Suiform Soundings

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Suiform Soundings

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*Photo front page: "*Wait, did you get my good side?!" A Bearded Pig, *Sus barbatus,* captured by a camera trap in Central Kalimantan province, Indonesia. Sent in by Erik Meijaard.

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EDITORIAL

Despite the best efforts of the gremlins in my laptop, I'm happy to bring you the next issue of our newsletter, *Suiform Soundings* 12(2). This edition includes an article on a possible increase in White-lipped Peccaries in the Paranapiacaba Forest, São Paulo; a paper discussing the successful production of collared peccary sperm under the back skin of immunodeficient mice (!), and a short communication warning of the potential for an escalation in the international trade in Babirusa. We are also afforded a rare glimpse into the habits of the secretive Giant Forest Hog in Uganda.

On page 4, we are given an overview of the recent WPSG workshop held in west Java, which focused on the improved conservation of threatened wild pig species in Asia. One of the management options the group identified for the Endangered Javan Warty Pig was the establishment of 'safe' populations as a first step in securing the species and looking at future possible reintroductions. However, there is a lack of information about what habitats *Sus verrucosus* uses, with few studies conducted on the species' ecology in recent times. On page 18, Erik Meijaard takes the first steps in tackling this issue with a literature review of the ecological separation between *S. verrucosus* and *S. scrofa*. In addition to looking at the habitat preferences and morphology of the two species, Erik also discusses a possible release site for *S. verrucosus* in Ujung Kulon National Park. For this reason, we've included a contribution by Thiemo Braasch in our newsletter, where he describes a recent visit to Ujung Kulon. While Thiemo was on the trail of the elusive Javan rhino rather than assessing habitat for Warty Pigs, his account of the area and its scenery and wildlife is enough to make anyone volunteer to head up a potential reintroduction programme!

And please do click on the following links to see what the Cikananga Conservation Breeding Centre in west Java has been up to. You can view photos of the Javan Warty piglets from 2013, as well as read about the construction of their new enclosures for the female pigs. Many thanks to Stephan Bulk for sending this through.
http://cikanangacbc.wordpress.com/2013/07/03/preparing-enclosures-for-the-female-warty-pigs
http://stephanbulk.jimdo.com/warty-pig/projects/2013-new-enclosures/
http://stephanbulk.jimdo.com/warty-pig/piglets-2013/dayang-4-month-old/

Wishing you all a great 2014,

Anne-Marie Stewart
Nairobi, Kenya

Balipara Foundation Award to William Oliver

Many congratulations to William Oliver, who was recently acknowledged for his work with the Pygmy Hog Conservation Programme when he was nominated as an Earth Hero by the Balipara Foundation in Assam, India. William received an award at the inaugural 2013 Balipara Foundation Awards -Recognizing Ecological Best Practices in the Eastern Himalayas. The judges decision was based on the "pivotal role that the Pygmy Hog Conservation Programme has played in the restoration of an endangered species and its ecological habitat."

Think Pig. Results from our first Wild Pig Specialist Group Meeting for South-East and South Asia

Erik Meijaard [1], Kristin Leus [2], and James Burton [3]

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[2] Vice Chair, IUCN/SSC Wild Pig Specialist Group and Copenhagen Zoo. Antwerp, Belgium
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Background

From 19 to 21 November we held a very constructive workshop that brought together a range of experts on South-East and South Asian wild pig species with a specific agenda to develop a list of immediate action points to be implemented for improved conservation of threatened wild pig taxa in Asia. The meeting was held in the Cikananga Animal Rescue Center, which also has a *S. verrucosus* breeding population. The workshop was a great opportunity to discuss among pig husbandry experts the best ways to manage the species in captivity. The workshop was funded by Los Angeles Zoo and Jacksonville Zoo, and we are very grateful for the opportunities given to us by these donations.

People present

The following people were present: Alastair MacDonald (Edinburgh University), Resit Sözer and Stephan Bulk (Cikananga), Roland Wirth (ZGAP), Thiemo Braasch, Kristin Leus, Indra Warmann and Carl Traeholt (Copenhagen Zoo), William Oliver (Philippines Biodiversity Conservation Foundation), Laurent Frantz (Wageningen University), Parag Deka and Goutam Narayan (Pygmy Hog Conservation Program), Gono Semiadi (Indonesian Institute of Sciences), Radoslav Ratajszvzak (Poznan Zoo), James Burton (Asian Wild Cattle Specialist Group), Tedi Setiadi (Aksenta), and myself (Erik Meijaard). Jeff Holland, from LA Zoo, could unfortunately not make it in the end.

Sus verrucosus management in the Cikananga Integrated Conservation Society

The Cikananga center was set up to receive confiscated wildlife. In addition to those tasks, it has successfully bred threatened species such as Black-winged Starlings (*Acridotheres melanopterus*) and Javan Green Magpie (*Cissa thalassina*), and also maintains a significant population of Javan Warty Pigs (*S. verrucosus*). Cikananga has had increasing success breeding the Endangered *S. verrucosus* and has recently obtained funding for exploring release of surplus animals into a safe area.

Strategic planning for *S. verrucosus*

Kristin Leus guided an insightful session on strategic planning for ex situ species management. This started with an analysis of threats basically answering the question whether action was indeed needed. There is evidence for sufficiently strong threats (hunting, habitat loss, hybridization) so the group's formal decision is to take action and save *S. verrucosus*. Following discussion, we agreed to set up at least three safe populations until we have more habitat information that would allow safe reintroductions and better *in situ* management. We discussed a range of options for establishing safe populations (Table 1).

It was also decided that in order for intensive management to work well, a 2nd facility would be needed to get re-introduction happening as fast as possible. The related actions we agreed on were: 1) To introduce *S. verrucosus* to the Indonesian conservation authorities, so that it is on their agenda, and to discuss some opportunities, i.e., continue Cikananga, extra captive facilities and islands; 2) Conduct a study of islands that might be suitable for release; 3) Conduct a study of ex situ facilities on Java that could potentially host a *S. verrucosus*

population; and 4) Produce a strategy report for the above points within 6 months.

Table 1. Overview of population management options for *S. verrucosus*

Type of site	Pros	Cons
Island offshore mainland Java	• Natural area could result in better population growth • Low maintenance cost • Temporary place • Transit / semi captive • Behave like wild so easier to reintroduce • Natural selection	• Part of National Park- bureaucracy issues will cause delays • Need to establish facilities? • These would be introductions – based on unclear risk of hybridisations
Intensively managed area on mainland Java	• Cost effective • Low maintenance	• Expensive in effort and money
Managed *ex situ* facility	• Better options to manage genetic diversity • Safer for trans-located individuals	• Zoo option – risk of continuously good management/ responsibility with nervous animal
Fragmented habitat on mainland	•	• Hunting pressure • Not well received by community

Other issues that we decided to take action on were: 1) To facilitate a study of basic *S. verrucosus* biology - helpful for ex situ biology; 2) Observe and study ex situ population of *S. verrucosus*; 3) Potential habitat mapping using MAXENT on basis of historic records; 4) Consider the need for a new population survey (last one was in 2004); and 5) Implement conservation action in the Banjar area of West Java where overhunting is a major problem.

Hybridization threat

One of the issues discussed was hybridization between *S. verrucosus* and *S. scrofa vittatus* (the "banded pig", a second pig taxon of Java). The question was addressed as to what our position/strategy is regarding the threat of hybridization. The two species did not seem to have shown major levels of hybridization in the past so why would there appear to be more hybridization now? The species could have been forced out of ideal habitat and forced closer together. The problem is that we do not know enough about the ideal habitat of either species (see elsewhere in this issue of Suiform Soundings). Even if we did know, however, it is unclear what could be done to prevent hybridization in natural conditions. We can't get rid of *S. scrofa*, as this is a naturally occurring species that arrived on the island of Java some 70,000 years ago. The decision was made that the unquantified threat of hybridization would be taken seriously and would be further researched (habitat separation, species interactions, DNA studies), and that the aim was to save a "pure" from of *S. verrucosus* if at all possible.

Stress management

Javan Warty Pigs are highly excitable and very difficult to get "calm". This makes their management and study difficult. There were various useful inputs from the group about enclosure design and other management ideas to see if the population could be tamed to some extent. Experience with the species from Poznan Zoo confirms how hard it is to tame them. The Poznan keepers tried to play the radio, have people sit with them, and other ideas, but the pigs never calmed down, always looked stressed, and were always running. The people from the Pygmy Hog program stressed that it was important to find out what stresses them and fix it. For ex-

ample, if they don't give nest material for pygmy hogs to build a nest every day, they get very stressed. A gradual approach may be needed, i.e., when pygmy hogs first came into captivity, they were in fairly small enclosures with lots of cover and a normal food provisioning routine was used. It took a certain number of days per pig before they started eating, but it did work. Then they kept that routine until the pigs were used to it and then added another level of complexity.

Group size

We discussed what would be an ideal group size in captive conditions. This remains largely unstudied in wild Javan Warty Pigs so it is difficult to judge what *ex situ* group size would be best. In almost all species of pigs the nuclear family is females with young with males joining them at breeding time. It was therefore suggested that there may be a need to set up nuclear families and rotate the males.

Sus (v.) blouchi

We also had extensive discussion on the Bawean Warty Pig *Sus (verrucosus) blouchi*. This subspecies (or species) only occurs on the small Bawean Island in the Java Sea (note the island was previously called Pulau Babian [Pig Island] (Soerabaiasch Handelsblad, 16 Oct 1931). We know all but nothing about its ecology, but previous interview surveys suggested that the taxon might be highly threatened.

A 10-day survey in October 2013, which included in-depth interviews with hunters, farmers, communities and some camera trapping, confirmed that the taxon can still be found on Bawean. Gono Semiadi wrote a detailed report about his surveys on the island, which we can share if anyone is interested. Gono also managed to collect some tissues of a recently killed animal which will be useful for DNA analysis. It will be interesting to see how the Bawean Pig differs from the Javan Warty Pigs on the mainland.

Overall there still appears to be significant areas of good habitat left for *S. (v.) blouchi*. The species is primarily threatened by hunting, although hunting pressure is reportedly higher for *S. scrofa* which tends to feed in agricultural areas and is considered a greater pest species than *S. (v.) blouchi*.

Of interest to the Deer Specialist Group, Gono visited the successful breeding project for the Critically Endangered Bawean Deer *Hyelaphus kuhlii* (Figure 1). It now has 35 animals from an original founder population which started "10 years ago" and consisted of 2 males and 5 females.

Figure 1. The breeding center for Bawean Deer, showing in the background the forested hills where most *S. (v.) blouchi* seem to occur.

We attempted a Red List Assessment of *Sus (v.) blouchi*, but there is insufficient information to determine the conservation status, i.e. it is Data Deficient. Based on this assessment it was decided to fast track a number of actions with regard to *Sus (v.) blouchi*: 1) Organize an ecological study of the two pig species on Bawean Island to better understand ecological needs of *Sus (v.) blouchi*; 2. Conduct an interview-based assessment of threats to and perceived trends of *Sus (v.) blouchi*; and 3. Analyse the DNA of the species and determine genetic divergence from *S. verrucosus* on the Javan mainland.

Sulawesi pigs

General issues

On day 2 of the workshop, we discussed the Sulawesi pigs (*Babyrousa* spp.) and *S. celebensis*. Alastair Macdonald presented the preliminary findings of new research on the morphology and genetics of *Babyrousa*. This revealed that the genetic divergence between populations is much deeper than was anticipated, with populations on the Sulawesi mainland separating into monophyletic groups, mimicking biogeographic patterns found in, for example, Sulawesi macaques. Additionally, the island populations found on Buru Island and other islands are genetically very distinct, suggesting long-term *in situ* evolution rather than recent introductions from the Asian mainland. Similar phylogenetic patterns were found in *S. celebensis*, although not quite as pronounced as in *Babyrousa*. The results of these studies will be published over the coming few years, possibly requiring further taxonomic changes.

The genetic structuring in the populations of these species raises the question of what needs to be conserved. Certainly, conservation efforts should attempt to protect as much genetic diversity as possible, but in addition, the ecological variation that exists between different parts of the species' ranges should be considered.
At the moment, very few people are working on the conservation of Sulawesi and Moluccan (e.g., Buru Island) pigs. We decided that rather than trying to develop conservation programs solely focused on pig conservation, we should seek collaboration with other species groups that have important conservation values in this region. This includes, for example, primates, Asian wild cattle, freshwater fish, and plants. A coordinated strategy involving other specialist groups might be more effective for addressing threats, such as deforestation and unsustainable wildlife use, than a pig-focused strategy. This strategy resulted in the following action points: 1) Collate and provide info in suitable format to forestry and other conservation organisation so as to give a stronger case for prioritising Sulawesi for major funding for biodiversity conservation; 2) Ask if those groups have specific plans for Sulawesi and look for synergies; 3) Map mineral mining potential and overlay with key pig habitats; and 4) model migration between Sulawesi populations using available genetic data.

Hunting

Hunting appears to be the main threat to the pig species of Sulawesi and the Moluccas. It was decided to organize an island-wide survey to better understand the reasons why people hunt and trade pigs and how this varies across the island. Such understanding would help design spatially explicit management interventions that could target regions where particular threats are most severe, or where reducing threats might be most likely. As mentioned in the previous section, combining this work with assessments for other threatened Sulawesi and Moluccan taxa would make sense. Collaboration with other IUCN specialist groups would be a good start.

Buru + Sula population of *Babyrousa* spp.

The populations of *Babyrousa* on the islands of Buru, Masbate (possibly extinct), Taliabu and Samana remain pretty much unstudied, with most conservation-relevant insights deriving from anecdotal information. The group decided to make a field survey to these islands a high priority. Again, collaboration with other specialist and conservation groups would be useful.

Philippine pigs

We briefly reviewed the main challenges regarding the (likely more than) eight Philippine pig species, all of which are under significant conservation threat, primarily from habitat loss, over-hunting and hybridisation with other pigs. Captive breeding of the most threatened species, the Visayan Warty Pig *Sus cebifrons* has been successful and there are now over 80 individuals.

Pygmy Hog

Probably the biggest conservation success in wild pig conservation is the Pygmy Hog *Porcula salvania* of eastern India. The species was thought to be extinct but then rediscovered. By 1992, the only remaining wild population was found in Manas National Park. Currently a few hundred animals remain only in Manas.

The breeding program that was set up for this species aimed to ensure survival of pygmy hog in perpetuity by establishing at least 3 wild and captive populations. In 1996, the program started with 6 founders caught from the wild, of which 3 were pregnant females. By 2013, a total of 74 animals had been released in two different locations. Still, a capture operation in March 2013 managed to flush and catch far fewer animals than in the initial captures in 1996, possibly suggesting that the wild population is still in decline.

Figure 2. Juvenile group of Pygmy Hogs in Basistha Centre. Photo by William Oliver

Other issues

Thiemo Braasch - Social media coordinator
Thiemo Braasch volunteered to coordinate the social media work of the Wild Pig Specialist Group, including helping to maintain and update the website, and setting up a Facebook page to keep the "Think Pig" on the agenda of conservation organizations.

Laurent Frantz - Phylogeny coordinator
Laurent Frantz of the Animal Breeding and Genetics group at the Wageningen Agricultural University volunteered to coordinate the many genetic studies that are ongoing among wild Suidae, and help translate findings from these studies into practical guidance for conservation management of threatened wild pig taxa.

African and other Asian pig taxa
We briefly discussed African pigs and the group decided that it would be good to organize a workshop in 2016 for those species. This would follow another pig workshop which is presently being planned for June 2015 in Hoikkaido, Japan, which will address conservation issues related to the threatened pig taxa in central and eastern Asia, as well as the societal processes that supported the recovery of Wild Boar populations in Europe.

