOS (TM) either directly, by lifting the cone, or indirectly, by feeding once another animal had lifted the cone. Thus, we tested whether free-living wild boar fed from the BOS (TM) and whether the BOS (TM) could prevent bait uptake by nontarget species. We observed that free-living wild boar fed regularly from the BOS (TM) and that the device successfully prevented bait uptake by nontarget species. The BOS (TM) should be trialed more extensively to confirm its effectiveness and species-specificity to distribute pharmaceuticals to wild suids. If successful, the BOS (TM) could be used to deliver vaccines in disease control programs as well as contraceptives to manage overabundant populations of wild suids.

Orliac MJ, Pierre-Olivier A and Ducrocq S. 2010. Phylogenetic relationships of the Suidae (Mammalia, Cetartiodactyla): new insights on the relationships within Suoidea. Zoologica Scripta 39(4): 315-330.

In most analyses, both molecular and morphological phylogenies of the Cetartiodactyla support the

monophyly of Suoidea. However, the evolutionary history of this superfamily remains poorly known primarily due to long-lasting debates about the taxonomic content and relationships of the suoid families and subfamilies. Despite their crucial position in the reconstruction of the phylogeny of Cetartiodactyla, Suoidea themselves have received little attention in those phylogenies, and no extensive analysis of the group has been performed so far. We therefore examine the phylogeny of the Suidae through the first phylogenetic analysis of Suoidea, including recent and fossil representatives of all four putative families. The results support the monophyly of the traditional suid subfamilies and indicate the Sanitheriidae as sister taxon to the Suidae clade. The evolutionary history within Suidae reveals its complexity, with major convergences involving important morphological structures such as the auditory region or the upper male canine. Divergent signals gathered from either dental or craniomandibular features are responsible for two long-lasting unresolved issues within Suoidea: the question of the relationships between 'Old World' and 'New World' peccaries remaining unsolved, as well as the position and familial status of the mid-Tertiary tayassuid Perchoerus.

O'Leary MA. 2010. An anatomical and phylogenetic study of the osteology of the petrosal of extant and extinct Artiodactylans (Mammalia) and relatives. Bulletin of the American Museum of Natural History 335: 4-206.

I describe and figure petrosal bones for a sample of 35 (12 extinct, 23 extant) artiodactylans, perissodactylans, dagger mesonychids, and archaic ungulates. Detailed herein are the cladistic characters of the petrosal used in the recent combined analysis of molecular and morphological data by Spaulding *et al*. (2009). That analysis, the largest in taxa and characters for artiodactylans (including cetaceans) to date, showed that hippopotarnids are the closest living relatives of cetaceans. It also showed that in the shortest trees tindohyus is on the stem lineage to Cetacea and that dagger mesonychians are positioned outside Artiodactyla; however, these positions for fossils are highly unstable, as dagger mesonychians are more closely related to cetaceans than is dagger Indohyus in trees only two steps longer. I show that in many ways the osteology of the hippopotamid ear resembles that of certain stem cetaceamorphans more than it resembles the ear regions of suines (pigs and peccaries). Previous studies have suggested that many artiodactylans lacked an inflated tegmen tympani of the petrosal; however, that generalization is not supported by data presented herein. Petrosal characters, such as the presence of the prefacial commissure fossa, presence of a convex and hyperinflated tegmen tympani, and the absence of a subarcuate fossa, are shown to be synapomorphies of hippopotamids and cetaceans. Some of these features were previously argued to represent a special similarity between dagger mesonychids and cetaceans, but these are here interpreted as homoplasies. Other features previously argued to be extremely similar between dagger mesonychians and cetaceans to the exclusion of other ungulates, such as the presence of the anterior process of the tegmen tympani, are shown to be more widely distributed among ungulates than previously recognized. A number of artiodactylans, including ruminants, are also shown to have transpromontorial sulci on the petrosal despite reports that the internal carotid artery is absent in the neck of ruminants. The petrosals of dagger anthracothere and dagger entelodont species exhibit varied morphology, with the dagger anthracothere dagger Bothriogenys having the greatest gross similarity to the hippopotamid and cetaceamorphan condition; however, shortest trees indicate that these similarities are convergent.

Rossi S, Pol F, Forot B, Masse-Provin N, Rigaux S, Bronner A and Le Potier MF. 2010. Preventive vaccination contributes to control classical swine fever in wild boar (*Sus scrofa* sp.). Veterinary Microbiology 142(1-2 Special Issue SI): 99-107.

Over the last 20 years, oral vaccination implementing a live attenuated vaccine has been experimented in Europe in order to control classical swine fever (CSF) in Wild Boar (*Sus scrofa* sp.). This has generally led to an enhanced seroprevalence and a decreased viroprevalence at the scale of the whole vaccinated populations, but no quantitative analysis has demonstrated the protective effect of preventive vaccination or intensive baiting. In the present paper we conducted a retrospective analysis at the scale of the municipality, taking into account the local dynamics and possible covariates of infection to test the effect of preventive vaccination and of the baiting effort. To be efficient, vaccination was expected to increase seroprevalence above the level considered as suitable for preventing disease invasion (40-60%) independently of infection, to protect free areas from disease invasion or contribute to control subsequent disease intensity and duration. We also hypothesized that a better baiting effort would be correlated with an improvement of immunisation and disease control. In uninfected municipalities, seroprevalence increased up to 40% after 1 year, i.e., three vaccination campaigns. We observed a significant protective effect of preventive vaccination, especially within municipalities that had been vaccinated at least 1 year before disease emergence and where virus detection did not last more than one quarter. On the other hand, we did not detect a significant effect of the baiting effort on local seroprevalence or disease dynamics, suggesting that the baiting system could be improved. We discuss these results regarding the improvement of management measures and further research perspective.

Saragusty J, Hildebrandt TB, Bouts T, Göritz F and Herme R. 2010. Collection and preservation of pygmy hippopotamus (*Choeropsis liberiensis*) semen. Theriogenology. Article in Press, doi:10.1016/j.theriogenology.2010.03.002

Knowledge about the reproduction of the endangered pygmy hippopotamus is almost non-existent. This study takes the first step toward changing this by devising a protocol for the collection, evaluation, and short-term preservation of semen of this endangered species. Semen was collected successfully from seven bulls by electroejaculation, using a specially designed rectal probe. Mean ± SEM values of native sperm parameters from combined best fractions were: motility—80.0 ± 4.1%, concentration—2421 ± 1530 × 10^6 cells/mL, total collected cell number—759 ± 261 × 10^6 cells, intact acrosome—87.8 ± 1.2%, intact morphology—52.7 ± 4.3%, and, for some, hypoosmotic swelling test—79.3 ± 4.4% and seminal plasma osmolarity—297.5 ± 3.3 mOsm. Seven different extenders were tested for sperm storage under chilling conditions: Berliner Cryomedium (BC), Biladyl®, modification of Kenney modified Tyrode's medium (KMT), MES medium, Androhep®, boar M III™ extender and Human Sperm Refrigeration Medium. While differences between males were apparent, the BC was consistently superior to all other extenders in sperm motility and facilitated storage for 7 d with up to 30% motility and some motility even after 3 weeks. With this knowledge in hand, the obvious two directions for future research are to conduct artificial insemination and to develop a technique for sperm cryopreservation.

