Suiform Soundings

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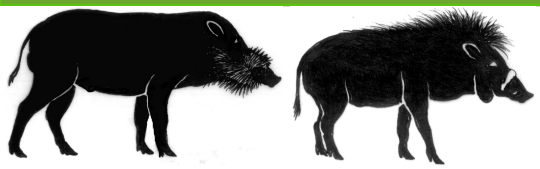
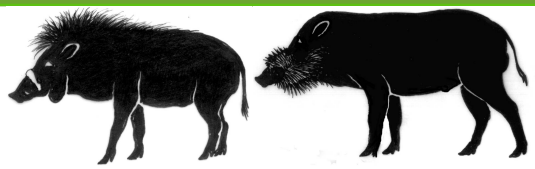

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Eurasian wild boar (*Sus scrofa*). Photo: Bao Shen Yap.

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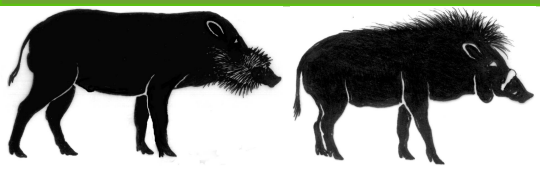

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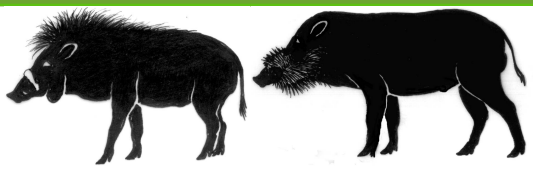

Editorial

Dear fellow reader,

I am glad to present to you this issue of Suiform Soundings!

This issue includes articles on young babirusas playfully diving in pools, important plant species for wild pigs in Singapore's secondary forests, the release of Pygmy hogs in Manas National Park in Assam, India, and the transitional areas for bushpigs and red river hogs in southern Benin's different eco-systems.

Piglet of the new "Pygmy pig"-variety in Siem Reap province, Cambodia. The name of this breed can be confused with the real species Pygmy Hog (*Porcula salvania*). Photo: S. Koemsoeun / Khmer Times.

Wild pigs sometimes face unexpected new threats.

Thanks to my friend Goutam Narayan, the former head of the Pygmy Hog Conservation Programme, I recently came across a news article on a breeding farm in Phnom Kulen, Siem Reap Province, Cambodia, that has interbred a local pig breed (Kulen pigs) with domesticated wild pigs (https://www.khmertimeskh.com/501133265/a-porky-development-thats-sure-to-be-a-dish/). The new hybrid breed was named 'pygmy hog' and is becoming increasingly popular in Cambodia, with its meat being highly sought after for parties. The pig breeding farm is under the Cambodian Ministry of Environment.

However, there is growing concern that this new domestic hybrid will be confused with the wild pygmy hog (*Porcula salvania*), which may have negative consequences on the wild species if news of the new hybrid breed spreads to Assam.

Alternatively, if the new hybrid pig breed is renamed 'Kulen pygmy hog', this would perhaps draw more visitors to the Kulen region in Cambodia, which is not far from Angkor Wat: a famous tourist hot spot.

I hope you enjoyed reading this issue of Suiform Soundings!

With warm regards,

Thiemo Braasch
Chief Editor Suiform Soundings

Return of Pygmy Hogs to their home in Manas National Park, Assam / India

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Ten captive-bred pygmy hogs have been released in Manas National Park of Assam, India by the Pygmy Hog Conservation Programme (PHCP) on 8th and 10th June 2022. This is the third time Pygmy hogs have been reintroduced in Manas after the successful release of 14 Pygmy Hogs in 2020 and 12 Pygmy Hogs in 2021. The PHCP plans to release a target of 60 pygmy hogs in Manas by 2025. The iconic species now returns to their home where their last original population still survives but has dramatically declined.

With this release, the number of pygmy hogs reintroduced into the wild by the PHCP has reached 152 (70 males, 82 females) which is more than their current original global wild population. In 1996, six hogs (2 M, 4 F) were captured from Bansbari range of Manas National Park to start the highly successful breeding programme. Later, a young male rescued in 2001, and another male and two females captured in 2013 from the same range joined the captive breeding stock. Reintroduction of captive hogs in the wild began in 2008. Initially, three Protected Areas in their

Fig. 1: Release of a Pygmy Hog in Manas National Park. Photo: PHCP

historical distribution range in Assam were selected for better protection and restoration of alluvial grasslands. Over the next decade, 35 hogs (18 M, 17 F) were released in Sonai-Rupai Wildlife Sanctuary, 59 (26 M, 33 F) in Orang National Park, and 22 (11 M, 11 F) in Barnadi Wildlife Sanctuary. The reintroductions in Orang have been particularly successful as they have multiplied almost two and a half times in number, and have spread to areas far from release locations. As part of its rewilding strategy, the PHCP will continue to maintain about 70 captive hogs at its two centres in Assam and breed more hogs for release.