Conclusion

This was an excellent and very constructive workshop, the first in quite some time, in which we managed to

bring together experts from different backgrounds with a shared interest in wild pig conservation. The discussions were very useful and focused on developing lists of realistic, useful and feasible action items for 2014 and 2015 which should directly benefit wild pigs. The Cikananga Center provided with us with rather remote, but excellent facilities that helped make this meeting a major success. Many thanks again to our donors, LA and Jacksonville Zoos, the Cikananga people who helped facilitate the meeting, and our participants who travelled from far to provide their input.

A trip through Ujung Kulon National Park – trying to find the mystic rhino

Thiemo Braasch

The Ujung Kulon National Park at the western tip of Java in Indonesia is the last known place of Javan rhinos (*Rhinoceros sondaicus*) and one of the remotest national parks on Java. It is also relatively rarely visited by Indonesians and foreigners. Here I describe a visit to Ujung Kulon in November 2013.

The tour was specially designed by a company, but similar hiking trips can be organized easily. The hiking tour took a small trail around the core area which cannot be visited, starting in Ujung Kulon village. Ujung Kulon village is near to the Gunung Honje at the entrance of the park. Some houses are even built within the park boundaries. The trail is only a small path almost invisible in the dense lowland rainforest, leading first through the mangroves along the north coast then going south to the southern beaches. You already feel the remoteness of the national park after just a few kilometers hiking. The hornbills and monkeys are not afraid

when they encounter human beings. On the way through the rainforest along the south coast, some old footprints of Javan rhinos can be found less then four hours away from Ujung Kulon village. Suddenly the rainforest opens to a long lonely beach leading to the west, only inhabited by several crab species running on the sand, and plovers. After the second day of hiking mostly along the southern beach, a savannah area on a cliff is crossed, where we glimpse two Javan bantengs (*Bos javanicus javanicus*) through the adjacent forest. Eagles fly over the coast and at least three different hornbill species pass by.

On the third day the trail heads north again, now leaving the core area of the national park to the east. It is this part of the trail where most of the rhino encounters take place. Only 40 to 60 rhinos still survive here (van Strien *et al*., 2008). Fresh footprints and the smell of rhinos (a typical rhino smell known from Indian rhinoceros, *Rhinoceros unicornis*, in zoos) indicate the recent presence of rhinos, but through the dense forest even such a big mammal like a rhino cannot be seen. The mystic rhino stays hidden somewhere in the jungle.

The rainforest looks undisturbed and pristine, although it is only a forest in recovery. In August 1883, the Krakatoa volcano less then 100 km away from Ujung Kulon exploded, the second biggest volcanic eruption in the last 10,000 years (Winchester, 2003), sending big tsunamies through the Indonesian Archipelago. Interestingly, this eruption became a lucky incident for the wildlife of Ujung Kulon as it depopulated the area leaving space for rhinos, bantengs, Javan leopards and other endangered animals on this, the most populated island in the world.

Nightfall is a spectacle in Ujung Kulon: the cicadas start their noisy concert, later joined by different frog species. Near to the north coast, less then 100 m away from a lagoon, banteng and green peafowl (*Pavo muticus*) can easily be observed on a small savannah. There are approx. 800 banteng in Ujung Kulon, the biggest population of the Javan subspecies (Timmins *et al.*, 2008). Peucang Island near to the north coast of Ujung Kulon is home to approx. 150 Javan rusas (*Rusa timorensis*), according to the park rangers there. The coral reefs around Peucang Island and along the north coast of Ujung Kulon National Park near to the core area are almost undisturbed by human beings, building huge gardens for hundreds of fish and invertebrate species. After three days of hiking and three more days of scuba diving near to Ujung Kulon the tour comes to an end. The journey back to Jakarta takes almost one day.

Although we did not see Javan rhinos, visiting Ujung Kulon is an extraordinary experience, breathtaking and fascinating. Thanks to Laurent Frantz for the companionship and Lahuka Indonesian Expedition Services for the organization of the unique tour to the home of the mystic rhino

Banteng on Ujung Kulon

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Thiemo Braasch is field biologist and social media officer of the WPSG.

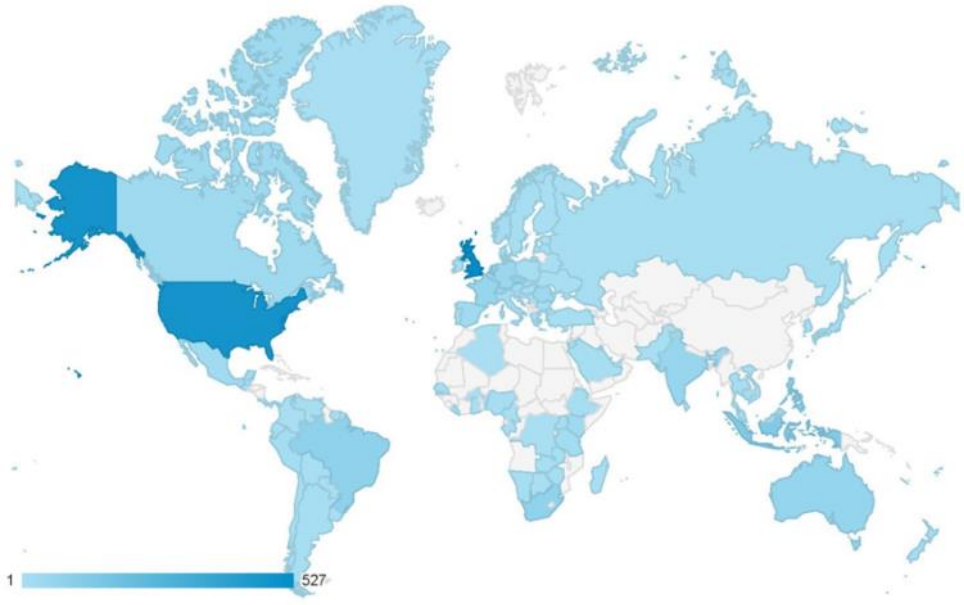
Wild Pigs on the Web

Erik Meijaard, WPSG Chair

People & Nature Consulting International, Jakarta, Indonesia

The WPSG website (https://sites.google.com/site/wildpigspecialistgroup/home) came online at the end of January 2013, and some 7 months into it – I write this in early October 2013 – it would be interesting to do a bit of analysis. How many hits do we get, who is using the website, and which particular pages are most popular?

Using the Google Analytics website I found the following. In the first 7 months since the WPSG website came online, we had 2,506 visits, by 1,903 unique visitors, resulting in 7,791 page views, or 3.31 pages per visit. We had visitors to our site from 102 countries, with the highest 10 scores for: the UK (527 visits), the USA (479), Indonesia (133), Philippines (102), Czech Republic (90), Brazil (88), Netherlands (86), South Africa (82), Australia (65), and France (60). The map below indicates from which countries our site was accessed. Note the many African wild pig range countries from where we have not had any visitors yet, while the complete lack of visitors from China is also noteworthy. Maybe I should consider translating all web texts into Mandarin, if indeed we are interested in attracting Chinese visitors. I find it interesting that, apart from Indonesia and the Philippines, none of the top 10 visiting countries actually have endangered pig species. It seems that we are primarily attracting western visitors with an interest in wild pig conservation, maybe people from the zoo community or research organizations.



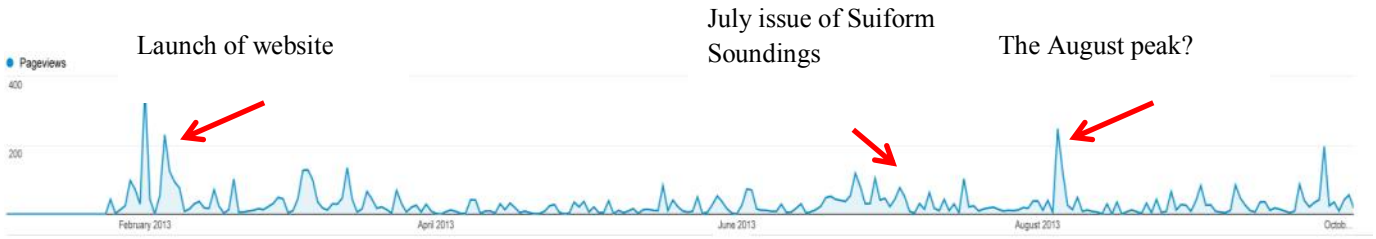
Most of the visitors (56%) get to our site through Google search, with 23% finding the site directly, 4% through Facebook, and 6% through the IUCN.org website, or the IUCN SSC Species e-Bulletin. The most common landing page (i.e., the part of the website where a visitor first arrives) is the home page with 23% of the visit. Visitors stay some 1.37 minutes on this page which should be just enough to watch the slide show of wild pigs. The second most common landing page is the Suiform Soundings site, which is largely due to our editor including a link to our online newsletter in her announcement email of the latest issue (thanks Anne-Marie). This also indicates that some 340 people so far downloaded the latest issue of Suiform Soundings, which is actually quite a reasonable readership. The third most common landing page is the Wild Pigs of the World page, which I find a bit surprising because it is neither very attractive nor majorly informative.

This analysis can also show us which of the species pages are most popular. This is how it works out (Table 1, left column), with, somewhat surprisingly, the Bushpig (*Potamochoerus larvatus*) getting the most visits. Warthogs (*Phacochoerus* spp.) and Wild Boar (*Sus scrofa*) are also popular, as are the two Critically Endangered species, the Visayan Warty Pig (*Sus cebifrons*) and the Pygmy Hog (*Porcula salvania*). Actually, a quick look at averages (Table 1, right column) indicates that indeed the two Critically Endangered species get most attention, but that the Endangered, Vulnerable, and Least Concern species get least. The relatively common species of least conservation concern are also popular. That could indicate that quite a few people come to site with a general interest in wild pigs, rather than a specific conservation interest.

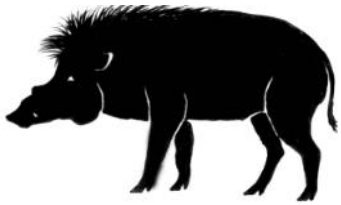
Table 1. Number of visits to the individual species pages on the WPSG website since its launch (left), and average number of site visits per IUCN threatened species category (right).

Species	site visits	IUCN status		IUCN status	Mean	N	Std. Deviation
Potamochoerus larvatus	307	LC		CR	275.5	2	27.58
Sus cebifrons	295	CR		EN	199.33	3	13.58
Phacochoerus africanus	269	LC		LC	262.67	6	25.21
Sus scrofa	266	LC		NT	163	1	.
Porcula salvania	256	CR		VU	199.6	5	23.65
Hylochoerus meinertzhageni	253	LC					
Potamochoerus porcus	247	LC					
Phacochoerus aethiopicus	234	LC					
Babyrousa celebensis	230	VU					
Sus oliveri	215	EN					
Sus barbatus	213	VU					
Sus ahoenobarbus	203	VU					
Sus verrucosus	192	EN					
Babyrousa togeanensis	191	EN					
Sus philippensis	178	VU					
Babyrousa babirussa	174	VU					
Sus celebensis	163	NT					

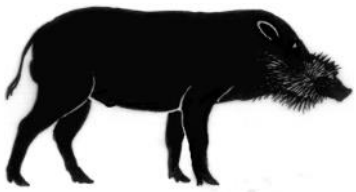
The general interest in pigs referred to above could also be indicated by something that happened on August 5th and 6th, 2013. Those two days saw some of the highest daily site visits since the WPSG website came online, with 183 and 77 visits respectively (Figure 3). Google Analytics indicated that all these visits originated in England and Wales, with 60 from London alone. I checked whether wild pigs were in the British news that day but couldn't find anything. Something significant—a school project, a TV program, or remarkable pig news—must have directed people to our site, but I never found out what it was.



Finally, let's not get carried away by this slight success. At any moment I can check whether anyone is visiting the WPSG website, and where these visitors are from. At the moment there is no one on our site. Someone was there about 10 minutes ago, but I am pretty sure that was me accessing the site to write this piece. Let's face it, we had some nice numbers coming to our website, but it isn't a blockbuster success quite yet. We need a much bigger effort than just a simple website to get the global public interested in wild pig conservation. This is our real challenge for the next few years. THINK PIG!



Papers and communications



Production of functional collared peccary sperm under the back skin of immunodeficient mice: a powerful approach to germplasm conservation in wild suiforms

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KEYWORDS: Collared peccary, testis xenograft, testis development, spermatogenesis, Sertoli cells, Leydig cells, sperm production, biotechnology.

Testis tissue xenograft is a powerful approach in which small testis fragments from donor species are placed subcutaneously under the back skin of an immunodeficient mouse, where they respond to the recipient gonadotropins, initiating and leading to complete spermatogenesis (Honaramooz *et al*., 2002; Rodriguez-Sosa & Dobrinski, 2009). Therefore, this technique is a very attractive tool for investigating the testis function in non-model species as well as to preserve the germplasm of individuals in which sperm collection is not an option (Rodriguez-Sosa & Dobrinski, 2009). In a more plastic approach, when dissociated testes cells are xenografted under the back skin of an immunodeficient mouse, these cells are able to organize and rearrange into seminiferous cords (*de novo* testis morphogenesis) that subsequently undergo complete spermatogenesis (Honaramooz *et al*., 2007).

In previous studies from our laboratory, we observed that the collared peccary (*Tayassu tajacu*) presented a unique testicular cytoarchitecture, in which Leydig cells are observed almost exclusively surrounding the seminiferous tubules lobes (Costa *et al*., 2011; Campos-Junior *et al*., 2012). This particular characteristic allowed us to use this species as a model to investigate the spermatogonial stem cell physiology and niche in mammals (Campos-Junior *et al*., 2012). Taking into consideration these aforementioned aspects and the ecological and economical importance of the collared peccary, the testis xenograft technique represents a functional procedure to study gametogenesis and to preserve the germplasm from suiform species.

In this very promising scenario, we performed a testis tissue and cell suspension xenograft using sexually immature collared peccary as a donor (Campos-Junior et al., 2013). In these studies, we observed full spermatogenesis at six months after testis tissue xenograft (Fig. 1). When the testis cells suspensions xenografting technique was employed, the cells interacted and *de novo* testis morphogenesis occurred, with the peculiar collared peccary testis cytoarchitecture observed. More importantly, complete spermatogenesis with the formation of functional sperm was observed at eight months post-grafting (Fig. 2). In comparison to other mammalian species, although some studies showed that sperm produced in testis xenografts were able to produce diploid embryos and healthy progeny (Honaramooz *et al*., 2004; Nakai *et al*., 2010), the fertility of cell suspen-

sions of graft-derived sperm has never been evaluated in a wild species. In our study, functional sperm were successfully harvested from collared peccary testis xenografts and, after *in vitro* fertilization, diploid embryos were produced (Fig. 2). Strengthening these findings, the expression of the paternally-imprinted gene neuronatin (*NNAT*) (Chankitisakul *et al*., 2012) was observed in these embryos. Therefore, similar to the few other mammalian species investigated with this approach, our findings demonstrated that the testis xenograft represents a powerful method of preserving the suiform germplasm.