Silva RW, de Freitas TRO and Sbalqueiro IJ. 2010. Evaluation of genetic variability in the collared peccary *Pecari tajacu* and the white-lipped peccary *Tayassu pecari* by microsatellite markers. Genetics & Molecular Biology 33(1): 62-72.

In this study, the microsatellite technique was used to evaluate the genetic variability in populations of collared and white-lipped peccaries kept in captivity. Six primers developed for domestic pigs were used and amplified in both species. They revealed the presence of five polymorphic loci and one monomorphic locus. The polymorphic loci included 4 of the 16 alleles in collared peccaries, and 3 of the 10 alleles in the white-lipped peccaries. Polymorphic information content (PIC) in both species and all the loci was highly informative. The probability of paternity exclusion (PEC), if one of the parents is known, was almost as high in white-lipped peccaries (95.53%) as in the collared (99,48%). The Fst values for collared (0.042) and white-lipped (0.1387) peccaries showed that both populations are not structured. The Fis values for all loci, except ACTG2 in white-lipped peccaries (-0.0275) and in both species (0.1985 to 0.9284 in collared peccaries and 0.3621 to 0.4754 in the white-lipped), revealed a high level of homozygosis, probably caused by inbreeding. Data on heterologous amplification and genetic variability in collared and white-lipped peccaries are presented for the first time.

Wacheck S, Fredriksson-Ahomaa M, Konig M, Stolle A and Stephan R. 2010. Wild Boars as an Important Reservoir for Foodborne Pathogens. Foodborne Pathogens & Disease 7(3): 307-312.

One hundred fifty-three wild boars shot in the canton of Geneva, Switzerland, were studied for the occurrence of foodborne pathogens. Tonsils and fecal samples of the animals were examined using real-time polymerase chain reaction, enzyme-linked fluorescent immunoassay, and cultural methods. The detection rate of *Salmonella* spp., *Yersinia enterocolitica*, *Yersinia pseudotuberculosis*, stx-positive *Escherichia coli*, and *Listeria monocytogenes* was 12%, 35%, 20%, 9%, and 17%, respectively, when tonsil samples were studied. Only *Y. enterocolitica* (5%) and *L. monocytogenes* (1%) were detected in fecal samples. None of the samples was positive for *Campylobacter* spp. Females (71%) and young animals (61%) carried more frequently one or more pathogens than males (53%) and older ones (44%). In total, 8 *Salmonella* spp., 14 *Y. enterocolitica*, 4 *Y. pseudotuberculosis*, and 26 *L. monocytogenes* strains were further characterized. Most of the *Salmonella* spp. strains were of serotype *Salmonella Enteritidis* (75%) followed by serotypes *Salmonella* Stourbridge (13%) and *Salmonella* Veneziana (13%). *L. monocytogenes* strains belonged to serotypes 1/2a (42%), 1/2b (19%), and 4b (38%). Serotypes O:3 (36%), O:5,27 (21%), and O:9 (29%) were identified among Y. enterocolitica strains and serotypes O:1 (75%) and O: 2 (25%) among *Y. pseudotuberculosis* strains. This study shows that wild boars are frequent carriers of foodborne pathogens. High wild boar densities and increasing popularity of outdoor ranging of pigs may intensify the risk of transmission of these pathogens to fattening pigs.

Taxonomic, Morphological, Biogeographic and Evolutionary Studies

Campbell KE, Prothero DR, Romero-Pittman L, Hertel F and Rivera N. 2010. Amazonian magnetostratigraphy: Dating the first pulse of the Great American Faunal Interchange. Journal of South American Earth Sciences 29(3): 619-626.

The chronostratigraphy of the youngest Neogene deposits of the Amazon Basin, which comprise the Madre de Dios Formation in eastern Peru, remains unresolved. Although Ar-40/Ar-39 dates on two volcanic ashes from this formation in Peru provide critical baseline data points, stratigraphic correlations among scattered riverine outcrops in adjacent drainage basins remain problematic. To refine the chronostratigraphy of the Madre de Dios Formation, we report here the magnetostratigraphy of an outcrop on the Madre de Dios River in southeastern Peru. A total of 18 polarity zones was obtained in the similar to 65-m-thick Cerro Colorado section, which we correlate to magnetozones Chrons C4Ar to C2An (9.5-3.0 Ma) based on the prior Ar-40/Ar-39 dates. These results confirm the late Miocene age of a gomphothere recovered from the Ipururo Formation, which underlies the late Miocene Ucayali Unconformity at the base of the Cerro Colorado outcrop. The results also support earlier interpretations of a late Miocene age for other fossils of North American mammals recovered from basal conglomeratic deposits of the Madre de Dios Formation immediately above the Ucayali Unconformity. These mammals include other gomphotheres, peccaries, and tapirs, and their presence in South America in the late Miocene is recognized as part of the first pulse of the Great American Faunal Interchange.

Fisher RE, Scott KM and Adrian B. 2010. Hind limb myology of the common hippopotamus, *Hippopotamus amphibius* (Artiodactyla: Hippopotamidae). Zoological Journal of the Linnean Society 158(3): 661-682.

Based on morphological traits, hippos have traditionally been classified with pigs and peccaries in the suborder Suiformes. However, molecular data indicate that hippos and cetaceans are sister taxa. This study analyses muscle characters of the common hippo hind limb in order to clarify the phylogenetic relationships and functional anatomy of hippos. Several muscles responsible for propelling the body through water are robust and display extensive fusions, including mm. semimembranosus, semitendinosus, biceps femoris and gluteus superficialis. In addition, common hippos retain long flexor and extensor tendons for each digit, reflecting the fact that all four toes are weight-bearing. These flexor tendons, together with the well-developed intrinsic muscles of the pes, serve to adduct the digits, preventing splaying of the toes when walking on soft terrain. Lastly, common hippos retain a number of primitive features, including the presence of m. articularis coxae, a well-developed m. obturator internus, superficialis and profundus tendons to all digits, mm. flexor digitorum brevis, abductor digiti V, lumbricalis IV, adductores digitorum II and V, and two mm. interossei per digit. Pygmy hippos share these features. Thus, hippopotamids retain muscles that have been lost in the majority of artiodactyls, including other suiforms. These and previously reported findings for the forelimb support the molecular data in indicating an early divergence of the Hippopotamidae from the rest of the Artiodactyla.

Gasparini GM and Ferrero BS. 2010. The Tayassuidae (Mammalia, Artiodactyla) from the Quaternary of Entre Rios Province. A palaeofaunal review in Argentina. Neues Jahrbuch für Geologie und Paläontologie - Abhandlungen 256(2): 151-160.