In the last two years when both Coronavirus and African Swine Fever in Assam have presented major challenges for the PHCP, the successful release of these 14 hogs in 2020 and 12 hogs in 2021 is a landmark achievement and is the key step on the road to the establishment of a new sub-population of pygmy hogs in Manas National Park. It has been estimated that with the release of these 10 (3 M, 7 F) hogs in Rupahi grasslands in the Bhuyanpara range of Manas National Park, the total number of reintroduced hogs and their progeny may have reached 200 in the four release sites.

Manas Field Director, Dr. Vaibhav Chandra Mathur stated that, “The Pygmy Hog is a species which has been recovered from the verge of extinction in the wild. With Manas Tiger Reserve serving as the source stock of hogs for the Pygmy Hog Conservation Program, this tranche of supplementation with a captive bred population is going to strengthen conservation efforts especially for tall wet grasslands, for which the pygmy hog serves as an indicator species. At the same time, this is an opportunity to develop scientifically and statistically robust monitoring protocols for the species, which are practically implementable in the field on a periodic basis, so that a pulse can be kept on pygmy hog numbers and their distribution status.”

Manas contains some of the largest remaining grassland blocks in the sub-Himalayan grassland ecosystems. Found only in these tall dense alluvial grasslands, pygmy hogs are incredibly shy and are almost never seen. Dr Lesley Dickie, CEO, Durrell Wildlife Conservation Trust, came to Assam to take part in this year’s pygmy hog release. She said, “Durrell has been committed to conserving the tiny but precious pygmy hog, and their grassland home, for decades. With our partners, including government, we strive to create a functioning habitat that also allows local communities to thrive. It was an honour to take part in this latest release, meet with our partners and see at first hand the amazing work of the Durrell team in India. I hope to return in the not too distant future.”

Fig. 2: 34 Pygmy Hogs have been released in Manas National Park so far. Photo: PHCP

Dr. Bibhab Kumar Talukdar, CEO of Aaranyak - a key partner of the programme, added that, “Conservation of lesser known species such as Pygmy Hogs, Bengal Florican and Hispid hare and other grassland obligatory species is equally important as those of charismatic species such as the Tiger and the One-Horned Rhinoceros. Pygmy Hog reintroduction effort will help the grassland as they indicate health of the habitat and also the programme envisaged to contribute for restoration of their habitat.”

Plants associated with wild pig (*Sus scrofa*) foraging activities in Singapore secondary forests

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Abstract

Wild pig (*Sus scrofa*) populations in Singapore have been rising over the past two decades, likely due to a lack of hunting or large natural predators to regulate their numbers, in addition to the availability of suitable habitats to expand into and possibly supplemental food from anthropogenic sources. In other nearby Asian forests, high densities of wild pigs have been shown to inhibit forest regeneration through seed predation, trampling, foraging for food (i.e., digging or rooting), creating wallows, and building birthing nests, which all may damage seedlings and saplings. Wild pigs may also facilitate the spread of invasive species by causing soil disturbances or acting as seed dispersers. Here we assessed the plants associated with pig foraging sites in Singapore along eight 6 m (W) × 1000 m (L) straight-line transects in secondary forests. In contrast to many studies elsewhere, we found that wild pig foraging sites do not appear to be associated with any specific plant group or origin status (native or non-native) within the secondary forests of Singapore. Our work is situated within secondary forests so that the knowledge gained can help inform Singapore's substantial reforestation efforts and specifically help to restore or protect habitats from wild pig degradation.

Fig. 1: A wild pig (*Sus scrofa*) in Singapore with traces of foraging (soil disturbances from rooting behaviour) in the background. Photo: B. S. Yap.