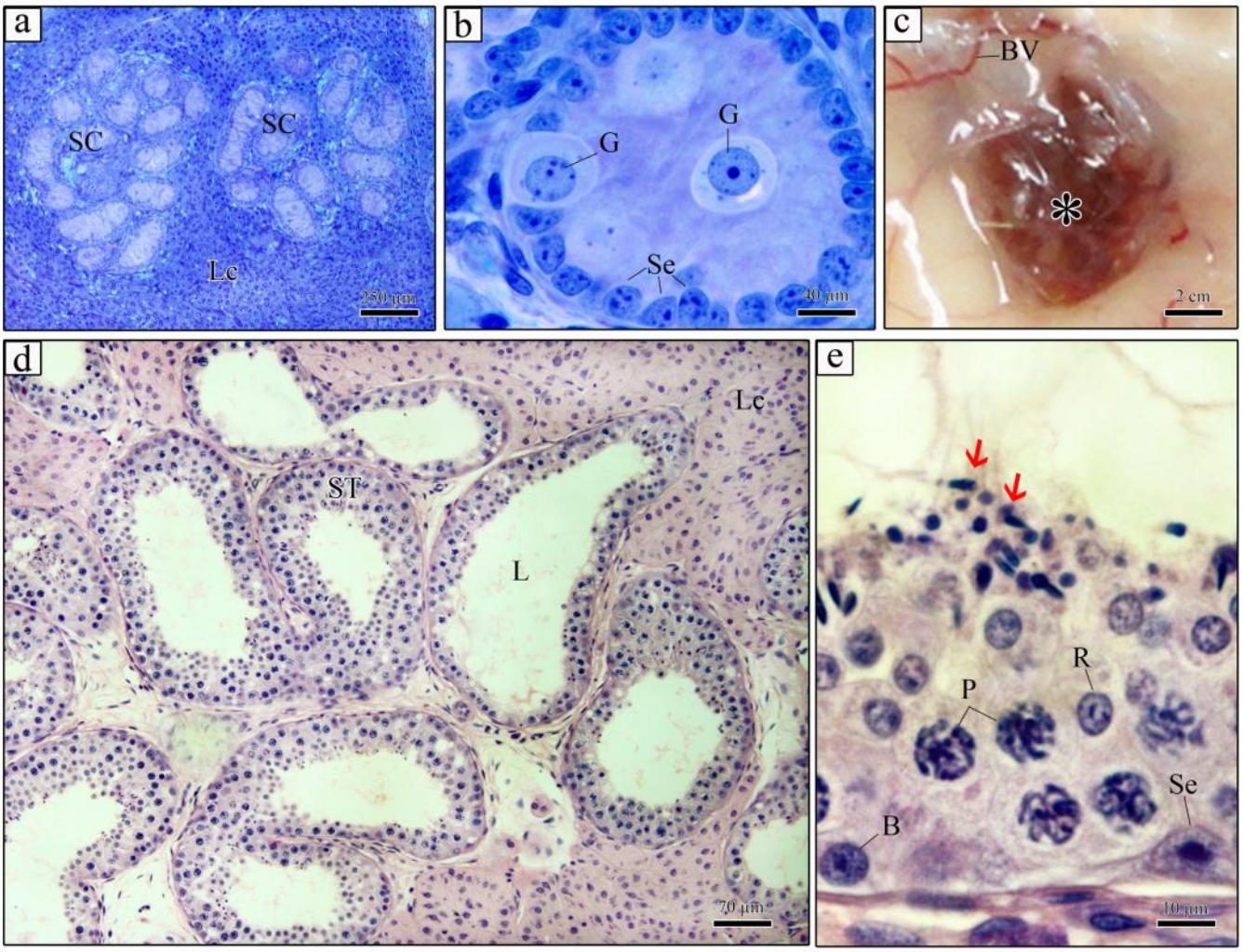

Figure 1 – Testis tissue xenograft. (**a)** Sexually immature collared peccary donors (three months old) present the peculiar testis cytoarchtecture, in which Leydig cells (Lc) surrounded the seminiferous cords (SC); **(b)** In the seminiferous epithelium, gonocytes (G) were the only germ cell type present at this age and Sertoli cells (Se) were still immature; **(c)** These grafts (*) were maintained healthy under the back skin of the immunodeficient recipient mice, and a noticeable vascular network was observed (blood vessels – BV); **(d)** Six months after xenograft, complete spermatogenesis was observed in the seminiferous tubule (ST) that presented a prominent tubular lumen (L); **(e)** In a higher magnification of the seminiferous epithelium, mature Sertoli cell (Se), type B spermatogonia (B), pachytene spermatocytes (P), round (R) and mature spermatids (arrows) are observed six months post-grafting.

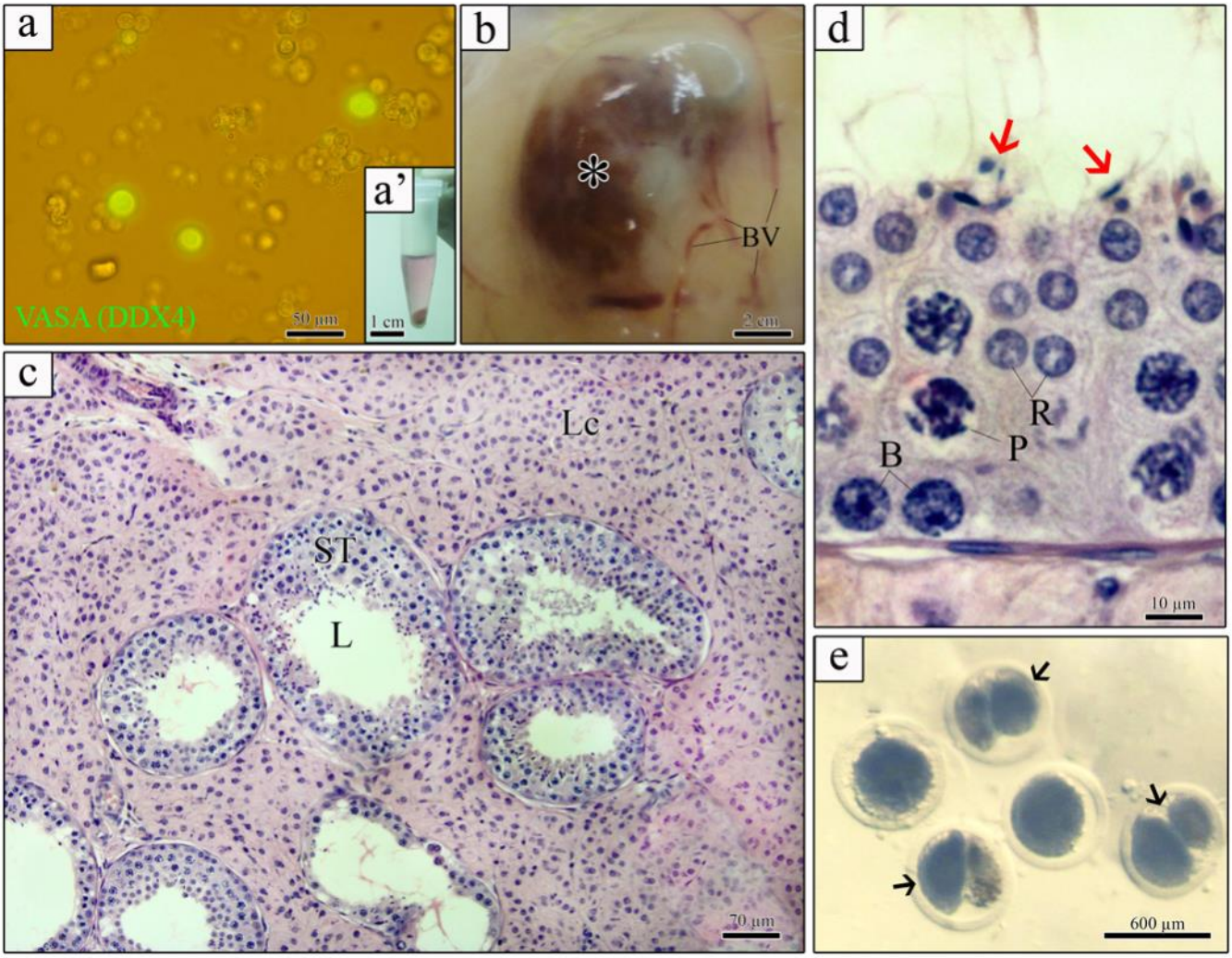

Figure 2 - Testis cell suspension xenograft. **(a)** Testicular parenchyma from a three month old collared peccary was completely dissociated and gonocytes were immunolabeled against VASA (DDX-4, in green), and pellets containing ~50 x10^6 were obtained **(a')** and xenografted under the back skin of immunodeficient mice; **(b)** After grafting, *de novo* testis morphogenesis occurred, health of the grafts was maintained (*), and **(c-d)** full spermatogenesis was observed, with the production of fertile sperm; **(e)** 24 hours after *in vitro* fertilization, this gave rise to diploid two-cells embryos (black arrows). BV = blood vessels; ST = seminiferous tubules; Lc = Leydig cells; L = tubular lumen; B = type B spermatogonia; P = pachytene spermatocyte; R = round spermatids; red arrows = mature spermatids.

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Interspecific association between Collared Peccaries (*Pecari tajacu* Linnaeus, 1758 - Tayassuidae) and Azara's Capuchin (*Sapajus cay* Illiger, 1815 - Cebidae) in the Pantanal, Brazil

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Interspecific associations involving collared peccaries (*Pecari tajacu*) have been previously described in nature, as with wedge-capped Capuchin (*Cebus olivaceous*) in Venezuela (Robinson & Eisenberg, 1985), white-faced Capuchin (*C. capucinus*) in Costa Rica (Rose *et al.*, 2003), and coati (*Nasua nasua*) and howler monkey (*Alouatta caraya*) in the Pantanal (Desbiez *et al.*, 2010). *P. tajacu* occurs from Mexico to northern Argentina, while species within the Cebidae family occur through major parts of Central and South America (Emmons & Feer, 1999). Thus, as their geographic distributions significantly overlap, interspecific interactions likely occur between *P. tajacu* and other capuchin species.

During the course of a transect conducted on April 17, 2013 at 08:31h (2.5 hours after sunrise) in the northern Pantanal of Brazil (17°20' S; 56°41' WGS84), an interaction was observed between a group of four *P. tajacu* and a group of eight Azara's capuchin (*Sapajus cay*). The group of *S. cay* was foraging on the fruits of palm trees (*Attalea phalerata* - Arecaceae) and the group of *P. tajacu* followed, feeding on discarded fruits. The interaction was observed for a total distance of 300 meters and lasted for approximately 20 minutes. The foraging *S. cay* vocalized with each other while the *P. tajacu* browsed for fruits in silence. The authors counted the number of fruits dropped and consumed by *S. cay* at the base of two individual *A. phalerata*. A total of 16 fruits were dropped and one fruit consumed at the first individual tree, and at the second tree 10 fruits were dropped and two fruits consumed.

The observational data presented here provide further evidence of the interspecific association between *P. tajacu* and the primate family Cebidae, as previously described by Robinson and Eisenberg (1985) and Rose *et*

al. (2003). The foraging behavior of these primates is often characterized by the discarding of seeds and fruits (Peres, 1991). This provides *P. tajacu* with a food source at the base of the foraged trees. By presenting an intense vocal behavior (Bitetti, 2005), capuchin monkeys can be easily detected by groups of *P. tajacu*. All species which exhibited an interspecific association with *P. tajacu* (Robinson & Eisenberg, 1985; Rose *et al*., 2003; Desbiez *et al.,* 2010) live in groups and frequently vocalize. Thus, the behavioral data suggest the existence of a learning process in *P. tajacu*, by associating food availability with the vocalization of the species foraging for fruits in the treetops.

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A literature review of ecological separation between *Sus verrucosus* and *S. scrofa*

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Background

Little is known about the ecological separation between two pig taxa endemic to the island of Java in Indonesia: *Sus verrucosus*, the Endangered Javan Warty Pig, and *Sus scrofa vittatus*, the Banded Pig, a subspecies of *S. scrofa*. Lack of knowledge on the ecology of *S. verrucosus* hampers the ex situ management of the species, as well as the planning for its reintroduction. This issue was recently highlighted during a meeting of the Wild Pig Specialist Group in the Cikananga animal rescue center, West Java, which has an ex situ population of *S. verrucosus*. Plans for releasing some of the captive bred animals into a safe area were complicated by the lack of knowledge about what habitats *S. verrucosus* uses, and how it separates ecologically from *S. scrofa*. Because no one has studied the species's ecology in recent times, the present study aims to contribute to this issue by reviewing some of the historic literature.

Methods

I searched the Indoaustralian Mammal Atlas (van Strien, 2001) and the online databases of the Smithsonian Institution National Museum of Natural History and the Field Museum for records of historic collection localities of *S. verrucosus*. I also searched the historic literature for any information about the ecology of wild pigs on Java.

Results

Habitat differentiation

On Java, *S. verrucosus* is sympatric with the Indonesian wild pig or 'banded pig, *S. scrofa vittatus*, the latter also occurring on Sumatra. Olivier (1925) mentioned that, in West Java, *S. verrucosus* and *S. scrofa* were both common, and that they occurred in similar habitats from coastal to montane forests, though van Balen (1914) stated that *S. verrucosus* occurred only in lower areas. There is at least one apparently reliable record of *S. verrucosus* from an altitude of 1,500 m a.s.l., and its restriction to lower altitudes needs to be re-evaluated.

Jentink (1891) differentiates between the two pig species on Java and says of *S. verrucosus* (Figure 1) that it is generally less frequent than *S. scrofa*, and prefers "the high *alang-alang* (*Imperata cylindrica*), in thick grown dales and other distant wild localities in the lower parts of the mountains, and seldom is to be met with in troops but generally alone or two or three together." He further states that the nature of *S. verrucosus* is wilder and more courageous than *S. scrofa*, and that the strong canines of the former are very dangerous to dogs. *S. verrucosus* causes significant damage to plantations and "therefore the natives pursue and destroy it where they can." (Jentink 1891). According to Jentink, *S. scrofa* instead prefers high and thick growing *alang-alang* grassland, hence its name in West Java of *Babi alang-alang* (i.e. grassland pig). *S. scrofa* ranges up to about 1,700 m, and its habitat seems broadly similar to *S. verrucosus*: "large plains grown with *alang-alang* , wild dales overgrown with trees, shrubs and briers, low mountains thickly covered with wood and bamboos, and dark moist regions, along the foot of the high mountains, covered with wildernesses impenetrable to man; the moist and cool teakwoods in low countries too are to its taste." (Jentink, 1891).

Figure 1. Adult male S. verrucosus showing warts (Olivier 1928).

Jentink was a Dutch zoologist based in Leiden and his insights into pig ecology on Java borrowed heavily from other zoologists. Among others, he may have referred to Junghuhn (1850-1854), although the latter wrote that *S. verrucosus* usually inhabits extensive *alang-alang* fields with small forest scattered about them, and *S. vittatus* (= scrofa) the primary forest, i.e., more or less the opposite of what Jentink stated. Olivier (1925), who himself worked extensively in the Banten, Batavia, Cirebon, and Preanger Districts of West Java, considered the two pig species equally common in these areas, and both occurred from sea level to high up the mountains. The species were, however, often mutually exclusive. Some areas, primarily had *S. verrucosus*, whereas in other areas *S. scrofa* dominated. Olivier noted that *S. scrofa* had adapted better to human-influenced landscapes, whereas *S. verrucosus* tended to seek out areas with fewer people and less ecological disturbance. According to Olivier's data, *S. verrucosus* dominated in the largest forest complexes, such as those then found in Kerawang-Indramayu, the coastal forest of the Batavia (=Jakarta) District – now all gone - the forests on the northern slopes separating the Priangan region from Kerawang, and the then largely undisturbed forests of south Banten. *S. scrofa* dominated in other areas. Only in the area between Cikampek and Purwakarta, in which teak forests alternated with extensive areas of agriculture (wet rice), did the two species seem to co-occur (Olivier, 1925). Olivier (1928) wrote an extensive treatise on the ecology of *Sus* on Java, but he intentionally did not differentiate between the two species and thus, for the present purpose of understanding ecological separation between *S. verrucosus* and *S. scrofa*, those analyses are not very useful. In a later publication he commented on the difficulty of reliably differentiating between

the two species, especially the females and young, but he maintained that their mutual exclusion in more areas was confirmed (Olivier, 1933).