The Tayassuidae has a wide geographic distribution and stratigraphic record during the Quaternary of South America. Three genera of Tayassuidae (*Platygonus, Catagonus* and *Tayassu*) are recognized in

this continent. Argentina has the greatest diversity and abundance of fossil tayassuids in South America. In the Argentine Mesopotamian, the oldest tayassuid records are from the late Pleistocene of Corrientes and Entre Rios provinces, and from an archaeological site in the Holocene of Misiones Province. This paper aims to: 1) describe the tayassuid materials found in the Pleistocene in Entre Rios Province; 2) review and update the palaeontological record of the family in the Mesopotamian region during the Quaternary; and 3) check the geographic and stratigraphic distribution in South America, specially in Argentina, of the tayassuids from the Mesopotamian region. The palaeontological evidence indicates that in this area, *Tayassu* and *Catagonus*, the latter for the first time, are registered only in late Pleistocene sediments. Furthermore, the record of *Tayassu* and *Catagonus* during the late Pleistocene in Entre Ríos Province reflects a faunistic difference in comparison with the extant mammal fauna. Today, in the Mesopotamian region, *T. pecari* and *T. tajacu* are part of the mammalian fauna of Misiones Province. In the north of Corrientes Province there is possibly the most austral record of *T. pecari. Catagonus* reaches its most southern distribution in the north of Santiago del Estero and the northeast of Tucumán; therefore at present this tayassuid does not inhabit the Argentine Mesopotamian.

Gasparini GM, Soibelzon E, Zurita AE and Mino-Boilini AR. 2010. A review of the Quaternary Tayassuidae (Mammalia, Artiodactyla) from the Tarija Valley, Bolivia. Alcheringa 34(1): 7-20.

Three genera of Tayassuidae are recognized in South America: *Platygonus* Le Conte, 1848, *Catagonus* Ameghino, 1904 and *Tayassu* Fischer, 1814. This study provides the first systematic review of the Pleistocene tayassuids yet reported from Bolivia. The richest records of the family in South America derived from central-eastern Argentina and southern Brazil. *Catagonus stenocephalus* (Lund in Reinhardt, 1880) is documented for the first time in Bolivia, significantly extending the geographic distribution of this species in South America. We cannot confirm the validity of *Platygonus tarijensis* (Ameghino, 1904), but accept its generic allocation. Both taxa show adaptations to arid or semi-arid and relatively open environments, which is consistent with the palaeoenvironmental conditions previously proposed for the Tarija Valley. The veracity of other records of the family from Bolivia cannot be confirmed.

Kneepkens AFLM and Macdonald AA. 2010. Cranial Muscles of the Sulawesi Babirusa (*Babyrousa celebensis*). Anatomia, Histologia, Embryologia: Veterinary Medicine Series C 39(2): 120-137.

The detailed muscular anatomy of the head of the Sulawesi Babirusa (*Babyrousa celebensis*) is described for the first time. The results show that the muscular anatomy of the *Babyrousa* is very similar to the pig genus *Sus*, despite long geological separation from it. Some differences were noted: the M. parietoauricularis was more clearly separated into two parts in the Babirusa than in the domestic pig; the rostral fibres of the M. levator anguli oculi reached the infraorbital sinus in the Babirusa but only as far as the medial corner of the eye in the domestic pig; the M. palatinus of the Babirusa is paired and did not reach the Os palatinum, unlike its description in the domestic pig and the Platysma pars zygomatica originates from the fascia of the neck in the Babirusa, whereas that of the domestic pig originates largely or entirely from the scapula.

Larson G, Liu RR, Zhao XB, Yuan J, Fuller D, Barton L, Dobney K, Fan QP, Gu ZL, Liu XH, Luo YB, Lv P, Andersson L and Li N. 2010. Patterns of East Asian pig domestication, migration, and turnover revealed by modern and ancient DNA. Proceedings of the National Academy of Sciences of the United States of America 107(17): 7686-7691.

The establishment of agricultural economies based upon domestic animals began independently in many parts of the world and led to both increases inhuman population size and the migration of people carrying domestic plants and animals. The precise circumstances of the earliest phases of these events remain mysterious given their antiquity and the fact that subsequent waves of migrants have often replaced the first. Through the use of more than 1,500 modern (including 151 previously uncharacterized specimens) and 18 ancient (representing six East Asian archeological sites) pig (*Sus scrofa*) DNA sequences sampled across East Asia, we provide evidence for the long-term genetic continuity between modern and ancient Chinese domestic pigs. Although the Chinese case for independent pig domestication is supported by both genetic and archaeological evidence, we discuss five additional (and possibly) independent domestications of indigenous wild boar populations: one in India, three in peninsular Southeast Asia, and one off the coast of Taiwan. Collectively, we refer to these instances as "cryptic domestication," given the current lack of corroborating archaeological evidence. In addition, we demonstrate the existence of numerous populations of genetically distinct and widespread wild boar populations that have not contributed maternal genetic material to modern domestic stocks. The overall findings provide the most complete picture yet of pig evolution and domestication in East Asia, and generate testable hypotheses regarding the development and spread of early farmers in the Far East.

MacFadden BJ, Kirby MX, Rincon A, Montes C, Moron S, Strong N and Jaramillo C. 2010. Extinct *Peccary "cynorca" occidentale* (Tayassuidae, Tayassuidae) from the Miocene of Panama and correlations to North America. Journal of Paleontology 84(2): 288-298.

Recently collected specimens of the extinct tayassuine *Peccary "Cynorca" occidentale* (and another indeterminant tayassuid) are described from new excavations along the southern reaches of the Panama Canal. Fossil peccaries were previously unknown from Panama, and these new tayassuid specimens therefore add to the extinct mammalian biodiversity in this region. *"Cynorca" occidentale* Occurs ill situ in the Centenario Fauna (new name) from both the upper part of the Culebra Formation and overlying Cucaracha Formation, thus encompassing a stratigraphic interval that includes both of these formations and the previously described and more restricted Gaillard Cut Local Fauna. *"Cynorca" occidentale* is a primitive member of the clade that gives rise to modern tayassuines in the New World. Diagnostic characters for *"C." occidentale* include a retained primitive M 1, reduced M3, and shallow mandible, and this species is small relative to most other extinct and modern tayassiune peccaries. Based oil the closest biostratigraphic comparisions (Maryland, Florida, Texas, and California), the presence of *"C." occidentale* indicates an interval Of uncertain duration within the early Hemingfordian (He1) to early Barstovian (Ba 1) land mammal ages (early to middle Miocene) for the Centenario Fauna, between about 19 and 14.8 million years ago. Based on what is known of the modern ecology of tayassuines and previous paleoecological interpretations for Panama, *"C." occidentale* likely Occupied a variety of environments, ranging from forested to open Country habitat mosaics and fed oil the diverse array of available plants.

Musilova P, Kubickova S, Hornak M, Cernohorska H, Vahala J and Rubes J. 2010. Different Fusion Configurations of Evolutionarily Conserved Segments in Karyotypes of *Potamochoerus porcus* and *Phacochoerus africanus.* Cytogenet Genome Res Published online.

The karyotype of the red river hog *Potamochoerus porcus* (2n = 34) differs from that of the domestic pig by the presence of 2 fusion chromosomes homologous to pig chromosomes 13/16 and 15/17. Moreover, chromosomes corresponding to pig chromosomes 13/16 and 1 are both acrocentric. Hybridization with region-specific painting probes confirmed tandem fusion of pig chromosomes 13 and 16, and a pericentric inversion of the pig chromosome 1p equivalent in *P. porcus*. The chromosome complement of the wart hog *Phacochoerus africanus* (2n = 34) differs from the pig karyotype in 2 centric fusions, 13/16 and 15/17. Karyotypic relationships among different Suidae species are discussed in the article. Besides fusions 13/16 and 15/17, which are common to several suids, another fusion of pig chromosomes 14 and 18 is suggested to exist in the karyotype of *Sus cebifrons*.

Orliac M, Boisserie JR, MacLatchy L and Lihoreau F. 2010. Early Miocene hippopotamids (Cetartiodactyla) constrain the phylogenetic and spatiotemporal settings of hippopotamid origin. Proceedings of the National Academy of Sciences of the United States of America 107(26): 11871-11876.

The affinities of the Hippopotamidae are at the core of the phylogeny of Cetartiodactyla (even-toed mammals: cetaceans, ruminants, camels, suoids, and hippos). Molecular phylogenies support Cetacea as sister group of the Hippopotamidae, implying a long ghost lineage between the earliest cetaceans (similar to 53 Ma) and the earliest hippopotamids (similar to 16 Ma). Morphological studies have proposed two different sister taxa for hippopotamids: suoids (notably palaeochoerids) or anthracotheriids. Evaluating these phylogenetic hypotheses requires substantiating the poorly known early history of the Hippopotamidae. Here, we undertake an original morphological phylogenetic analysis including several "suiform" families and previously unexamined early Miocene taxa to test previous conflicting hypotheses. According to our results, *Morotochoerus ugandensis* and *Kulutherium rusingensis*, until now regarded as the sole African palaeochoerid and the sole African bunodont anthracotheriid, respectively, are unambiguously included within the Hippopotamidae. They are the earliest known hippopotamids and set the family fossil record back to the early Miocene (similar to 21 Ma). The analysis reveals that hippopotamids displayed an unsuspected taxonomic and body size diversity and remained restricted to Africa during most of their history, until the latest Miocene. Our results also confirm the deep nesting of Hippopotamidae within the paraphyletic Anthracotheriidae; this finding allows us to reconstruct the sequence of dental innovations that links advanced selenodont anthracotheriids to hippopotamids, previously a source of major disagreements on hippopotamid origins. The analysis demonstrates a close relationship between Eocene choeropotamids and anthracotheriids, a relationship that potentially fills the evolutionary gap between earliest hippopotamids and cetaceans implied by molecular analyses.

Pickford M, Miller ER and El-Barkooky AN. 2010. Suidae and Sanitheriidae from Wadi Moghra, early Miocene, Egypt. Acta Palaeontologica Polonica 55(1): 1-11.

New suid and sanithere material from Wadi Moghra, early Miocene, Egypt, is described and dis-

cussed. The new material greatly improves the sample size and diversity of suoids known from North Africa, and includes one species of Sanitheriidae and three species of Kubanochoerinae. The Moghra suoid assemblage most closely resembles that from Gebel Zelten, Libya, suggesting that at least part of the Moghra deposits may overlap in time with part of Zelten, i.e., is equivalent in age to MN 4-5 of the European mammal zonation, or PIII of the East African one. Information from suids and sanitheres is consistent with previous interpretations, that the Moghra deposits were formed under swampy and littoral paleoenvironmental conditions.

van der Made J. 2010. The pigs and "Old World peccaries" (Suidae and Palaeochoeridae, Suoidea, Artiodactyla) from the Miocene of Sandelzhausen (southern Germany): phylogeny and an updated classification of the Hyotheriinae and Palaeochoeridae. Palaeontologische Zeitschrift 84(1): 43-121.

The fossil remains of two species of Suoidea (Artiodactyla, Mammalia) from the Early/Middle Miocene locality of Sandelzhausen (MN5; Bavaria, Germany) are described. A skull and some isolated teeth and bones reveal hitherto unknown features of Schizoporcus muenzenbergensis, Schizoporcini, Taucanaminae, Palaeochoeridae (Old World peccaries), Suoidea. The phylogeny of the Taucanaminae is discussed and an updated classification of the Palaeochoeridae is presented. The new names Schizoporcus and Schizoporcini replace the junior homonyms Schizochoerus Crusafont and Lavocat (1954) and Schizochoerini Golpe-Posse (1974). Remains of several skulls and mandibles, over 50 associated tooth rows, over 300 isolated teeth, and over 200 bones, constitute one of the largest collections of a Miocene suid known, and are assigned to *Hyotherium soemmeringi wylensis*, Hyotheriini, Hyotheriinae, Suidae (pigs), Suoidea. *Hyotherium* is the oldest certain suid genus known and many assumed it to be one of the most primitive. While the postcranial bones of the Suidae and Palaeochoeridae differ in many ways, the bones of *Hyotherium* are already very similar in morphology to those of living pigs, although they are much more slender, suggesting that the genus was more fleet-footed. Features related to rooting behaviour indicate that Hyotherium was a more efficient rooter than Palaeochoeridae and living Dicotylidae, but not as efficient as living suids. The phylogeny of the Hyotheriinae is discussed. The subfamily is divided into Hyotheriini and Aureliachoerini, new tribe, and an updated classification is presented.

Vislobokova IA. 2010. The first record of Chleuastochoerus (Suidae, Artiodactyla) in Russia. Paleontological Journal 43(6): 686-698.

A new species, *Chleuastochoerus tuvensis*, from the Late Miocene Taralyk-Cher locality in Tuva is described. Phylogenetic relationships and lifestyle of Chleuastochoerus, a unique member of the family Suidae, are discussed.

Ecology and Conservation Studies

Bauer KK, Abbott JC and Quigley K. 2010. Collared Peccary (*Peccary tajacu*) in Bastrop County, Texas. Southwestern Naturalist 55(1): 138-139.

We discovered a previously unknown population of collared peccaries (*Pecari tajacu*) in Bastrop County, Texas (30.26245 degrees N, 97.31024 degrees W). Prior to this report, collared peccaries had been reported in western Texas and in the brush country south of San Antonio. There also are introduced populations in several counties in north-central Texas. The newly discovered population was in forests of post oak (*Quercus stellata*) and black jack oak (*Q. marilandica*), similar to the oak forest occupied by the population in Trans-Pecos Texas. Range extensions have been documented in northern New Mexico, western Texas, and eastern Texas. Whether or not the population in Bastrop County is an introduction or a range extension is unknown.

Beck H, Thebpanya P and Filiaggi M. 2010. Do Neotropical peccary species (Tayassuidae) function as ecosystem engineers for anurans? Journal of Tropical Ecology 26(4): 407-414.

The concept of ecosystem engineering has catalysed novel approaches and models for non-trophic species interactions and ecosystem functions. Ecosystem engineers physically modify abiotic and biotic environments, thereby creating new habitats that can be colonized by a new suite of species. In the Peruvian Amazonas, we tested whether peccaries (Tayassuidae) function as ecosystem engineers by creating and maintaining wallows. Such wallows could be critical aquatic habitats and breeding sites for anuran species during dry seasons. We compared hydroperiods of 21 peccary wallows and 13 naturally formed ponds across three dry seasons and found that wallows had a consistently higher mean water surface area than ponds. We also examined the pH. dissolved oxygen and temperature, and found no significant differences in these parameters between water bodies. Wallows had a significantly higher density of tadpoles, metamorphs and adult anurans, as well as higher beta-diversity and species richness than ponds. This study not only provides the first systematic evidence of the ecosystem engineering processes of peccaries. but also reveals the positive consequences of such for anuran species.