A few years following Olivier's publication, Franck (1936) noted that in most of Java, *S. scrofa* now outnumbered *S. verrucosus*. He noted that the two species were not that well separated geographically and often co-occurred in the same area. He had once caught both species during the same drive hunt. Although Franck thought that normally groups of the species did not mingle, he had seen them in one group at least twice, both on Java's north and south coasts. On those occasions, *S. verrucosus* would be in the minority, with only 1 or 2 animals present in a larger group of *S. scrofa* (as indicated by the presence of snout bands). The animal in Figure 2, which Franck identified as *S. verrucosus*, was shot in the "Tjemara" coconut plantation, "on Java's south coast along the Sunda Strait", an area in which *S. scrofa* predominated. This record is of interest, because it is from the area in which potential releases of *S. verrucosus* are considered, and also because it is apparently one of the largest *S. verrucosus* specimens on record. Franck measured its length (along the back) at 188.9 cm, dressed weight at 103 kg. There are, however, greater recorded weights of 100 kg and 124 kg, whereas the subspecies from Madura - now thought extinct - was thought to weigh between 70 and 80 kg (Sody, 1942). Interestingly, Sody (1942) quoted several hunters from Madura who had never seen *S. scrofa* on the island, and only found *S. verrucosus*.

Figure 2. Photo of S. verrucosus killed on Java's further south or west coast (after Franck 1936).

In his book "Udjung Kulon. The land of the last Javan rhinoceros" (Hoogerwerf, 1970), the author writes that there are scarcely any indications that *S. verrucosus* differs ecologically from *S. scrofa*, but "investigations on this point are far from complete and hardly permit of an opinion." He refers to Bartels (1940, 1942), who was very familiar with the differences between the species, as he shot 40 *S. scrofa* and 23 *S. verrucosus* within a few years' time in the vicinity of Hunibèra (South Bantam) in probably the same biotope. Hoogerwerf (1970) noted that "the remarkable feature of this was that not a single sign of cross-breeding was found." Elsewhere in his book, Hoogerwerf (1970, p 343) wrote that "there proved to be no apparent ecological differences [between *S. verrucosus* and *S. scrofa*], although it is very probable that these do exist; for instance, a *verrucosus* was once observed in a wallow by a dried-up swamp where a small band of *Sus scrofa* was foraging, and both species were repeatedly encountered during the same day without it being possible to establish any difference in habitat, although they were never seen associating."

A final historic record comes from the Rembang District, situated on the northeast coast of Central Java Province (Rakoen, 1952). This area of poor soils and pronounced seasonality was poorly suited for agriculture, and forest plantations were considered better land use. In this area, *S. verrucosus* was still common in the 1950s and together with different monkey species caused significant damage to agricultural crops that had expanded during and after the Second World War Frequent, illegal burning of forest undergrowth had reduced cover for the many leopards (*Panthera pardus*) in the area after which pig and monkey populations had exploded, resulting in much crop damage.

One extra-limital record of *S.verrucosus* was recorded by Sody (1941a), who quoted from a publication by Mertens (Abhandlungen Senckenb. Naturf. Ges., XLII, 1930, p. 130) in which the author says that he saw pigs

on the island of Lombok (east of Bali) which could only be *S. verrucosus*. No other such reports have been recorded from Lombok or Bali, but if true it might indicate that either *S. verrucosus* or *S. celebensis*, which looks somewhat similar, had been introduced to Lombok.

Tables 1 and 2 summarize some historic records of *S. verrucosus* from museum specimens and recorded hunting kills, which generally confirm that the species occurred across the island of Java (as well as the islands of Madura and Bawean).

Table 1. Specimen localities of *S. verrucosus* as compiled by van Strien (2001).

Locality	Specimen number	Latitude	Longitude	Alt. (m)	Source
Banten	USNM 155342	106.15	-6.13		(Schwarz, 1940)
South Banten	KLHB	na	na		(Olivier, 1925)
Binuangeun	USNM 156494	105.86	-6.13		(Schwarz, 1940)
Blencong riv, E of	KLHB	106.95	-6.10		(Olivier, 1925)
Cikampek	KLHB	107.56	-7.53		(Olivier, 1925)
Cikao	RMNH 13509	107.51	-6.71		(van Strien, 2001)
Cilacap	BMNH	109.00	-7.22		(Thomas & Wroughton, 1909)
Cilacap	BMNH 9.1.5.827/9,31	109.00	-7.22		(Lydekker, 1915)
Kalipucang	BMNH 9.1.5.832,3	na	na		(Lydekker, 1915)
Krawang-Indramaju	KLHB	na	na		(Olivier, 1925)
Krawang-Preanger border	KLHB	na	na		(Olivier, 1925)
Ngawun, N of	MZB 012	111.80	-7.03		(Blouch & Groves, 1990)
Pangandaran	BMNH	108.65	-7.68		(Thomas & Wroughton, 1909)
Parang	RMNH	111.32	-7.75		(Jentink, 1891)
Parigi Bay	BMNH 9.1.5.814/21	108.58	-7.70		(Lydekker, 1915)
Rancasuni Estate	KLBH	107.33	-7.13	1500	(van Strien, 2001)
Sumberjambe	KLBH	113.88	-8.07	700	(Blouch & Groves, 1990)
Sumenep, Madura	MZB 8390	113.90	-6.94	100	(Sody, 1941b)
Tasikmalaya	BMNH	108.20	-7.33		(Thomas & Wroughton, 1909)

Behavioural observations

As noted by Jentink (1891), *S. verrucosus* was often considered the more aggressive of the two species. Olivier (1925) assumed that *S. scrofa* had adapted better to the presence of people, and was more likely to keep out of the way of people. His data however did not support the suggestion that *S. verrucosus* was the more aggressive of the two. There are countless reports from the colonial-era newspaper in the Dutch Indies that refer to attacks by pigs on people, sometimes unprovoked, sometimes during hunts. None of these reports, however, differentiate between the two species of Javan pig, and thus do not provide much insight into any possible differences in behaviour.

Sody (1941c) provided useful information on breeding behaviour in *S. verrucosus* (Table 2), which indicates that the mating season for *S. verrucosus* runs from approximately July to December, i.e., the dry season and the run up to the wet season. Most births appear to be between December and June, i.e., during the wet season on Java. Litter sizes at birth seem to vary between 2 to 6, but most litters appear to consist of either 4 or 5 young.

Table 2. Historic localities and information about litter size and breeding seasonality (after Sody 1941c, 1942)**.**

Locality	Latitude	Longi-tude	Number of young	Breeding season/mating season/Month of birth
Kali Asin	107.16	-6.04	3 embryos	Estimated month of birth May or June
Kencong, Jember	113.37	-8.28	8 embryos	Estimated month of birth early December
Batoe (Batu)	112.53	-7.87	nest of 5 young animals	Mating season July, August, December, January
Cisaat (Purwakarta)	107.39	-6.86	6 embryos	Estimated month of birth March; Teats slightly tight, some milk production
Tarikkolot	106.72	-6.67	5 embryos	3 teats of female enlarged, no milk
Tarikkolot	106.72	-6.67		Observed mating in July during full moon
Tarikkolot	106.72	-6.67		Observed mating in August
Tarikkolot	106.72	-6.67	nest of 5 young animals	Nest found on December 14th
Tarikkolot	106.72	-6.67		Observed mating on September 22nd
Tarikkolot	106.72	-6.67		Pregnant female shot on October 4th
Tarikkolot	106.72	-6.67	nest with young	Young about 1 week old, estimated birth in December
Tarikkolot	106.72	-6.67	nest with young	Young about 3 weeks old, estimated birth in December
Geneng (Madiun)	111.41	-7.48	juveniles of 3 months old	Observed in late February
Asembagus (Situbundo)	114.21	-7.75	nest of 5 young animals	Observed on January 7, estimated birth in December
Tjiampel (Tegalwaru)	107.37	-6.43	2 young killed	Young about 3-4 days old, estimated birth in April
Dukuhwringin (Tegal)	109.13	-7.00	5 embryos	shot in February, estimated birth in March
Dukuhwringin (Tegal)	109.13	-7.00	4 embryos	shot in February, estimated birth in March
Madura	112.83	-7.03	6 embryos	shot on February 28th, estimated birth in June/ July
Captive birth in Surabaya Zoo			2 young	Born on February 25th. Mother possibly ate some of the young
Djoengke (East of Sumenep, Madura)	na	na	6 embryos	

Morphological notes

Olivier (1933) notes several apparent characteristics that differ between *S. verrucosus* and *S. scrofa* such as the absence of a clear diastema between the upper canines and first molar in the former species, the reported absence of striping in *S. verrucosus* piglets, and the convex rather than concave shape of the inner surface of the canines. Neither characteristic is, however, absolute, and intermediate conditions do occur (Olivier, 1933). Overall colour is not a clear characteristic for differentiating between the species, because this can be influenced by external factors, although Olivier (1933) notes that whereas *S. scrofa* is homogenously coloured black or blackish, *S. verrucosus* has more colour contrast, with blackish legs and lower body, and a more reddish head, neck and back, and no whitish snout band, which characterizes *S. scrofa vittatus* (but see Fig. 3). Olivier noted that he had come across 5 pigs from one unspecified area that shared characteristics of both species. They had two set of warts rather than the usual three (those on the lower jaw were missing) and a white snout band, suggesting hybridization between *S. verrucosus* and *S. scrofa*.

Finally, Sody (1939), who was interested in and published widely on the differences among Javan pigs, compiled information about how hunters on Java differentiate between what they consider distinct races of pig: Widjoeng, Widjoeng-kembang, Gonteng, Wraha, Srengi, Gambjang, Dommas, Rogo, and Roho-Brintik. He repeats the morphological characteristics that typify each of these types, but does not consider them taxonomically distinct.

Figure 3. A photo of *S. scrofa* from the area near present-day Bogor, which according to Olivier (1925) indicates hybridization with *S. verrucosus*, because of the absence of the white snout band, characteristic for *S. scrofa vittatus*.

Comments about Pulau Panaitan

One of the potential release sites for captive bred *S. verrucosus* is Pulau Panaitan, an island that is part of Ujung Kulon National Park. Hoogerwerf (1952) describes this island and its flora and fauna in detail. About 50% of the island is hilly, with lowland areas turning swampy during the rainy season. He noticed the primary state of the forest when he visited the island in October 1951. 65% of the island was covered in tall, seemingly undisturbed forest, dominated by very large trees. Judging the recent Google Earth image of the area (Fig. 4) the area still seems largely covered in tall forest.

According to Hoogerwerf many of the tree species on Pulau Panaitan were deciduous, which may indicate that adverse ecological conditions occurred during the dry season that prohibited the development of evergreen rainforest. Water stress during the dry season may be a reason for this. Hoogerwerf noticed that only in a few places along the coast there appeared to be permanent water throughout the year, and many of the forests in the higher areas would be very dry in the dry season. This may impact the suitability of the island as a release site for *S. verrucosus*. Interestingly though, Hoogerwerf commented on the very rich and abundant mammal fauna that he encountered during his trip, including many pigs (*S. scrofa*), barking deer (*Muntiacus muntjak*), and mousedeer (*Tragulus javanicus*). He saw these species almost every day, including one day one where he saw 12 barking deer, 15 mousedeer and 7 boars. He frequently saw pigs in groups of 5 to 10 animals. He further commented that "many juvenile specimens observed and on one occasion very young ones which were less than 2 months old and had not yet lost their stripes."

Figure 4. Recent Google Earth view of Pulau Panaitan, and the adjacent West Javan mainland, including the Peninsular part of Ujung Kulon National Park.

Discussion

During the recent WPSG meeting (19-21 November 2013) questions were raised about the ecological suitability of potential release sites for *S. verrucosus*. The conclusion was that without adequate knowledge of the ecological requirements of the species it would not be possible to determine which sites would potentially be able to harbour viable populations. The present review seems to indicate that both *S. verrucosus* and *S. scrofa* are ecologically very versatile. They naturally occurred in most parts of Java, from the dry and very seasonal east to the nearly permanently wet west, and from coastal swamps and beach forests to mixed agricultural and silvicultural areas, and extensive forest areas on higher hills and mountains. Overall, the main factor determining the distribution and density of both species seems to be disturbance and hunting by people, and maybe, to a lesser extent, predation by Javan leopard (although only rarely. See van der Vegte, 1938) and tiger. Such insights should help determine which potential release sites are most suitable for repopulation by *S. verrucosus*. The present data indicate that avoiding conflict and killing by people would play a more important role in site selection than ecological considerations, assuming that basic ecological conditions such as year-round water and natural or semi-natural vegetation cover are met.

Pulau Panaitan seems to have many characteristics that would make it a potentially suitable site to release *S. verrucosus*. It has abundant forest resources, and ecological variation (hills, lowland areas, swamps, clearings, mangroves on the eastern shores) that indicates that food availability varies both spatially and temporally throughout the year. Fresh water appears to be available throughout the year – albeit locally limited during the dry season. The abundance of pigs and deer (not grazing deer of the genus *Cervus* but browsing and fruit-eating deer) indicates that the area used to be ecologically suitable to sustain forest species like *S. verrucosus*. Interestingly, this appears to be in conflict with a brief study by Dr. Gono Semiadi who visited the island in 2005 and found it be largely devoid of wildlife and probably unsuitable for *S. verrucosus* releas (Semiadi, pers. comm.). It is unclear what causes the significant discrepancy in opinions. Maybe there is significant resource fluctuation on the island causing major population changes. One good thing is that the large island (20 km long) is uninhabited by people so conflicts with pigs should not be a problem, although the area is visited by tourists so some care needs to be taken.

Blouch (1983, 1988) did not survey the island of Madura during his surveys in the 1980s and neither did Semiadi and Meijaard (2006), as all assumed that no suitable habitat remained that could possibly harbour *S. verrucosus*. Considering that historically only *S. verrucosus* was recorded on the island, it might be useful to conduct a quick survey, especially in the east of the island near Sumenep to check whether there are indeed no more records of this possibly extinct subspecies.

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Reintrodução do macho reprodutor ao grupo de origem em *Pecari tajacu*: consequências da discriminação individual para o manejo de grupos em cativeiro

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1. Introdução I

Discriminação e reconhecimento individual envolvem sinais de comunicação entre os indivíduos que são detectados por sistemas sensoriais que os permitem diferenciar seus coespecíficos em função de suas classes sexuais e etárias, seu status reprodutivo e sua familiaridade (Johnston & Delbraco-Trillo, 2009).

Um efeito especialmente importante do reconhecimento interindividual é o direcionamento de agressões intensas contra indivíduos estranhos recém-introduzidos em grupos mantidos em cativeiro (Thompson, 1993). O início e a manutenção da agressividade entre suínos estão relacionados com a habilidade de distinguir indivíduos próximos ou parentes (Puppe, 1998; Stookey & Gonyou, 1998). Os registros de agressão significativa e de infanticídio entre caititus (*Pecari tajacu*) cativos têm sido atribuídos à inclusão de animais estranhos em grupos já estabelecidos (Lochmiller & Grant, 1982; Packard *et al*, 1990; 1991). Para garantir a troca de material genético e evitar os efeitos deletérios da endogamia entre indivíduos mantidos no cativeiro, a introdução de novos animais é altamente recomendada (Nogueira-Filho *et al.,* 1999; Kleiman *et al*, 2009).

Grupos formados por animais familiarizados podem manter relações estáveis por toda a vida de acordo com o estabelecido nos encontros iniciais, entretanto, quando dois indivíduos se encontram, após um período de separação, suas relações podem ser idênticas àquelas estabelecidas inicialmente ou podem depender, por exemplo, das características fenotípicas de cada animal no momento do reencontro (Taillon & Côté, 2006).

2. Material E Métodos

O criatório científico de caititus (IBAMA 1501.5219/2011-PA) está localizado dentro da Embrapa Amazônia Oriental em Belém (01°24'S;48°20'W), Pará, Brasil. As matrizes são provenientes da natureza, oriundas de capturas realizadas na rodovia Transamazônica, no Pará e no município de Mossoró, Rio Grande do Norte entre os anos de 1999 e 2000, respectivamente, o restante do plantel é formado pelos animais nascidos em cativeiro.

Os recintos são de alvenaria, medindo 36m^2, cercados parcialmente por arame galvanizado contendo um bebedouro e um tanque com água (Fig. 1). Para evitar disputas por comida os comedouros foram removidos

e o alimento é colocado livremente na parte anterior da baia. A água fica sempre disponível. As condições de temperatura, umidade e ciclo claro-escuro são naturais, considerando que as baias são parcialmente cobertas.

Os indivíduos são mantidos em seus grupos de origem formados pelo macho reprodutor e uma ou duas fêmeas reprodutoras acompanhados pela sua descendência. Fêmeas prenhas não são isoladas e os partos acontecem naturalmente dentro da baia coletiva. A maioria dos procedimentos médicos, sanitários e de pesquisa é realizado na baia, porém, em casos extremos os indivíduos são capturados, removidos e isolados do grupo, o que aconteceu com o macho reprodutor M121 (código alfanumérico identificando o sexo e o número do brinco auricular) que teve uma inflamação ocular com recorrência. O prazo de isolamento do animal foi de cinco meses até que em seis de maio de 2013, ele foi reintroduzido em seu grupo de origem, do qual foi fundador.

Após a reintrodução duas observadoras, além dos tratadores, passaram a monitorar o grupo durante duas horas, cinco dias por semana, através de observações *ad libitum*. Nos finais de semana os tratadores monitoravam a baia e a equipe, uma bióloga, duas veterinárias e duas alunas de zootecnia ficavam de prontidão para eventuais necessidades. O animal seria retirado do grupo em caso de agressões físicas contínuas, apatia ou perda de peso significativa.

3. Resultados

No momento da reintrodução o grupo era formado por oito animais: duas fêmeas adultas reprodutoras (> 10 anos) e seis machos com idades variando de 1 a 8 anos. Imediatamente após a reintrodução os indivíduos eriçaram suas crinas e aproximaram-se de M121 que, também com os pelos eriçados, emitia um som oco acompanhado de batidas rápidas de dentes (descrito como “tooth clack” por Byers & Bekoff, 1981). A glândula de odor intumesceu e a secreção glandular esbranquiçada escorria por seus pelos caindo no chão. Mesmo com o aumento do porte, em decorrência do ganho de peso que passou de 20 para 25 quilos, seu filho primogênito M208 passou a enfrentá-lo e os dois iniciaram uma briga. Com as bochechas feridas M121 foi procurar abrigo no tanque sob vigilância de M208 que permanecia por perto. Os demais indivíduos faziam suas atividades normalmente. Na semana seguinte o macho foi examinado para avaliação do estado de saúde e tratamento desses ferimentos dentro da própria baia.

Durante os 22 dias após a reintrodução, M121 permanecia a maior parte do tempo no fundo da baia, muitas vezes dentro do tanque com água. Nesse período os alimentos passaram a ser colocados também nessa área. Quando algum indivíduo se aproximava tentando cheirá-lo ele iniciava o “tooth clack”, especialmente, quando M208 investia contra ele, mesmo sem agredi-lo fisicamente, o que raramente acontecia. A partir do dia 28 de maio M121 subiu para a parte mais alta da baia, onde os outros animais se concentram, porém, continuava evitando o contato através do “tooth clack”, mesmo quando eram os jovens e as fêmeas que se aproximavam. Algumas vezes ele preferia descer se afastando de todos. Paulatinamente, M121 começou a ficar mais tempo nessa área e até adormecia. No início de julho o macho já ficava deitado próximo aos outros indivíduos, sem “tooth clack”, e já se alimentava junto com eles, porém, aparentemente, em quantidade menor do que os outros animais. O “tooth clack” só era observado quando os animais tocavam em M121, cheirando-o, por exemplo. Apesar da perda de peso, os resultados observados mostravam que o processo de reintrodução poderia ter êxito e decidimos manter o animal no grupo.
No início de setembro, pela primeira vez, foi visualizada uma tentativa de esfregação de um outro indivíduo em M121 que não correspondeu a essa iniciativa. Ele não se afastou mas deitou interrompendo a interação. Na manhã do dia 23 de setembro, M121 foi encontrado morto na baia. Observações externas não identificaram nenhuma marca de agressão.

4. Conclusões

Caititus (*P. tajacu*) cativos possuem algum tipo de reconhecimento individual que pode ser modificado, mesmo entre indivíduos aparentados geneticamente e mantidos juntos por longos períodos de tempo, quando remoções temporárias são realizadas.

Fatores sociais, estímulos indutores de medo e situações novas podem ter colocado o animal em um estado de estresse, comprometendo a ingestão de alimento ou água levando a um quadro de morte súbita por desnutrição ou desidratação. Além disso, em alguns grupos sociais existe uma ordem de prioridade de acesso ao alimento, o que pode ter prejudicado a ingestão adequada de nutrientes pelo macho reintroduzido apesar do aumento de alimento na baia durante todo o período de monitoramento.

As práticas de manejo precisam obrigatoriamente considerar o tipo de estrutura social das espécies mantidas em cativeiro, bem como sua tolerância a novos indivíduos e a remoções temporárias, para garantir a produção satisfatória e o bem-estar dos animais.

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Are white-lipped peccaries back in the Paranapiacaba Forest, São Paulo, Brazil?

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Large mammals need large areas for their survival, have a low reproductive rate and are heavily affected by poaching. Consequently, they are the first species to disappear in response to human presence (Morrison et al., 2007). White-lipped peccaries (*Tayassu pecari*) have disappeared from 20% of their historical distribution during the twentieth century (Altrichter et al., 2012); most of this reduction occurred in the margins of the geographical distribution of the species. In most of the Atlantic forest, located in the eastern border of this distribution, the species has a low probability of survival because it is mostly represented by small, fragmented populations (Altrichter et al., 2012). In the Brazilian Atlantic forest, the species was categorized as Critically Endangered (CR), according to IUCN criteria, because none of the populations of white-lipped peccaries in this biome was considered to be free from the risk of becoming extinct in a time interval of less than three generations (18 years), and all of them have been declining continuously in number of individuals, geographical distribution parameters and habitat quality (Keuroghlian et al., 2012a, b). The exceptions are the populations of the Ilha do Cardoso State Park (Bernardo, 2004; Nakano-Oliveira, 2006; Hortenci, 2012) and of the northern portion of the Serra do Mar State Park (Marques, 2004; Nobre, 2007; Rocha-Mendes, 2010; Norris et al., 2011), both in São Paulo state, which are reported to be abundant and do not appear to be threatened by extinction in the next three generations.

White-lipped peccaries are very susceptible to sudden local extinctions. In the Atlantic forest, the species has recently disappeared from three large remnants which contained healthy populations: Iguaçu National Park, Paraná State (Azevedo & Conforti, 2008), Turvo State Park, Rio Grande do Sul State (Kasper et al., 2007) and Morro do Diabo State Park, São Paulo State (Cullen Jr. et al., 2001; J.M. Aragão pers. comm. in Keuroghlian et al., 2012a). In Iguaçu National Park, the population was already declining during the period of 1990-1995 (Crawshaw Jr., 1995), and it completely disappeared sometime between 1997 and 2000 (Azevedo & Conforti, 2008). In Turvo State Park, white-lipped peccaries were seen until the 1980's (Wallauer & Albuquerque, 1986, Kasper et al., 2007), but the species was completely absent during the study of Kasper et al. (2007). In Morro do Diabo State Park, the population density of white-lipped peccaries was 6.94 ind./km^2 in 1995-1996 (Cullen Jr. et al., 2001), but there were no records of the species by 2010, when there was a Brazilian assessment of white-lipped peccary conservation status (J.M. Aragão, pers. comm., in Keuroghlian et al., 2012a). Poaching is considered the main cause of the disappearance of the species in these three areas (Cullen Jr. et al., 2001; Kasper et al., 2007; Azevedo & Conforti, 2008).

The Paranapiacaba forest remnant, in the South of São Paulo State, consists of more than 2,000 km^2 of continuous forest across both public and protected areas. It represents one of the largest Atlantic forest remnants. Currently, the forest includes five public conservation units with full protection: the State Parks of Carlos Botelho (PECB), Intervales (PEI), Turístico do Alto Ribeira (PETAR), Nascentes do Paranapanema (PENAP, recently created) and Xitué Ecological Station (EEcX). The Paranapiacaba forest remnant was considered one of the Peccary Conservation Units (PCU) by Taber et al. (2007) and potentially highly suitable in a species distribution model (Jorge et al., 2013). PCUs are sites where the species should be in a better conservation situation than in the rest of its distribution, and where populations of white-lipped peccaries are considered

"stable".

Despite this classification, most of the records of white-lipped peccaries in the Paranapiacaba remnant are old. At the PECB, white-lipped peccaries were recorded only sporadically in the last two decades (one sighting on April 30, 1997, Beisiegel, 2006; one sighting in 1999, P.P. Soares, pers. comm., and one sighting on June 9, 2006, at coordinates 24° 11' 27'' S, 47° 55' 33'' W, A.Z. Antunes, pers. comm.). The last herd was composed of six or seven individuals, of which three were clearly observed while crossing the road SP 139, with the remaining individuals spotted inside the forest. In two research projects conducted at PECB, which used extensive camera-trapping from 2006 to 2012 with a sampling effort of 9,318 camera-trap days, the species was never recorded (B.M. Beisiegel unpublished data). At PEI, the presence of the species is cited by Vivo and Gregorin (2001), but it is based on research conducted in the 1980's and 1990's, without reference to the source of data, in a list which includes both primary and interview data. The species was not recorded in the Park in a study including 3,352 camera-trap days in 2010 and 2011 (B.M. Beisiegel unpublished data), and only one sighting of the species was reported in 2011 (L.A. Soares pers. comm.). Experienced members of PEI staff report that the species has disappeared from the area due to overhunting. At PETAR, the occurrence of the species is cited by Allegrini (1997). However, this is based on interview data and the species was not recorded during inventories conducted for the Management Plan of the area (2009 and 2010), although a sighting of a herd in the beginning of 2010 was reported by an experienced member of the staff (A. Modesto pers. comm.). Brocardo et al. (2012) considered that this species was extinct in the Paranapiacaba remnant, based, however, on limited sample effort (ca. 600 km of census and less than 800 camera-trap days).

Data from studies in the Amazon indicate that the recolonization period of an area by white-lipped peccaries after their local extinction may be more than 15 years (Fragoso, 2004). However, according to Keuroghlian et al. (2012a), this long time span occurs only in areas which are contiguous with areas with source populations. The protected areas close to the Paranapiacaba forest, where white-lipped peccaries are present, are Cunha and Santa Virgínia, at the north of Serra do Mar State Park (Marques, 2004; Nobre, 2007; Rocha-Mendes, 2010), Juréia-Itatins Ecological Station (Pardini & Develey, 2004; R. Martins pers. comm., 2012) and Ilha do Cardoso State Park (Bernardo, 2004; Nakano-Oliveira, 2006; Nakano-Oliveira, unpublished data; Hortenci, 2012), all of them separated from the Paranapiacaba remnant by highways with heavy traffic and large urban areas.

This note presents the recent records (2011 - 2013) of white-lipped peccaries which we obtained at PECB and PETAR. At PECB, many tracks of the species were found in October and November 2012 and January 2013. Two camera-trap pictures, with three or four animals, were obtained on March 28, 2013 (Fig. 1), and one picture with two individuals was obtained on April 5, 2013 (Fig. 2). These records were all located in an area delimited approximately by the coordinates 24°05'36'' S 47°56'15'' W, 24°04'21'' S 47°55'28'' W, 24°02'54'' S 47°57'11'' W and 24°04'29'' S 47°57'02'' W (datum WGS 84), which comprises long stretches of a creek and its tributaries, covered by well-preserved, dense ombrophilous montane forest and dense ombrophilous alluvial forest (Souza *et al.*, 2006), and long stretches of the two internal roads of PECB. In January 2013, the tracks were found on a road with many fruiting *indaiás* (*Attalea dubia*), and fruits on the ground showed signs of consumption by white-lipped peccaries. At PETAR, data was collected during research conducted in 2011, using ten camera-trap stations for three months, totaling 940 camera-trap days. Three pictures of white-lipped peccaries were obtained on August 12 (two animals), September 10, (one animal), and September 21, (three animals) (Figs. 3-6), at coordinates 24°25'90'' S 48°35'22'' W, 24°25'70'' S 48°32'40'' W and 24°21'20'' S 48°30'21'' W (datum WGS 84), in an area of secondary-growth vegetation in initial to intermediate stages of regeneration. Although there are still only a few recent records of the species in the Paranapiacaba forest remnant, and they are concentrated in space and time, these records are in strong contrast with the sporadic nature of the records of white-lipped peccaries in the region in the last two decades.

White-lipped peccaries are considered Neotropical forest architects (Taber *et al.*, 2007) because they have a deep influence on the recruitment of seedlings and saplings. They are also one of the main prey species of

jaguars, *Panthera onca* (Oliveira, 1994), and the Paranapiacaba remnant is one of the last areas in the Atlantic forest to harbor considerable numbers of jaguars (Beisiegel *et al.*, 2012). Thus, the potential recovery of the white-lipped peccary population in the Paranapiacaba forest is relevant not only for its own conservation, but also for the conservation of other species and of the structure of the entire forest. Taber *et al.* (2007) describe the occurrence of poaching in the Paranapiacaba remnant as "some" and the occurrence of timber and non-timber illegal harvest as "inexistent". However, this situation does not describe the present conditions in this forest. The Florestal Foundation, which is the State institution responsible for the management of the public conservation units of the Paranapiacaba remnant, has been relegating the enforcement of the Parks to a secondary role, with a drastic reduction in the number of people responsible for law enforcement and in the number and quality of vehicles used for this purpose. As a result, illegal palm (*Euterpe edulis*) harvest as well as signs and reports of poaching have been increasing year after year across the entire area, with the exception of very small areas in the immediate vicinity of the Park's headquarters. Unless this situation is not quickly amended with heavy investments in the enforcement of the protected areas, it is very probable that the recovery of the white-lipped peccary population in the area, as well as the ecological consequences of this recovery, cannot happen.

Figure 1. White-lipped peccaries at Carlos Botelho state Park on March 28, 2013, 4:21 PM

Figure 2. White-lipped peccaries at Carlos Botelho state Park on April 4, 2013, 3:27 PM.

Figure 3. White-lipped peccaries at PETAR on August 12, 2011, 3:32 PM

Figure 4. White-lipped peccaries at PETAR on September 10, 2011, 4:57 PM.

Figure 5. White-lipped peccaries at PETAR on September 21, 2011, 2:12 PM.

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Trade in Babirusa skulls on Bali in 2013

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Babirusas (lit: pig-deer in Indonesian) are endemic to the islands of Sulawesi (*Babyrousa celebensis*), Togean (*B. togeanensis*) and Sula and Buru (*B. babyrussa*). The males are easily recognizable by their elaborate tusks (with both the upper an lower canines growing upwards and curving back to the top of the head). All three species of babirusa are considered globally threatened, largely as a result of loss of habitat, hunting and commercial trade for their meat (Milner-Guland & Clayton, 2002). Babirusas are protected under Indonesian law. Trade in protected species, in whole or in parts, is prohibited, and offenders are liable for fines of up to IDR 100 000 000 (USD 10 000) as well as an imprisonment for up to five years. In 1982, Babirusas were added to Appendix I of the Convention on International Trade in Endangered Species of Fauna and Flora (CITES) precluding all international trade, although a decade later, MacDonald (1993) did not consider international trade in the species to be significant. Indonesia is a Party to CITES since 1978.

In June 2013 we made a brief visit to Bali to assess levels of wildlife trade for medicinal and decorative purposes (Nijman & Nekaris, in press) and observed a small number of babirusa skulls in trade. We here communicate our findings primarily as a forewarning for a potential increase in international trade in these species.

Bali is known to many as a holiday paradise, and in 2012 three million international tourists visited the island, in addition to over six million domestic visitors (Admojo, 2013). In many of the towns on the southern part of

the island so-called *barang antik* shops sell animal products for decorative purposes, and animal products can be bought in specialized shops and in distinct sections of wildlife markets. Apart from the latter, these shops cater (especially) for tourists and expats residing on Bali.