Blowers TE, Waterman JM, Kuhar CW and Bettinger TL. 2010. Social behaviors within a group of captive female *Hippopotamus amphibius*. Journal of Ethology 28: 287–294.

Grouping is known to occur in many species of mammals, and the structure of groups can range along a continuum from basic aggregations to complex social systems. Any social patterns that may occur within the group must be determined in order to understand the adaptive nature of the group. Female *Hippopotamus amphibius* are known to aggregate in the wild, but their social behaviors are still not understood. Our objective was to determine if captive female hippos display social structure within an aggregation by examining their interactions, and if kinship, familiarity, and dominance influence these interactions. Behavioral data, using continuous focal animal sampling and scan sampling, were collected on a group of captive female hippos housed at Disney's Animal Kingdom and were used to analyze their interactions, association patterns based on kinship and familiarity, and a dominance hierarchy. Our results support the hypothesis that hippos exhibit social patterns due to the attraction to particular individuals. There were more associations between kin than non-kin and also between individuals that were more familiar. Dominance patterns were also found among these hippos. These results may aid in the general understanding of hippopotamus behavior and provide a framework for future research.

Braga C, Alexandre N, Fernandez-Llario P and Santos P. 2010. Wild boar (*Sus scrofa*) harvesting using the espera hunting method: side effects and management implications. European Journal of Wildlife Research 56(3): 465-469.

Harvesting of wildlife by man has been linked to demographic and evolutionary impacts in many populations. We investigated the sex ratio and age class structure in hunting bags of wild boar harvested by espera-nocturnal single hunt at bait-during four hunting seasons in Alentejo (Portugal). In addition, we assessed whether the hunting method is a significant predictor of the probability of harvesting an animal of a particular gender, of particular age class or of a particular combination of these two attributes. We found that the espera hunting method allows very selective harvesting regimes, and thus, it seems a highly effective population management tool. Removing a large proportion of adult males, however, may bias the population sex ratio towards females, reduce male life expectancy and raise the degree of polygyny. Our results suggest that recruitment rates are resilient to this skewed sex ratio, and possibly the higher proportion of females in the adult population may even increase productivity.

Bywater KA, Apollonio M, Cappai N and Stephens PA. 2010. Litter size and latitude in a large mammal: the wild boar *Sus scrofa*. Mammal Review 40(3): 212-220.

A positive relationship between clutch size or litter size and latitude exists in birds and many species of small mammal. Hitherto, however, analyses for large mammals have failed to provide evidence that litter sizes increase with latitude. We collated data from published studies of wild boar in Europe, to analyse the relationship between litter size and latitude in this widely distributed terrestrial mammal. Depending on the specific data set (whether only the most reliable data or all available data were included), latitude explained 58% to 72% of the variation in mean litter sizes across studies. On average, litter size increases by approximately 0.15 piglets per degree of latitude. A strong correlation between litter size and latitude for wild boar in Europe provides a starting point for demographic modelling of this species of both ecological and economic importance. The pattern for wild boar is consistent with Ashmole's explanation for the effects of latitude on reproduction. The contrast between our results and those generated for other large mammals may result from our focus on an herbivore in contrast to previous work which was focused on carnivores. Further work could usefully examine the extent of seasonality in the availability of resources for species of different dietary types.

Cavalcanti SMC and Gese EM. 2010. Kill rates and predation patterns of jaguars (*Panthera onca*) in the southern Pantanal, Brazil. Journal of Mammalogy 91(3): 722-736.

Jaguars (*Panthera onca*) often prey on livestock, resulting in conflicts with humans. To date, kill rates and predation patterns by jaguars have not been well documented. We studied the foraging ecology of jaguars in an area with both livestock and native prey and documented kill rates, characteristics of prey killed, patterns of predation, and the influence of prey size on the duration at kill sites and the time interval between kills. Between October 2001 and April 2004 we monitored 10 jaguars equipped with global positioning system (GPS) collars. We collected 11,787 GPS locations and identified 1,105 clusters of locations as sites of concentrated use (e.g., kill sites, bed sites, and dens). Of these, we

found prey remains at 415 kill sites and documented 438 prey items. Kills were composed of 31.7% cattle (9.8% adults and 21.9% calves), 24.4% caiman (*Caiman crocodilus yacare*), 21.0% peccaries (mostly *Tayassu pecari*), 4.1% feral hogs (*Sus scrofa*), 3.9% marsh deer (*Blastocerus dichotomus*), 3.2% giant anteaters (*Myrmecophaga tridactyla*), 2.0% capybaras (*Hydrochoeris hydrochaeris*), 1.6% brocket deer (*Mazama americana* and *M. gouazoubira*), and other avian, mammalian, and reptilian species. Individual jaguars differed in the proportion of each species they killed and the proportion of native prey versus cattle. Although all 10 cats killed cattle, 5 killed a high proportion of cattle (>35% of kills), and 3 killed few cattle (<15%). Males (27%) and females (35%) killed cattle in similar proportions. In contrast, male jaguars killed a higher proportion of peccaries than did females, and female jaguars killed more caiman than did males. The mean kill rate for all jaguars was 4.3 days +/- 4.4 SD between known consecutive kills. The time interval to the next subsequent kill by jaguars increased with increasing prey size. Jaguars also increased the length of time at a carcass as prey size increased. Jaguar kill rates on peccaries steadily increased over the 4-year study. In contrast, kill rates on cattle decreased during the same period. Rainfall, and subsequent water levels on the Pantanal, was the main driver of seasonal kill rates by jaguars on cattle and caiman. As water levels increased, predation on caiman increased as caiman became more distributed throughout the landscape. Conversely, as water levels fell, caiman became less plentiful, and cattle were moved out into pastures thereby increasing their availability to more jaguars.

Doupe RG, Mitchell J, Knott MJ, Davis AM and Lymbery AJ. 2010. Efficacy of exclusion fencing to protect ephemeral floodplain lagoon habitats from feral pigs (*Sus scrofa*). Wetlands Ecology & Management 18(1): 69-78.

Foraging by feral pigs can strongly affect wetland vegetation assemblages and so too wider ecological processes, although their effects on freshwater ecosystems have seldom been studied. We assessed the ecological effects of pig foraging in replicate fenced and unfenced ephemeral floodplain lagoons in tropical north-eastern Australia. Pig foraging activities in unfenced lagoons caused major changes to aquatic macrophyte communities and as a consequence, to the proportional amounts of open water and bare ground. The destruction of macrophyte communities and upheaval of wetland sediments significantly affected wetland turbidity, and caused prolonged anoxia and pH imbalances in the unfenced treatments. Whilst fencing of floodplain lagoons will protect against feral pig foraging activities, our repeated measures of many biological, physical and chemical parameters inferred that natural seasonal (i.e. temporal) effects had a greater influence on these variables than did pigs. To validate this observation requires measuring how these effects are influenced by the seemingly greater annual disturbance regime of variable flooding and drying in this tropical climate.

Dunham KM, Ghiurghu A, Cumbi R and Urbano F. 2010. Human–wildlife conflict in Mozambique: a national perspective, with emphasis on wildlife attacks on humans. Oryx 44: 185-193.

Human–wildlife conflicts are common across Africa. In Mozambique, official records show that wildlife killed 265 people during 27 months (July 2006 to September 2008). Crocodile *Crocodylus niloticus*, lion *Panthera leo*, elephant *Loxodonta africana* and hippopotamus *Hippopotamus amphibius* caused most deaths but crocodiles were responsible for 66%. Crocodile attacks occurred across Mozambique

but 53% of deaths occurred in districts bordering Lake Cabora Bassa and the Zambezi River. Hippopotamus attacks were also concentrated here. Lion attacks occurred mainly in northern Mozambique and, while people were attacked by elephants across the country, 67% of deaths occurred in northern Mozambique. Attacks by lions, elephants or hippopotamuses were relatively rare but additional data will probably show that attacks by these species are more widespread than the preliminary records suggest. Buffalo *Syncerus caffer*, hyaena *Crocuta crocuta* and leopard *Panthera pardus* were minor conflict species. Good land-use planning, a long-term solution to many conflicts, is particularly relevant in Mozambique, where the crocodile and hippopotamus populations of protected areas are often in rivers that border these areas, and cause conflicts outside them, and where people commonly live within protected areas. Poverty may prompt fishermen to risk crocodile attack by entering rivers or lakes. The high incidence of conflicts near Limpopo and South Africa's Kruger National Parks (both within the Great Limpopo Transfrontier Conservation Area) highlights the problems created for people by facilitating the unrestricted movement of wildlife between protected areas across their land.

Eaton MJ, Meyers GL, Kolokotronis SO, Leslie MS, Martin AP and Amato G. 2010. Barcoding bushmeat: molecular identification of Central African and South American harvested vertebrates. Conservation Genetics 11(4): 1389-1404.

The creation and use of a globally available database of DNA sequences from a standardized gene region has been proposed as a tool for species identification, assessing genetic diversity and monitoring the legal and illegal trade in wildlife species. Here, we contribute to the Barcode of Life Data System and test whether a short region of the mitochondrial cytochrome c oxidase subunit 1 (COX1) gene would reliably distinguish among a suite of commonly hunted African and South American mammal and reptile species. We used universal primers to generate reference barcode sequences of 645 bp for 23 species from five vertebrate families (Crocodilidae, Alligatoridae, Bovidae, Suidae and Cercopithecidae). Primer cocktails yielded high quality barcode sequences for 179 out of 204 samples (87.7%) from all species included in the study. For most taxa, we sequenced multiple individuals to estimate intraspecific sequence variability and document fixed diagnostic characters for species identification. Polymorphism in the COX1 fragment was generally low (mean = 0.24%), while differences between congeneric species averaged 9.77%. Both fixed character differences and tree-based maximum likelihood distance methods unambiguously identified unknown and misidentified samples with a high degree of certainty. Barcode sequences also differentiated among newly identified lineages of African crocodiles and identified unusually high levels of genetic diversity in one species of African duiker. DNA barcoding offers promise as an effective tool for monitoring poaching and commercial trade in endangered species, especially when investigating semi-processed or morphologically indistinguishable wildlife products. We discuss additional benefits of barcoding to ecology and conservation.

Elston JJ and Hewitt DG. 2010. Intake of mast by wildlife in Texas and the potential for competition with wild boars. Southwestern Naturalist 55(1): 57-66.

In Texas, introduced wild boars (*Sus scrofa*) consume mast Crops that are high-quality foods sought by native wildlife. Because mast often is abundant but ephemeral, competition among species is ex-

pected. Relative rates of intake among individuals call determine how much)l mast Call be obtained and digested. Our objective was to determine intake of mast by wild boars, white-tailed deer (*Odocoileus virginianus*), collared peccaries (*Pecari tajacu*), wild turkeys (*Meleagris gallopavo*), and raccoons (*Procyon lotor*). Trials were conducted with Pods from honey mesquites (*Prosopis glandulosa*), acorns from live oaks (*Quercus virginiana*), and acorns From Shumard oaks (*Quercus shumardii*). Raw of intake of dry matter (g/min), rate of bites (bites/min), and size of bites (g/bite) were determined for each species. Despite their larger Size, wild boars did not have consistently higher rates of intake than species of native wildlife. However, rates of intake for wild boars were among the highest for pods of honey mesquites and acorns of live oaks. Wild boars had low rates of intake for acorns of Shumard oaks, primarily because wild boars removed the shell, which increased handling till-le and reduced size of, bite. Collared peccaries and raccoons also exhibited shelling behavior when consuming acorns, which reduced their intakes as well. White-tailed (deer had relatively high rates of intake of mast compared to other species. Wild turkeys maintained the highest rates of bites for acorns of live oaks, which resulted in high rates of intake relative to body mass. The value of mast appears to be related to its size and shape, which may enable some species to attain higher rates of intake of dry matter than possible oil browse and other foods. Moderate to high rates of intake of mast by Wild boars, coupled) with their ability to displace other species from feeding sites and obtain a higher-quality diet by, discarding acorn shells should enable them to compete effectively with native species for mast.

Jolley DB, Ditchkoff SS, Sparklin BD, Hanson LB, Mitchell MS and Grand JB. 2010. Estimate of herpetofauna depredation by a population of wild pigs. Journal of Mammalogy 91(2): 519-524.

Herpetofauna populations are decreasing worldwide, and the range of wild pigs (*Sus scrofa*) is expanding Depredation of threatened reptile and amphibian populations by wild pigs could be substantial By understanding depredation characteristics and rates, more resources can be directed toward controlling populations of wild pigs coincident with threatened or endangered herpetofauna populations. From April 2005 to Match 2006 we used firearms to collect wild pigs (n = 68) and examined stomach content for reptiles and amphibians We found 64 individual reptiles and amphibians. composed of 5 different species, that were consumed by wild pigs during an estimated 254 hours of foraging Primarily arboreal species (e.g. *Anolis carolinensis*) became more vulnerable to depredation when temperatures were low and they sought thermal shelter Other species (e.g. *Scapluopus holbrookn*) that exhibit mass terrestrial migrations during the breeding, season also faced Increased vulnerability to depredation by wild pigs Results suggest that wild pigs ate opportunistic consumers that can exploit and potentially have a negative impact on species with particular life-history characteristics.

Keuling O, Lauterbach K, Stier N and Roth M. 2010. Hunter feedback of individually marked wild boar *Sus scrofa* L.: dispersal and efficiency of hunting in northeastern Germany. European Journal of Wildlife Research 56(2): 159-167.