In the town of Ubud we observed a single male babirusa skull in a barang antik shop, and in the village of Tampaksiring, we observed two shops selling a total of one female and three male skulls. Finally in the Satria animal market in the capital Denpasar, we observed one female and two male skulls in a single shop. The owner of the latter shop informed us that he additionally acted as a supplier for the barang antik shops. We were not able to identify these skulls to the species-level. The trade is fully open and there is no need to resort to undercover techniques. Prior to our survey, babirusa skulls have been found for sale in souvenir shops in Rantepao, South Sulawesi (Melisch, 1993) and in large department stores in Indonesia's capital Jakarta (MacDonald, 1993), but it seems that trade in babirusa skulls in Bali is a new development.

We did visit only a twenty or so barang antik shops and specialized wildlife shops but it would be worthwhile to conduct a more thorough assessment of the levels of trade in Babirusa skulls on Bali, to identify the species involved and the trade routes used, and to quantify to what extent the trade in these skulls is to supply the international market. Given the large numbers of shops catering for tourists, Tampaksiring, Ubud and Kuta/ Legian are prime localities to survey.

Babirusa skulls for sale in Tampaksiring, Bali, Indonesia in June 2013.

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The Invisible Animal: Kibale National Park's Giant Forest Hogs in Danger of Extinction

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Kibale National Park (hereafter KNP) is famous for its rich biodiversity, particularly the high primate diversities and densities (Chapman *et al*, 2005), although other mammal species such as the wild suids are also present. Two species of suids inhabit KNP, the bush pig (*Potamochoerus larvatus)* and the giant forest hog (*Hylochoerus meinertzhageni*). The giant forest hog is the largest of all the wild pig species in the world, weighing up to 275 kg (Kingdon, 1997; d'Huart & Klingel, 2008). We have spent almost two years in KNP searching for the forest hogs, but we were lucky to see them only four times, especially when it was raining. Rain probably helped conceal our smell, as they always sense us and run away. Even though giant forest hogs are very hard to see, tracking them is relatively easy, because they leave obvious and typical marks on the vegetation while browsing and also have communal latrines where they pile dung in close proximity to their nest site. In fact, the first day the first author went to the field to follow hogs, he thought he was discovering a mountain gorilla in KNP as they feed almost in a similar manner. Because of their rarity and the dense vegetation in which they roam, most people are unaware of this species and this is why we have considered calling it the 'invisible animal'. When the first author tells colleagues that he studies the giant forest hog, he is usually asked where this species can be found. Their sense of smell is so good that they can sense you at a distance of 100 m.

The species has traditionally been considered rare, but populations continue to decline throughout its range (d'Huart & Klingel, 2008), and there have been extinctions at the national level, such as in Equatorial Guinea and Rwanda where the species is believed to be extinct (d'Huart & Klingel 2008). There are three recognised subspecies of giant forest hogs, each with a distinct range: *H. m. ivoriensis* occurs in isolated populations in

West Africa from Guinea to Ghana; *H. m. rimator* inhabits the Congo basin forests and savannahs, although it appears to overlap with the "true" giant forest hog *H. m. mienertzhagheni in* the Albertine rift. The "true" giant forest hog *H. m. mienertzhagheni* is the largest of the three subspecies (d'Huart & Klingel, 2008). It inhabits the forests and savannah wood lands of the Albertine rift, although there are other scattered small populations to the northeast of Lake Victoria and in the Ethiopian highland forests. This later subspecies is the one that occupies KNP. It is declining in most Ugandan parks, with recent reports suggesting that they could be extinct in most of these parks (Mugerwa *et al*, 2012; Mwima *et al*, 2010).

There is very limited information on how giant forest hogs are being affected by hunting pressure, habitat encroachment, forest fragmentation, or diseases. These threats are likely to be further exacerbated by climate change that is expected to affect water availability due to increased dry spells, as this species depends heavily on water. The giant forest hog is known as a carrier for diseases such as African swine fever and is susceptible to rinderpest (Thomson, 1985; Kingdon, 1997), and is preferred by vectors such as tsetse fly (Moloo, 2011). Yet little information is available on how these could impact the population. Deforestation removes the dense vegetation cover that the forest hogs prefer, thus limiting their range as they are unable to cope with low humidity or prolonged exposure to the sun (Kingdon, 1997). Contrarily, logging facilitates the growth of fresh young vegetation that is preferred by the species; thus, the species may do well in logged areas. However, even when logging *per se* may not be much of a threat to the giant forest hog, logging trails allow poachers to easily follow the species (Chapman *et al,* 2000). Within KNP, snares are often set for the giant forest hog and other mammals although they accidentally capture primates (Emily Otali, pers. comm.) and carnivores (David Mills, pers. comm.; also see Rafael Reyna-Hurtado, this volume). The aggressiveness of the giant forest hogs also makes them easy targets when they attack the dogs that poachers use to track them. For many local tribes around protected areas in Uganda, giant forest hog meat is a special delicacy (e.g., the Banyaruguru and Bakojo around Queen Elizabeth National Park). Furthermore, there are reports of infanticide in the Virunga and Ethiopian population, which may impede giant forest hog population growth. Unfortunately there is no detailed information at other locations to infer the causes of this infanticide, although in Ethiopia it is known that the boar only kills male piglets (Siege, 2011).

The IUCN red list however, has consistently considered the conservation status of the giant forest hog as of least concern (d'Huart & Klingel, 2008), despite its continuous decline with local and national extinctions in most of its range. The mistaken identification of the bush pig for the giant forest hog (Grimshaw, 1998; Kock & Howell, 1999) is another issue of concern. Possibly because these species are shy and run away on hearing people, chances for clear sightings are limited. In most cases, telling the two species apart relies on identifying tracks, which requires experience. Considering the rarity of the species in Kibale National Park, the historical information about the occurrences of this species and its present distribution, there is an urgent need to explore in further detail its current distribution and to re-evaluate its conservation status before it is completely wiped out.

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On the track of the Giant Forest Hog in Kibale National Park, Uganda: a preliminary report on studying the species

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The Giant Forest Hog (*Hylochoerus meinertzhageni;* hereafter GFH) is the largest wild suid of the world with males reaching more than 250 kg and one meter in height (Wilson & Mittermeier, 2011). The massive body is covered by black hair and has naked prominent cheeks and tusks that protrude from the mouth horizontally. This species lives in tropical Africa from Ethiopia to Western Africa, in scattered populations inhabiting diverse vegetation types, ranging from bamboo forest and subalpine forest to lowland swamps and secondary growth thickets (Kingdon, 1997). A highly herbivore species, the GFH feeds on herbaceous species from dense bushes or thickets to grasslands, but always close to forest that the group likely uses for refuge. The GFH is a social species living in family groups with a dominant male and several females with piglets, typically forming groups from 8 to 12, but aggregations of up to 40 animals have been seen (Kingdon, 1997). The GFH is listed as Least Concern on the IUCN red list (http://www.iucnredlist.org/), but there is evidence that at least Eastern African populations have been decreasing at alarming rates in the last 30 years (Tumukunde *et al.*, this issue). Thus, a revision is urgently needed to determine their real status at regional scales.

In 2010, after the first author visited Kibale National Park (KNP, Uganda), he became interested in studying this social ungulate. Given that few ungulates form groups in dense forested habitats, the GFH was an excellent model to compare with a Neotropical species he has been studying for the past 9 years, the white-lipped peccary (*Tayassu pecari*; WLP), a member of the Tayassuidae family which lives in large groups and inside dense forest in tropical America. Questions of interest were: how large is the home range of GFH? Are there seasonal differences in range use and are they linked to resources? Does group size correlate with home range size? Are the groups cohesive? Why is this species so rare? All these questions remain of high rele-

vance for this species because little is known about its ecology and social behavior since very few people have studied the GFH, with the notable exceptions of d' Huart (1978), Kingdon (1997), and Klingel and Klingel (2004). Moreover, the few observations on this species come from animals that live and forage near grasslands or that visit salt licks (i.e., Queen Elizabeth and Murchison Falls National Parks, Uganda: Kingdom, 2013; Klingel & Klingel, 2004; Jibat, Ethiopia: d'Huart & Siege, 2013).

With the moral and financial support of Dr. Colin A Chapman, who quickly overcame the disappointment of seeing his postdoc abandon the study of primates in favor of suids, we started to develop ideas and proposals, and looked for the right student to lead a field project. We found it in Alex Tumukunde, a highly motivated Ugandan PhD student who devoured the literature and developed a protocol in just a few nights. His final proposal included additional topics such as disease and parasite transmission between the GFH and other suids such as the bush pig (*Potamochoerus larvatus*, also present in the area) and domestic pigs living in the periphery of Kibale National Park. To complete the team, two skilled wildlife veterinarians that have experience with suids were included on the project, Edith Rojas and Mauro Sanvicente, and a landscape ecologist, Sophie Calme, with experience in the tropics. Finally, we created a team of highly motivated field trackers.

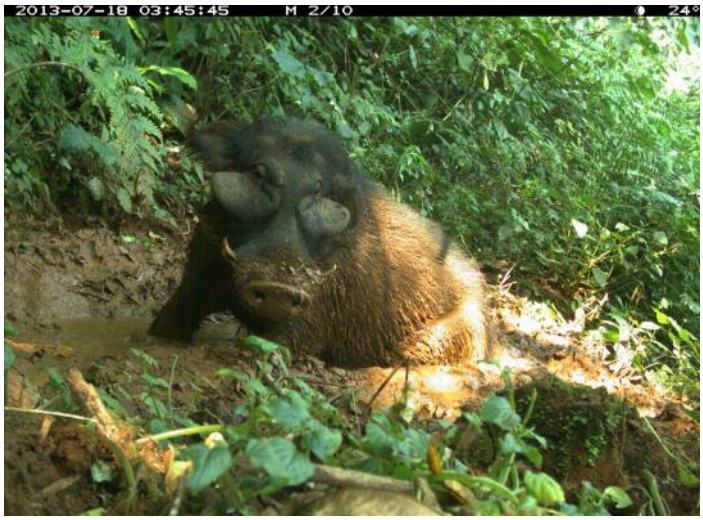
Armed with such a team and with the support of a FQRNT (Fund Quebec for Research of Nature et Technology) grant to Colin Chapman, Sophie Calmé, and Raja Sengupta, a CFI (Canada Foundation for Innovation) grant to Colin Chapman, and a National Geographic Research and Exploration grant to the first author, this project was launched in 2011 with Alex Tumukunde leading the field work and the rest of the team visiting the area during the summers of 2012 and 2013. For two years, and thanks to the skills of the trackers, we were able to track one group of GFH to collect information on ranging behavior, diet, and, in some instances, social composition and social behavior. Additionally, we collected faeces to determine the parasite load.

After two years of closely following one of the groups, that we called the Rwembata Swamp group, we have estimated that it moves in an area close to 10 km^2, with a preliminary estimation of a home range (Fixed Kernel at 95%) of 9.87 km^2 and a core area of 2.85 km^2 (Fixed Kernel at 50% of observations). This group home range was located in a forest that includes primary pre-montane forest, riverine forests, forested swamps, *Papyrus* swamps, and several open areas of secondary/regenerating forest that were the consequence of selective logging 40 years ago (Chapman *et al*., 2010). These regenerating areas have only a few large trees, but they have dense thickets of shrubs, mainly composed of *Mimulopsis* spp, *Acanthus pubescens*, and *Piper* spp. (Lawes & Chapman, 2006). These areas with dense bushes and sparse trees seem to be the favorite habitat for the GFH where they feed on the herbaceous species and also take refuge inside the dense thickets that they form. The GFH groups rest in specific sites that we called "sleeping sites", - shady areas under the densest thickets of approximately 25m^2, where the hogs have cleaned the ground by removing the leaf layer and where they rest in contact with the fresh ground. These sites were repeatedly used and we are currently monitoring them closely.

Thanks to the deployment of eight cameras trap stations in the summer of 2013 (Reconyx HyperFire C800 Professional IR), we were able to estimate that the Ruhembata group has between 8 to 12 individuals with apparently only one adult male and several females with piglets. However, the group sometimes splits into temporary subgroups with one or two individuals travelling apart for a few days, then rejoining the group later. Another group has also shown a subadult male together with two juveniles.

The hard work done in the lab by Alex Tumukunde and other personnel of Makerere University of Kampala in analyzing 183 feces samples of GFH have resulted in the identification of 16 species of helminth parasites. This also leaves us to wonder whether the decline in the GFH population could be due to diseases as exemplified by these high levels of infection with different parasite species. However, we believe it is more likely the result of hunting pressure. The GFH is under severe hunting pressure in KNP. We detected and removed snares that were specifically targeting our group; we also observed tracks and other signs of humans within

the park boundary. In fact, all ungulates in the KNP are under severe pressure from poachers. As an example of this, the Snare Removal Team recently found 59 snares in just 4 days of work (John Okwilo, chief of the team, pers. comm.). Snared chimpanzees, elephants, and even carnivores are often recorded by camera traps in the park (David Mills, pers. comm.). People also recognize that GFH meat is the best among wildlife species, along with that of hippopotamus (*Hippopotamus amphibious*) (John Okwilo, pers. comm.), which probably contributes to the pressure on the species.



We are still determined to study the movements of this species with radiotelemetry in KNP and are initiating a study using camera traps to more accurately assess group size and composition and ranging. The fact that the GFH is under heavy pressure encourages us to dedicate more efforts to investigate the movement patterns and the social behavior of this very interesting and secretive species of suid. We cannot afford to lose this species: if the GFH disappears, we will lose a species that plays special ecological roles as a herbaceous predator, soil modifier, and the prey of large carnivores, and we will always wonder how the largest of all suids moved so secretively and in such large groups inside the dense tropical and montane forests of Africa.

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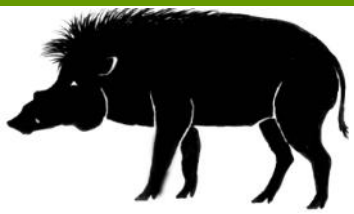
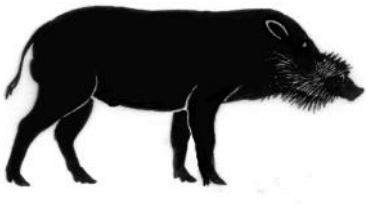


Articles in the news



Warthog craze in the Addo Elephant National Park

http://science.nmmu.ac.za/News/Warthog-craze-in-the-Addo-Elephant-National-Park

22/03/2013

Honours' student Kelsey Hattingh, together with her supervisor, Dr Gideon Rossouw, has recently put together a research project in order to investigate the reproductive biology of the warthog in the Addo Elephant National Park.

Since the introduction of the common warthog, *Phacochoerus africanus* in the Eastern Cape, their numbers and distribution have increased considerably. They have attracted a lot of attention over the past few years as they have become a problem for conservation managers and local farmers despite population regulation attempts. Warthogs are known to have the highest reproductive rate in comparison to other ungulates of similar size and therefore this study may provide insight into why this species has become so invasive by virtue of their reproductive biology.

"We will be attempting to describe the reproductive cycles, including hormone levels, as well as answer some interesting questions regarding their age at sexual maturity, age-related litter sizes and embryonic growth", says Dr Rossouw.

This study, together with future research, will contribute towards a broader understanding of how to manage this alien invasive species in the Eastern Cape more efficiently.

For more info contact Dr Gideon Rossouw: Gideon.Rossouw@nmmu.ac.za

Warthog rocks YouTube with dance moves

http://www.news24.com/Green/News/Warthog-rocks-YouTube-with-dance-moves-20131120

Trish Beaver, The Witness

2013-11-20

Durban - A little lost warthog has become a YouTube sensation, attracting fans to support a wildlife organisation through his bizarre dance antics.