Increasing wild boar (*Sus scrofa* L.) population densities all over Europe cause severe economic problems. For understanding mechanisms of epidemics, the knowledge of dispersal is required. Thus, we investigated dispersal rates and distances with regard to sex and age of wild boar in southwestern

Mecklenburg-Western Pomerania. From 152 marked wild boar, 105 have been registered as dead, of which, 51% were males and 49% females. Forty-five percent were shot as piglets, 41% as yearlings, and 14% as adults. The distance between capture site and site of death ranged between 184 m and 41.5 km. Piglets were shot closer to their capture site (mean distance 1 km) than older animals (mean 4 km), although this difference was only significant for males. In general, males tended to disperse further before being shot (3.8 km) than females (1.6 km). Only 3.8% of all animals were shot at distances larger than 10 km. As most animals (84.6%) were shot inside their natal home range, only a small proportion (15.4%) did actually disperse (shot outside mothers home range), which is 32% of all animals surviving to the age of yearlings. Of those dispersed animals, 25% were females. The low dispersal rate is biased by female philopatry and allows actual dispersal only at very high population densities or in sparsely populated regions. In consideration for the low natural mortality proved by radio-tagged animals, the harvest rate is lower than the net reproduction. We did not detect any sex-biased hunting. The dominating hunting method was single hunt at bait, although drive hunts are highly effective. However, hunting rates on piglets and females were too low for regulating the population.

Kuprewiczi EK and Garcia-Robledo C. 2010. Mammal and insect predation of chemically and structurally defended *Mucuna holtonii* (Fabaceae) seeds in a Costa Rican rain forest. Journal of Tropical Ecology 26(3): 263-269.

To prevent seed losses from predation, plants have developed protective strategies. Seeds may utilize chemical or structural defences to deter predators. *Mucuna holtonii* (Fabaceae) has large seeds containing a toxic amino acid, L-dopa, and covered with a hard seed coat. Our study assessed the effectiveness of chemical and mechanical seed defences against vertebrate and invertebrate seed predators within Estacion Biologica La Selva, Costa Rica. Pre-dispersal insect and fungus attack of *M. holtonii* seeds was low (95.7% of 1493 seeds were undamaged). Camera traps monitoring 90 marked *M. holtonii* seeds showed that the collared peccary (*Pecari tajacu*) consumed 98.6% of 69 removed seeds over 16 d. Field experiments involving 100 seeds with intact and 100 with opened seed coats found that only opened seeds had endosperm removed by *Sericomyrmex amabilis* ants (0.5-100% of endosperm removed). Shade-house experiments showed that seeds with high amounts of endosperm removed by ants resulted in low germination success and low seedling biomass production. Although *M. holtonii* seeds are rich in L-dopa, this compound is not an effective chemical defence against mammals that possess foregut fermentation. The seed coat of *M. holtonii* is an effective structural defence against invertebrate seed predators, preventing endosperm removal and enhancing seedling survival.

Nogueira SS da C, Silva MG, Dias CT dos S, Pompéia S, Cetra M and Nogueira-Filho SLG. 2010. Social behaviour of collared peccaries (*Pecari tajacu*) under three space allowances. Animal Welfare 19(3): 243-248.

Captive breeding of peccaries is on the increase in neotropical countries. Few studies, however, have reported behavioural responses of wild animals under farmed conditions. Therefore, the aim of this study was to evaluate the effects of space allowance on the occurrence of social behaviour patterns on farmed collared peccary (*Pecari tajacu*). We observed three herds of collared peccaries each containing eight acquainted individuals. Using a 3 × 3 Latin square design, herds were allocated, in a ran-

dom order, to one of the three experimental enclosures, each with a different size: 375, 750 and 1,500 m^2 of total available area, each with three wooden shelters. We recorded all the occurrences of selected positive and agonistic behavioural patterns that occurred 90 min before and during feeding. Enclosure size had a significant effect on agonistic patterns of peccaries during feeding, in that more agonistic behaviour was observed in smaller spaces. We also found that shelter usage increased as space decreased. Differing space allowances, however, did not have an effect on the occurrence of positive interactions that were more frequent before compared to during feeding. We concluded that enclosure size had an effect on the expression of agonistic behaviours and the use of shelters by collared peccaries. Thus, animal welfare can be improved by adopting at least 187.5 m^2 per peccary. In addition, our study also confirmed the importance of shelter areas in collared peccary husbandry.

Ogutu JO, Piepho HP, Dublin HT, Bhola N and Reid RS. 2010. Rainfall extremes explain interannual shifts in timing and synchrony of calving in topi and warthog. Population Ecology 52(1): 89-102.

We tested the hypothesis that ungulates time and synchronize births to match gestation and lactation with peak food availability and quality in seasonal environments, using ground counts of topi and warthog conducted over 174 months (July 1989-December 2003) in the Mara-Serengeti ecosystem. During this 15-year period, 2,725 newborn and 45,574 adult female topi and 933 newborn and 7,831 adult warthogs were recorded. Births were distinctly synchronized in both species but far less so than in ungulates in temperate regions. Extreme droughts delayed onset and reduced synchrony of calving and natality rates but high rainfall advanced onset and increased synchrony of calving and natality rates in both species, supporting the seasonality hypothesis. Annual shifts in birth peaks were significantly negatively correlated with the preceding wet season rainfall. Varying the timing and synchrony of births and natality rates are widespread but little understood adaptations of ungulates to climatic extremes. Climate change heightens the need for advancing this understanding because increasing frequency and severity of droughts is likely to decouple phenology of breeding in seasonally breeding ungulates from that in their food plants. Similar studies of African ungulates are either extremely rare or non-existent. New approaches to estimating the time of peak births and its confidence limits and the degree of synchrony of breeding are also presented.

Parkes JP, Ramsey DSL, Macdonald N, Walker K, McKnight S, Cohen BS and Morrison SA. 2010. Rapid eradication of feral pigs (*Sus scrofa*) from Santa Cruz Island, California. Biological Conservation 143(3): 634-641.

Eradication of invasive alien species from islands is often necessary to protect native biota. The rapidity in which eradication projects are implemented can help reduce risk they will fail. We describe the eradication of feral pigs (*Sus scrofa*) from Santa Cruz Island, California, highlighting those control techniques that removed the most pigs and those that removed the last pigs. In 411 days, a total of 5036 pigs were removed from the 25,000-ha island. Before the eradication began, the island was fenced into five zones. Within each zone, the same general sequence of control methods was used: trapping (16% of dispatches in 1660 trap-nights); aerial shooting from a helicopter (77% of dispatches in 13,822 km of flight path); and then ground-based hunting with trained dogs (5% of dispatches in 1111 hunter-days). Sterilized adult pigs fitted with radio collars were subsequently used to aid in the location of

surviving wild pigs and to monitor the success of the project. Female telemetered pigs were more effective than males at locating remaining wild pigs. Only 10% of the last 102 pigs (the last 20 or so present in each fenced zone) were dispatched as a result of being found with a telemetered pig, but telemetered animals were responsible for finding 43% of the very last pigs once normal hunting had ceased. The time taken to eradicate pigs on Santa Cruz Island was about half that taken on a neighbouring island of similar size (Santa Rosa Island) and 12 times as fast as that on Santiago Island (58,465 ha), Galapagos Islands. The deliberate sequencing of control methods, using first those that taught surviving pigs the least, and the intensive implementation of those methods, represent important advances in the practice of eradication and so biodiversity conservation.

Sanguinetti J and Kitzberger T. 2010. Factors controlling seed predation by rodents and non-native *Sus scrofa* in *Araucaria araucana* forests: potential effects on seedling establishment. Biological Invasions 12(3): 689-706.