Spike, the little warthog, was found abandoned on a local farm and was brought to UmPhafa private nature reserve by staffers who planned to rear the tiny orphan.
He was barely a week old and had been abandoned after a severe storm in which his mother had fled for shelter and he had been left behind.
Eager staffers were lining up to hand feed the tiny warthog with his milk bottle and he quickly became very fond of his human carers, and followed them everywhere.
He soon became quite the party animal when he engaged in hilarious behaviour during a staff first aid meeting. Ignoring the dummy, which needed resuscitating, he started um … dancing. The staff were stunned by his version of bushveld break dancing. A savvy staffer captured Spike's unique movements on film and now Spike has been immortalised among YouTube's list of animal celebs.

But since those heady days of stardom a few months ago, Spike has grown up and been rehabilitated into the wild, and now does what most warthogs do - he forages for tasty roots and digs holes in the mud. Occasionally, you will see his tail sticking in the air as he zooms off in the distance.
UmPhafa private nature reserve belongs to Colchester Zoo in the United Kingdom.

Stone age hunters brought home the bacon

http://www.news24.com/Green/News/Stone-age-hunters-brought-home-the-bacon-20130827

2013-08-27

Paris - Stone Age hunter-gatherers in Europe may have been trading with settled farmers as long as 7,000 years ago -- acquiring pigs to supplement their hauls of wild boar, scientists said on Tuesday.

A study in the journal Nature Communications claims to provide the first evidence of live animal trade between the indigenous, nomadic Ertebolle hunters of northern Europe and more advanced, settled farmers who originally came from the Fertile Crescent - today's Turkey, Syria and Iraq.
"Hunters and farmers were not only acquainted with each other but even traded live animals," said a statement from Germany's Kiel University, which contributed to the study.
Hunter-gatherers and farmers co-existed in northern Europe from about 5 500 to 4 200 BC.
The hunter-gatherers lived off seals and wild boar on the western Baltic coast, while the farmers cultivated crops and livestock south of the Elbe River that runs through central Europe.

The two groups are believed to have made sporadic contact, as suggested by excavated axes and pottery resembling those of the farmers at hunter-gatherer settlements, but the nature and extent of the exchanges remain a mystery.
There has been no previous evidence that the hunters had access to any domestic animals other than dogs.
For the new study, a team analysed DNA from pig remains unearthed at different Ertebolle settlements. They found the swine had maternal ancestors from the Middle East, like the domestic pigs of their farmer neighbours across the river.
"Members of the Mesolithic [middle Stone Age] Ertebolle culture already had domestic pigs as early as 4 600 BC, although they were - as hunters and gatherers - not yet familiar with animal husbandry," said the statement.
"Ertebolle hunter-gatherers acquired domestic pigs of varying size and coat colour," added the study.
Some of the Ertebolle pigs had a light-coloured coat with black spots - a typical feature of domesticated swine and completely different to the inconspicuous grey coat of the wild boar they would have been more familiar with.
The researchers concluded that the two groups likely traded with one another, though they could not rule out livestock theft as a possible explanation.
"Although it is unclear why the Ertebolle sought domestic pigs, both large and small pigs with multi-coloured coats would likely have seemed strange and exotic compared with the more familiar appearance of the locally available wild boar they traditionally hunted," the team reported.
Their acquaintance with domestic pigs did not immediately revolutionise the hunter-gatherer lifestyle, however.
The Ertebolle continued hunting wild prey for hundreds of years after they started raising a few domestic pigs, before finally settling down to farm full-time.
The study also showed that domestic pigs were present in the region some 500 years earlier than previously thought.
- AFP

Wildlife Conservation Society (2013, November 7). White-lipped peccary trails lead to archeological discovery in Brazil: 4,000- to 10,000-year-old cave drawings.

ScienceDaily. Retrieved from http://www.sciencedaily.com-/releases/2013/11/131107162302.htm

Nov. 7, 2013 — While tracking white-lipped peccaries and gathering environmental data in forests that link Brazil's Pantanal and Cerrado biomes, a team of researchers from the Wildlife Conservation Society and a local partner NGO, Instituto Quinta do Sol, discovered ancient cave drawings made by hunter-gatherer societies thousands of years ago.

The drawings are the subject of a recently published study by archeologists Rodrigo Luis Simas de Aguiar and Keny Marques Lima in the journal *Revista Clio Arqueológica* (see link below). The diversity of the renderings, according to the authors, adds significantly to our knowledge of rock art from the Cerrado plateau region that borders the Pantanal.

"Our work with the Wildlife Conservation Society focuses on promoting sustainable land use practices that help protect important wildlife species and the wild places where they live," said Dr. Alexine Keuroghlian, re-

searcher with WCS's Brazil Program. "Since we often work in remote locations, we sometimes make surprising discoveries, in this case, one that appears to be important for our understanding of human cultural history in the region."

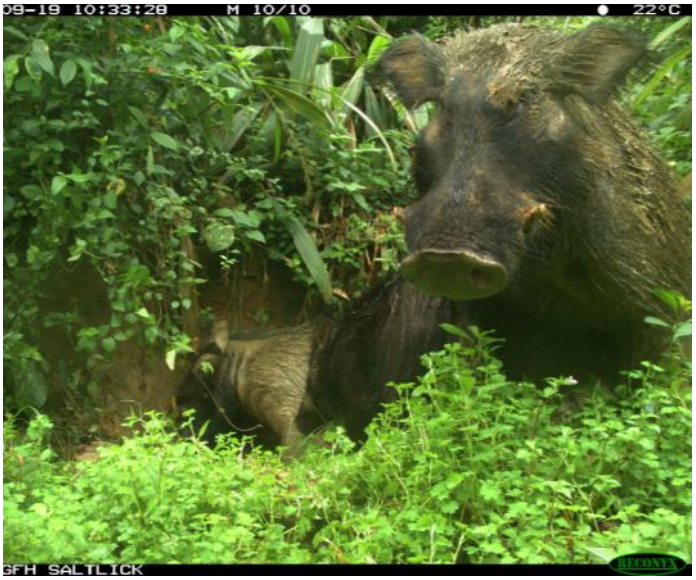
Bring home bacon all day long

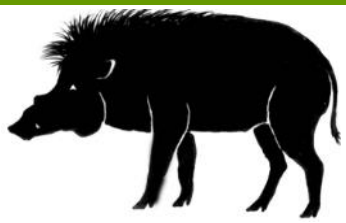
Cape Times 11.11.2013

A DEODORANT that "provides 24 hours of bacon scent" has been launched by Seattle-based makers J&D's Foods.
Power Bacon deodorant comes with the tagline "For when you sweat like a pig" and has been designed specifically for people with active lifestyles. Instructions for the $9.99 (R103.3) stick say: "For all-day meat-scented protection apply liberally to underarms or private areas."
J&D's was set up by bacon-crazy entrepreneurs Dave Lefkow and Justin Esch to offer a range of products celebrating pork. Their product range includes bacon-themed lip balm, shaving cream and...a coffin.
Justin says: "Common sense is like deodorant. The people who need it most never use it."
"So be smart and buy the bacon lover in your life a stick of Power Bacon this holiday season." -*orange news*

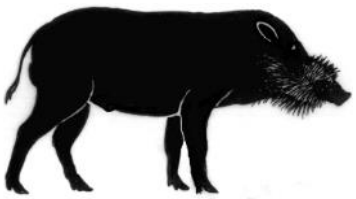
National Gepgraphic recently published a short note on the Giant Forest Hog research currently being undertaken in Uganda by Dr Rafael Reyna and his colleagues. The article can be accessed via the following link:

http://newswatch.nationalgeographic.com/2013/11/06/exclusive-video-worlds-biggest-pig-revealed/?source=hp_dl1_ww-biggest-pig_20131107





New Literature on Suiformes



Dear colleagues,
We have teamed up with Malgosia Nowak-Kemp, of Oxford University Museum of Natural History, to delve into the history of natural history, and produce two papers discussing separate evidence of the presence of warthogs in 17th century Europe and UK.
A skull that reached Europe between 1656 and 1678 in the OUMNH collection, and a water colour painted on vellum by Nicolas Robert (1614-1685) of a warthog in Louis XIV Ménagerie Royale in Versailles are the two earliest known specimens present in Europe, about 100 years before the 1788 naming of the common warthog!
We thought that you would enjoy sharing this curious discovery with us.
Jean-Pierre d'Huart & Tom Butynski

d'Huart JP, Nowak-Kemp M and Butynski TM. A seventeenth-century warthog skull in Oxford, England. *Archives of Natural History* 40.2 (2013): 294–301

There are two widely recognized species of warthog: the Cape warthog, *Phacochoerus aethiopicus* (Pallas, 1766), and the common warthog, *P. africanus* (Gmelin, 1788). On this basis, it has been assumed that the first warthog specimen arrived in Europe in about 1766. This paper documents the discovery of a common warthog skull in the Tradescant Collection at Oxford University Museum of Natural History (OUMNH) that probably reached Europe sometime between 1656 and 1678, and that was listed in the Ashmolean Museum 1685 catalogue. This specimen represents the oldest evidence for a warthog in Europe. The skull pre-dates the 1766 naming of the Cape warthog by more than 80 years, and the 1788 naming of the common warthog by at least 100 years. It is surprising that this skull was never the subject of scientific investigations. This is particularly astonishing as, prior to being transferred to the OUMNH in the 1860s, it was in the Ashmolean Museum from at least 1685.
Keywords: Phacochoerus – Tradescant – Ashmolean Museum – Oxford University Museum of Natural History.

d'Huart JP, Nowak-Kemp M and Butynski TM. A seventeenth-century French painting of a warthog. *Archives of Natural History* 40.2 (2013): 360

Veterinary, Genetic and Physiological Studies

Alves HM, Oliveira IRS, Castelo TS, Lima GL, Souza ALP, Moreira MAP, de Paula VV and Silva AR. 2013. Comparison of Different Glycerol and Egg Yolk Concentrations Added to Tris-based Extender for the Collared Peccaries (*Tayassu tajacu*) Semen Freezing. *Reproduction in Domestic Animals* 48(3): 506-511.

This study aimed to evaluate various concentrations of egg yolk (5, 10, or 20%) in combination with different concentrations of glycerol (3% or 6%) added to a Tris-based extender on the post-thaw characteristics of sperm obtained from *Tayassu tajacu*. For this purpose, semen from 10 sexually male mature collared peccaries was collected by electroejaculation and evaluated for sperm motility, vigour, viability, morphology and

functional membrane integrity. The ejaculates were initially extended in Tris-fructose plus egg yolk (5%, 10% or 20%). After cooling, the semen was added to Tris-egg yolk plus glycerol (6% or 12%), resulting in a final concentration of 3% or 6% glycerol of the extender. Straws were frozen using liquid nitrogen and thawed in a water bath at 37°C for 30 s. The frozen-thawed semen was evaluated as reported for fresh semen. After thawing, a significant decrease was verified for sperm motility and vigour, for all the samples in comparison with fresh semen. However, no differences were evidenced among treatments for any sperm characteristics evaluated ($p > 0.05$), except for the combination between 10% egg yolk and 6% glycerol, which provided the worst preservation of functional membrane integrity ($p < 0.05$). The interactions between higher concentrations of egg yolk (20%) and glycerol (6%) and also between lower concentrations of the same substances (5% egg yolk and 3% glycerol) added to the Tris-based extender negatively affected the preservation of the normal sperm morphology after thawing ($p < 0.05$). In conclusion, the use of Tris-based extender added to 10% or 20% egg yolk plus 3% glycerol is recommended for effective sperm cryopreservation in collared peccaries.

Foni E, Garbarino C, Chiapponi C, Baioni L, Zanni I and Cordioli P. 2013. Epidemiological survey of swine influenza A virus in the wild boar population of two Italian provinces. *Influenza & Other Respiratory Viruses* 7 Suppl. 4: 16-20.

Objectives: An epidemiological survey was carried out in order to obtain a better understanding of the role of wild boars in the epidemiology of the influenza virus.
Design: The samples were submitted to Real-Time PCR testing for gene M of the swine influenza virus (SIV), and virus isolation was performed from the positive PCR samples. Genome sequence analysis was performed on the isolates. Additionally, 1,977 boar sera samples were analyzed using ELISA and hemoagglutination inhibition.
Setting: Over recent years, the wild boar population has greatly increased in Italy, including in areas of high-density industrial pig farming, where the influenza virus is widespread. From July to December 2012, wild boar lung samples were collected in the Parma and Piacenza area, in the Emilia Romagna region.
Sample: 354 wild boar lung samples were collected.
Main outcome measures: Wild-boar influenza A virus infection should be studied more broadly in order to obtain a better understanding of the epidemiological role played by this species.
Results: Three SIV strains were isolated out of 12 samples that resulted positive using PCR analysis and they were identified as avian-like SIV subtype H1N1. Phylogenetic analysis of the sequences obtained from isolate A/wild boar/291320/2012 showed that it clustered with recent Italian avian-like H1N1 SIVs isolated from domestic pigs. Sixty-eight sera samples showed a positive titer to the isolate A/wild boar/291320/2012.
Conclusions: This study suggests that SIV actively circulates in the wild boar population in the investigated area.

Gamelon M, Gaillard JM, Baubet E, Devillard S, Say L, Brandt S, Gimenez O and Mysterud A. 2013. The relationship between phenotypic variation among offspring and mother body mass in wild boar: evidence of coin-flipping? *Journal of Animal Ecology* 82(5): 937-945.

1. In highly variable environments, the optimal reproductive tactics of iteroparous organisms should minimize variance in yearly reproductive success to maximize the long-term average reproductive success. To minimize among-year variation in reproductive success, individuals can either minimize the variance in the number of offspring produced at each reproductive attempt (classical bet-hedging) or maximize the phenotypic diversity of offspring produced within or among reproductive attempts (coin-flipping).
2. From a long-term detailed study of an intensively exploited population facing a highly unpredictable environment, we identify a continuum of reproductive tactics in wild boar females depending on their body mass.
3. At one end, light females adjusted litter size to their body mass and produced highly similar-sized offspring

within a litter. These females fitted the hypothesis of individual optimization commonly reported in warm-blooded species, which involves both an optimal mass and an optimal number of offspring for a given mother. At the other end of the continuum, heavy females produced litters of variable size including a mixture of heavy and light offspring within litters.
4. Prolific heavy wild boar females diversify the phenotype of their offspring, providing a first evidence for coin-flipping in a warm-blooded species. This study provides the first evidence that 'coin-flipping' reproductive tactics occur in wild boars. The findings change the traditional view of mammalian reproductive tactics because the decoupling between phenotypic attributes and litter size and the high phenotypic variation among litter mates both suggest that developmental constraints of mammals could be less than generally assumed.

Michel AL, Hlokwe TM, Espie IW, van Zijll Langhout M, Koeppel K and Lane E. 2013. *Mycobacterium tuberculosis* at the Human/Wildlife Interface in a High TB Burden Country. *Transboundary and Emerging Diseases* 60 Suppl. 1: 46-52.

This study reports on an investigation of *Mycobacterium tuberculosis* cases in mostly captive wild animals using molecular typing tools [Variable Number of Tandem Repeat (VNTR) typing and Restriction Fragment Length Polymorphism typing]. The investigation included cases from (i) the National Zoological Gardens of South Africa (NZG) recorded between 2002 and 2011; (ii) Johannesburg Zoo, where tuberculosis was first diagnosed in 2007 and has since been detected in three antelope species; (iii) a rehabilitation centre for vervet monkeys (*Chlorocebus pygerythrus*) in which *M. tuberculosis* was diagnosed in 2008; and (iv) incidental cases in other facilities including a sable antelope (*Hippotragus niger*), two unrelated cases in chacma baboons (*Papio ursinus*) (one of which was from a free-ranging troop) and a colony of capuchin monkeys (*Cebus capucinus*). Identical genetic profiles of the latter three isolates indicate the persistence of a single M. tuberculosis strain in this population since at least 2006. Results of the outbreak investigation in the captive vervet monkey colony indicate that it was caused by two unrelated strains, while all 13 *M. tuberculosis* isolates from 11 animal species in the NZG showed different VNTR patterns. A substantial increase in tuberculosis cases of 60% was recorded in the NZG, compared with the previous reporting period 1991-2001, and may indicate a countrywide trend of increasing spillover of human tuberculosis to wild animals. South Africa ranks among the countries with the highest-tuberculosis burden worldwide, complicated by an increasing rate of multidrug-resistant strains. Exposure and infection of captive wildlife in this high prevalence setting is therefore a growing concern for wildlife conservation but also for human health through potential spillback.