Post-dispersal seed predation can severely limit plant recruitment, but its ultimate impact could be modulated by environmental factors and by the composition of the granivore guild. Here, we analyze the relative impact of the non-native wild boar and native rodents on seed survival and seedling establishment of the mast conifer *Araucaria araucana*. Predation, seed survival and seedling establishment were measured at different microsites and distances from 11 isolated trees in Lanin National Park (Argentina) over a period of marked fluctuation in seed production. Wild boar consumed between 10 and 30% of available seeds on a 13-day period, threefold less than rodents. Wild boar predation was mainly affected by forest canopy composition, while microsite conditions influenced both kind of predators, with high chronic rodent predation underneath dense vegetation and moderate (but interannually variable) wild boar predation at poorly vegetated microsites. Predation by rodents was spatially clustered at the microsite scale, particularly during non-mast years; while predation by wild boar was spatially structured at a coarser scale and less modified by masting. The exclusion of wild boar increased significantly the amount of surviving seeds, resulting in higher seedling establishment in intermediate production years, but not affecting it during the mast year. At tree level, seedling establishment was negatively correlated with predation; while at stand level, cone production accounted for most of the seedling establishment variability. The current wild boar population may not be affecting the seedling establishment at population scale, probably due to minimization of its impact by the *Araucaria* masting strategy. However, if wild boar population numbers continue to increase, their impact may shift from individual tree scale to stand scale, threatening *Araucaria* forest regeneration.

Scillitani L, Monaco A and Toso S. 2010. Do intensive drive hunts affect wild boar (*Sus scrofa*) spatial behaviour in Italy? Some evidences and management implications. European Journal of Wildlife Research 56(3): 307-318.

Wild boar have been increasing in numbers all over Western Europe in the last 30 years. The species is a major pest for agriculture, but it has a high value as a game species, and in Italy, as in several other countries, it is traditionally hunted in drive hunts by hunting teams with several dogs. This hunting method can have disruptive effects on the demography and spatial behaviour of wild boar, espe-

cially family groups. We conducted a 2-year study (2003 and 2004) to determine the effects of drive hunt disturbance on the spatial behaviour of wild boar family groups in the Northern Apennines (central Italy). Twenty wild boar belonging to ten family groups were ear tagged with a radio device. We located resting sites daily and used intensive tracking sessions during drive hunts. Three seasons were determined: pre-hunting, hunting and post-hunting. A general pattern of increased spatial instability during the hunting season was shown. Resting ranges were larger, and resting sites were more interspersed. Distances between consecutive resting sites were greater during the hunting season and, especially, on hunting days. The displacement of family groups caused by drive hunts was generally short lived except for those groups that were repeatedly hunted and so abandoned their pre-hunt (native) range. During drive hunts, wild boar showed a moderate tolerance to hunting disturbance, and only family groups which were directly chased by dogs escaped or altered their behaviour. The response of wild boar to hunting disturbance seemed to be highly related to the degree of hunting pressure combined with individual variability. The impact on wild boar behaviour should be reduced, above all by avoiding repeated hunts in the same areas within a short period and by employing well-trained hounds.

Steinmetz R, Chutipong W, Seuaturien N, Chirngsaard E and Khaengkhetkarn M. 2010. Population recovery patterns of Southeast Asian ungulates after poaching. Biological Conservation 143(1): 42-51.

Large ungulate populations in Southeast Asia have collapsed due to commercial poaching, but little is known about patterns of population recovery after poaching has been controlled. Using a sign-based index of abundance, we measured 6-year trends in abundance and habitat use of five ungulate species after poaching ceased at a site in Thailand. Regression slopes of annual indices against time indicated population growth rates (r) of 0.44 and 0.31 for muntjac (*Muntiacus muntjak*) and gaur (*Bos gaurus*), respectively-close to the intrinsic rates of natural increase for similarly-sized ungulates. Thus, muntjac and gaur can recover relatively rapidly from low population levels. In contrast, sambar (*Cervus unicolor*) remained consistently rare despite freedom from hunting, perhaps because prime males had been selectively targeted for trophies, disrupting the species mating system. Wild pigs (*Sus scrofa*) were already relatively abundant when monitoring started, illustrating their resilience to hunting and ability to quickly recolonize disturbed areas. Gaur herds (the key demographic unit of the population) and muntjac consistently selected deciduous over evergreen forest as their populations increased, revealing the importance of food-rich deciduous forest in driving recovery of these species. The unexpected failure of sambar to recover suggests that reproductive behavior may override seemingly positive interventions (i.e., stopping poaching) that reduce mortality. Small but well-protected recovery zones set within forested areas might help propel population recovery of ungulates and increase the prey base for endangered tigers.

White AM. 2010. A pigheaded compromise: do competition and predation explain variation in warthog group size? Behavioral Ecology 21(3): 485-492.

The reproductive payoff to an individual for participating in a group will often be affected by the size of the group. Competition for resources and predation pressure are 2 primary, factors that influence sociality and group size in a variety of species. In this correlative study, I investigated how resource

competition and predation influenced group size and female reproduction in the common warthog, *Phacochoerus africanus*. The distribution of group sizes indicated that group size depended on the age and sex of the participants. Yearlings formed larger groups than adults, whereas adult males and adult females formed similar sized groups, although males were more likely, to be solitary. The demand for preferred habitat, clan density, predation pressure, and the time of year explained significant variation in the size of adult, female groups but not in the size of adult male or yearling groups. Clan areas with more warthogs per area of preferred habitat were associated with smaller adult female groups, whereas higher densities of warthogs were associated with larger group sizes. Increasing indication of predator presence in a clan area had little influence on grouping behavior in general but resulted in larger female group sizes late in the dry season and with increased sightings of females with juveniles. The relationship between group size and predation pressure may be a consequence of group stability and higher mortality, in larger groups.

White AM, Cameron EZ and Peacock MM. 2010. Grouping patterns in warthogs, *Phacochoerus africanus*: is communal care of young enough to explain sociality? Behaviour 147(1): 1-18.

Group-living will evolve when individuals increase their lifetime reproductive success by joining with other individuals. In cooperatively breeding societies, individuals living in a group will participate in the communal rearing of young. Several factors can influence the evolutionary trade-offs of grouping and it is often unclear whether cooperative breeding is advantageous or is simply a by-product of selection acting on grouping behaviour. We used sightings of 1318 warthogs in 711 groups to investigate whether the advantages of sociality in the warthog differ depending on an individual's age, sex, reproductive state, or the time of year. Adult males only formed temporary associations with other individuals indicating that participation in a group was not advantageous. In contrast, yearlings were almost inevitably found in groups, regardless of their sex or time of year, suggesting any costs to sociality were outweighed by the benefits. Grouping in adult female warthogs was complex; adult females were more likely to form groups in the presence of juveniles and when juveniles were at their most vulnerable stage indicating that sociality in females could be partially explained by the benefits of communal care of young. However, other factors influenced female cooperation including group composition and the time of year.

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

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The IUCN/SSC Wild Pigs, Peccaries and Hippos Specialist Groups (WPSG, PSG and HSG) are three 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.

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

Pigs, peccaries and hippopotamuses are non-ruminant ungulates belonging to the Suborder Suiformes of the Order Artiodactyla (the even-toed ungulates).

Within the Suborder Suiformes, pigs belong to the Family Suidae, peccaries to the Family Dicotylidae and hippopotamuses to the Family Hippopotamidae.

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