Molnar J, Toth G, Steger V, Zsolnai A, Janosi A, Mohr A, Szanto-Egesz R, Toth P, Micsinai A, Ratky J and Marincs F. 2013. Mitochondrial D-loop analysis reveals low diversity in Mangalica pigs and their relationship to historical specimens. *Journal of Animal Breeding & Genetics* 130(4): 312-320.

The genetic relationship between 195 Mangalica and 79 non-Mangalica pigs was studied using mitochondrial D-loop SNP genotyping. Altogether, 35 polymorphic sites and 27 haplotypes were identified. Of the haplotypes, eight and 16 are Mangalica and non-Mangalica specific, respectively, while three contain both Mangalica and non-Mangalica individuals. Genetic distance values and phylogenetic analysis indicate that Mangalica individuals are very closely related, and five haplotypes represent approximately 92% of the Mangalica pigs involved in the study, thus determining the major maternal lineages. In contrast to previous microsatellite studies, individuals of Mangalica could not be distinguished as three separate breeds using mtDNA genotyping. Comparing modern and archaeological mtDNA sequences revealed that present day Mangalica is related to pigs that lived in the Carpathian basin where postulated ancestors of Mangalica also lived. This is the first DNA-based genetic evidence to support the described breeding history of Mangalica.

Risco D, Fernandez-Llario P, Garcia-Jimenez WL, Goncalves P, Cuesta JM, Martinez R, Sanz C, Sequeda M, Gomez L, Carranza J, de Mendoza HJ. 2013. Influence of Porcine Circovirus Type 2 Infections on Bovine Tuberculosis in Wild Boar Populations. *Transboundary and Emerging Diseases* 60 Suppl. 1: 121-127.

The wild boar is an important reservoir of bovine tuberculosis (bTB) in south-western Spain. Some risk factors such as wild boar density or age have been associated with the presence of high prevalences of bTB in wild boar. However, the influence of other risk factors such as co-infections with other pathogens has not yet been studied. This work aims to assess the influence of porcine circovirus type 2 (PCV-2) infection on bTB prevalence and bTB lesional patterns observed in wild boar. The presence of bTB-like lesions was evaluated in 551 hunted wild boar from 11 different game estates in south-western Spain, with a known history of bTB. Tuberculosis prevalences in each estate were calculated based on the percentage of animals found with bTB-like lesions. The percentage of animals with generalized bTB lesional patterns (bTB lesions in more than one organ) was also assessed. The prevalence of PCV-2 was studied in each estate using a specific PCR assay. The relationship between PCV-2 and bTB prevalences and between PCV-2 infections and the presence of generalized lesional patterns in wild boar were analysed. A statistical relationship between the prevalences of bTB and PCV-2 was found, with bTB prevalences being higher in estates where prevalences of PCV-2 were high. On the other hand, animals infected with PCV-2 were more likely to develop a generalized lesional pattern. Porcine circovirus type 2 prevalences seem to be associated with prevalences of bTB in wild boar. PCV-2 infection may aggravate the development and severity of bTB, favouring the presence of generalized lesional patterns and raising the risk of contagion in these estates. The implementation of sanitary measures that focus on the control of PCV-2 infection may be necessary as a preliminary measure in bTB control programmes for wild boar.

Song JY, Lim SI, Jeoung HY, Choi EJ, Hyun BH, Kim B, Kim J, Shin YK, de la Pena RC, Kim JB, Joo H and An DJ. 2013. Prevalence of Classical Swine Fever Virus in Domestic Pigs in South Korea: 1999-2011. *Transboundary and Emerging Diseases* 60(6): 546-551.

The major policy for eradication of classical swine fever (CSF) in South Korea has focused on the implementation of compulsory vaccination of the susceptible pig population. A vaccine strain of CSF virus, the LOM strain, is used to maintain high herd seroconversion, a practice complementary to the 'stamping-out policy' and restriction of animal movement during disease outbreaks. To survey for the prevalence of CSF in domestic pigs in South Korea over the past 13 years (1999-2011), we tested 4 193 782 and 1 162 645 samples for antibodies and antigens, respectively. Whereas seropositivity for CSF antibodies has been maintained at over 95% in the mainland, in Jeju Island, where no-vaccination has been administered since 1999, seroprevalence has been below 1% during the last 3 years of study (2009-2011). The highest number of outbreaks in South Korea occurred in 2002 and 2003; since then, outbreaks have decreased each year, with the last CSF outbreak recorded in 2009. No outbreaks have occurred during the past 3 years, and a high level of herd immunity has been maintained in the mainland pig population for 8 years; therefore, South Korea could now switch to a no-vaccination policy throughout the country. However, the constant threat of the re-emergence of the disease in the susceptible pig population should be the main consideration in planning and carrying out the last phase of the CSF eradication process.

Tart JK, Johnson RK, Bundy JW, Ferdinand NN, McKnite AM, Wood JR, Miller PS, Rothschild MF, Spangler ML, Garrick DJ, Kachman SD and Ciobanu DC. 2013. Genome-wide prediction of age at puberty and reproductive longevity in sows. *Animal Genetics* 44(4):387-397.

Traditional selection for sow reproductive longevity is ineffective due to low heritability and late expression of

the trait. Incorporation of DNA markers into selection programs is potentially a more practical approach for improving sow lifetime productivity. Using a resource population of crossbred gilts, we explored pleiotropic sources of variation that influence age at puberty and reproductive longevity. Of the traits recorded before breeding, only age at puberty significantly affected the probability that females would produce a first parity litter. The genetic variance explained by 1-Mb windows of the sow genome, compared across traits, uncovered regions that influence both age at puberty and lifetime number of parities. Allelic variants of SNPs located on SSC5 (27-28 Mb), SSC8 (36-37 Mb) and SSC12 (1.2-2 Mb) exhibited additive effects and were associated with both early expression of puberty and a greater than average number of lifetime parities. Combined analysis of these SNPs showed that an increase in the number of favorable alleles had positive impact on reproductive longevity, increasing number of parities by up to 1.36. The region located on SSC5 harbors non-synonymous alleles in the arginine vasopressin receptor 1A (AVPR1A) gene, a G-protein-coupled receptor associated with social and reproductive behaviors in voles and humans and a candidate for the observed effects. This region is characterized by high levels of linkage disequilibrium in different lines and could be exploited in marker-assisted selection programs across populations to increase sow reproductive longevity.

Taxonomic, Morphological, Biogeographic and Evolutionary Studies

Lima GL, Santos EAA, Luz VB, Rodrigues APR and Silva AR. 2013. Morphological Characterization of the Ovarian Preantral Follicle Population of Collared Peccaries (*Tayassu tajacu* Linnaeus, 1758). *Anatomia, Histologia, Embryologia* 42(4): 304-311.

The aim of this research was to characterize the preantral ovarian follicular population in collared peccaries (*Tayassu tajacu*) using light and electron microscopy. Ovaries from six mature females were collected and further fixed for histological and ultrastructural analysis. A total of 33273.45 +/- 5789.99 preantral follicles (PFs) were estimated for the population in each ovary. Most preantral follicles were primordial (91.56%), followed by primary (6.29%) and secondary (2.15%) ones. Most PFs were morphologically normal (94.4%), and only a few were atretic (5.6%). At histology assessment, amounts of lipid droplets were observed into the oocyte cytoplasm, which was confirmed through ultrastructural analysis. This work characterizes for the first time the ovarian population of preantral follicles, total and per category, in collared peccaries (*Tayassu tajacu*). The general follicles featured at primordial, primary and secondary categories are very similar to those described for other species.

Ecology and Conservation Studies

Chapman J and McEwan RW. 2013. Spatiotemporal dynamics of [alpha]- and [beta]-diversity across topographic gradients in the herbaceous layer of an old-growth deciduous forest. *Oikos* 122(12): 1679-1686.

Understanding the factors that regulate biodiversity over spatial and temporal gradients is an important scientific objective with ramifications for theory and conservation. Species composition is known to vary across spatial gradients, but how this spatial variation is linked to temporal dynamics is less well studied. Our objective was to understand how Shannon ([alpha]) diversity, spatial species turnover (Bray-Curtis dissimilarity), and temporal species turnover (Bray-Curtis dissimilarity) varied with regard to three topographic gradients (aspect, slope and elevation) over one growing season. In April, June and August of 2011, the herbaceous layer was sampled in 320 1-m^2 plots within Big Everidge Hollow, an old-growth forest in southeastern Kentucky. Multiple regression models revealed that Shannon diversity was linearly related to aspect (negative) and slope (positive), but unimodally related to elevation, indicating steep, mid-elevation, and south-facing plots were most diverse. Distance decay analysis showed that significant spatial species turnover occurred across

all three topographic gradients, but aspect and elevation had a greater influence on compositional dissimilarity than slope. Mean temporal species turnover was significantly greater ($p < 0.001$) between April and June (0.39 +/- 0.02 SE) than between June and August (0.20 +/- 0.01). April-to-June turnover was related to aspect (linear) and elevation (quadratic; $r2= 0.23$, $p < 0.0001$), suggesting greater temporal species turnover occurred on north-facing and mid-elevation plots during this period; however, June-to-August turnover was weakly related to slope only (positive linear; $r2= 0.08$, $p = 0.006$). Environmental heterogeneity generated by topography is one of many factors that may constrain or promote biodiversity through space and across time, and a solid understanding of these spatiotemporal patterns of diversity can benefit both conservation and ecological theory.

Luskin MS, Christina ED, Kelley LC and Potts MD. 2013. Modern Hunting Practices and Wild Meat Trade in the Oil Palm Plantation-Dominated Landscapes of Sumatra, Indonesia.
Human Ecology

The ongoing expansion of plantation agriculture has changed the ecological, demographic, and social conditions of Southeast Asia's forested areas, yet little is known about hunting practices in these novel landscapes. Using information from 73 in-depth interviews with hunters, agricultural workers and wild meat dealers in the Jambi province of Sumatra, Indonesia, we describe contemporary hunting practices, including how hunting methods, wildlife harvest and consumption rates vary between different indigenous and immigrant ethnic groups. Hunting is now primarily a commercial endeavour for harvesting wild boar (*Sus scrofa*) meat; over 7500 wild boars were sold in Jambi City alone in 2011. The Muslim majority avoids wild boar for religious reasons, but there is substantial local and export demand driven by Chinese and Christian Batak. We conclude that hunting within oil palm plantations may reduce crop damage from wild boar and also yield large amounts of wild meat with relatively little by-catch of threatened animals.
Keywords: Wildlife harvest, Bushmeat, Tropical rain forest, Human-wildlife conflict, Palm oil, Rubber, Wild boar, *Sus scrofa*, Livelihoods, Jambi, Southeast Asia, Sustainable hunting.

Perea R, Delibes M, Polko M, Suarez-Esteban A and Fedriani JM. 2013. Context-dependent fruit-frugivore interactions: partner identities and spatio-temporal variations. *Oikos* 122(6): 943-951.

Fruit-frugivore interactions are crucial for the dynamics and regeneration of most forested ecosystems. Still, we lack an understanding of the potential variation in the sign and strength of such interactions in relation to variations in the spatial and temporal ecological context. Here, we evaluated spatial (three sites) and temporal (two fruiting seasons) local variation in the sign (seed predation versus dispersal) and strength (frequency and quantity) of the interactions among six frugivorous mammals and a community of Mediterranean fleshy-fruited shrubs. We examined mammal faecal samples and quantified frequency of seed occurrence, number of seeds per faecal sample, seed species diversity and quality of seed treatment (i.e. percentage of undamaged seeds). The frequency of seed occurrence and number of seeds per faecal sample strongly varied among dispersers, sites, seasons and fruit species. For instance, fox *Vulpes vulpes* faeces showed between 6 and 40 times more seeds than wild boar Sus scrofa faeces in seasons or sites in which *Rubus* and *Juniperus* seeds were dominant. However, in seasons or sites dominated by *Corema* seeds, wild boar faeces contained up to seven times more seeds than fox faeces. Mammalian carnivores (fox and badger, *Meles meles*) treated seeds gently, acting mostly as dispersers, whereas deer (*Cervus elaphus* and *Dama dama*) acted mainly as seed predators. Interestingly, rabbit *Oryctolagus cuniculus* acted as either mostly seed disperser or seed predator depending on the plant species. Our results indicated that the sign of fruit-frugivore interactions depended mainly on the identity of the partners. For a particular fruit-frugivore pair, however, our surrogate of interaction strength largely varied with the spatio-temporal context (year and habitat), leading to a low specificity across the seed-frugivore network. The high spatio-temporal variability of seed dispersal (in quantity,

quality and seed diversity) by different frugivores would confer resilience against unpredictable environmental conditions, such as those typical of Mediterranean ecosystems.

Romero A, O'Neill BJ, Timm RM, Gerow KG and McClearn D. 2013. Group dynamics, behavior, and current and historical abundance of peccaries in Costa Rica's Caribbean lowlands. *Journal of Mammalogy* In Press. doi: http://dx.doi.org/10.1644/12-MAMM-A-266.1

Sarasa M and Sarasa JA. 2013. Intensive monitoring suggests population oscillations and migration in wild boar Sus scrofa in the Pyrenees. *Animal Biodiversity and Conservation* 36(1): 79–88.

Intensive monitoring suggests population oscillations and migration in wild boar *Sus scrofa* in the Pyrenees. As few studies have analysed local variability in populations of wild boar *Sus scrofa* in Western Europe in recent years, our understanding of ecological processes currently affecting this species is limited. To analyse questions regarding local variability in wild boar abundance, we used information from 442 traditional drive hunts monitored throughout eight hunting periods in the Pyrenees mountain range (Urdués, N Spain). Results showed temporal oscillations in abundance, and a non–linear decrease of 23% in the number of wild boar seen per drive hunt between 2004 and 2011. Numbers of dogs and hunters per drive hunt also affected indexes of wild boar abundance. Inter–annual variations in bag size may cause overestimations of variations in boar abundance and may even deviate from the population dynamics inferred from the number of wild boars seen per drive hunt. The multimodal patterns of wild boar abundance during the hunting periods suggest migrations in the Pyrenees. Our findings highlight the limitations of hunting bag statistics in wild boar. Further studies are required to guarantee information–based sustainable management of wild boar populations.
Keywords: Wild boar, *Sus scrofa*, Animal migration, Big game traditional hunting, Population dynamics, Wildlife management.

Simonetti JA, Grez AA and Estades CF. 2013. Providing Habitat for Native Mammals through Understory Enhancement in Forestry Plantations. *Conservation Biology* 27(5): 1117-1121.

The Convention on Biological Diversity (CBD) expects forestry plantations to contribute to biodiversity conservation. A well-developed understory in forestry plantations might serve as a surrogate habitat for native species and mitigate the negative effect of plantations on species richness. We experimentally tested this hypothesis by removing the understory in Monterey pine (*Pinus radiata*) plantations in central Chile and assessing changes in species richness and abundance of medium-sized mammals. Frequency of occurrence of mammals, including kodkods (*Leopardus guigna*), culpeo foxes (*Pseudalopex culpaeus*), lesser grisons (*Conepatus chinga*), and Southern pudu deer (*Pudu puda*), was low in forest stands with little to no understory relative to stands with well-developed undergrowth vegetation. After removing the understory, their frequency of occurrence decreased significantly, whereas in control stands, where understory was not removed, their frequency did not change. This result strongly supports the idea that facilitating the development of undergrowth vegetation may turn forestry stands into secondary habitats as opposed to their containing no habitat for native mammals. This forestry practice could contribute to conservation of biological diversity as it pertains to CBD targets.

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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.

These groups consist of technical experts focusing on the conservation and management of wild pigs, peccaries and hippos. 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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