Introduction

Wild pigs (*Sus scrofa*) were extirpated from mainland Singapore in the 1950s but they have recolonised the island in the early 2000s and their range and density have since increased (Figure 1; Khoo et al., 2021; Koh et al., 2018; Yong et al., 2010; Corlett, 1992). In Southeast Asia, large wild pig populations have been shown to negatively impact forests soils, limit tree regeneration through seed predation, digging up seedlings and sapling roots, and breaking

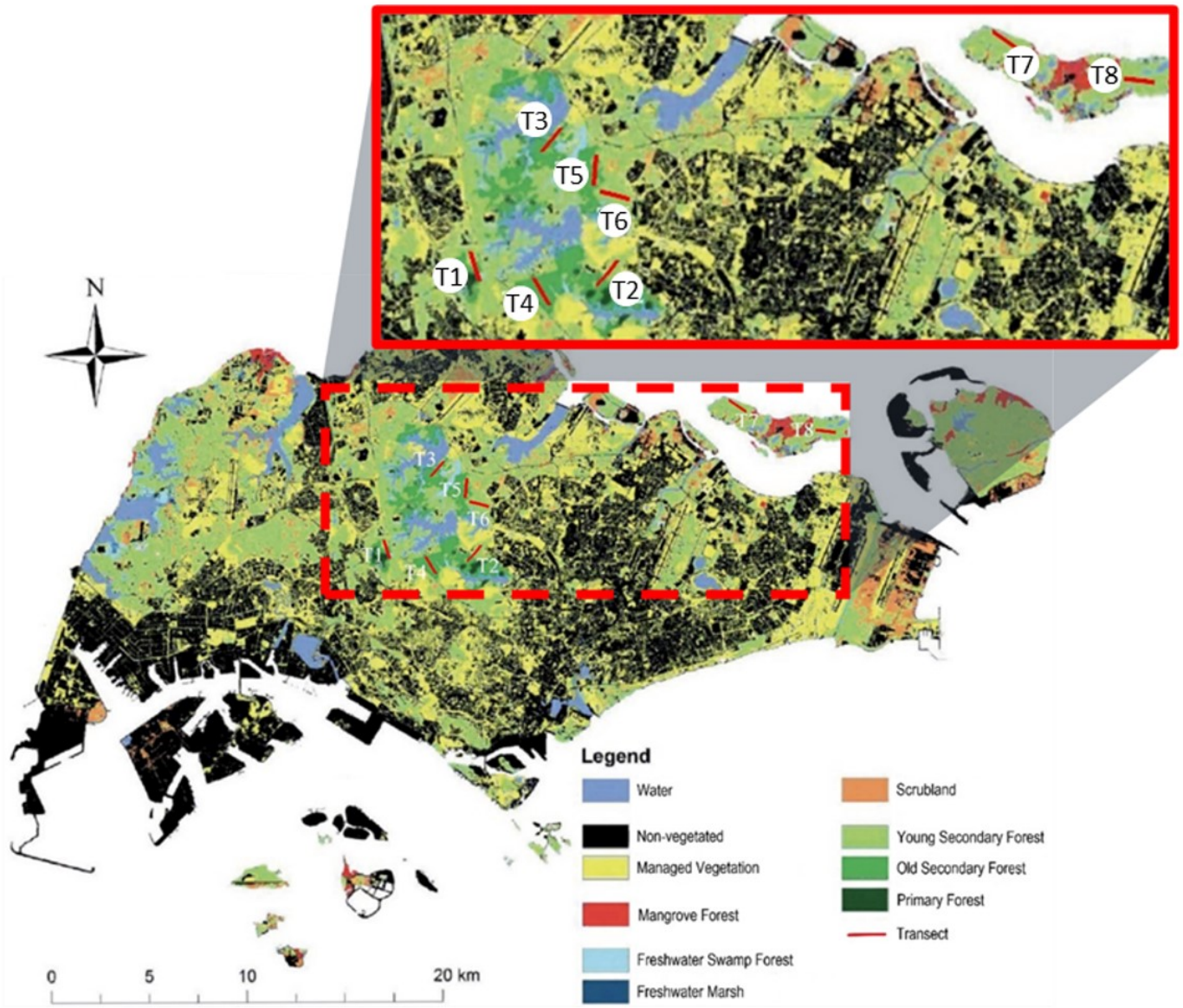

Fig. 2: Locations of eight flora and pig foraging transects surveyed across secondary forests in Singapore. Map adapted from Yee et al., 2011.

saplings to construct their birthing nests, and even reduce forest carbon storage (Luskin et al., 2021; O'Bryan et al., 2021; Williams et al., 2021; Luskin et al. 2019; Wehr et al., 2018, Luskin et al., 2017; Yong et al., 2010; Ickes et al., 2001). Furthermore, the suppression of native plant species recruitment and increased disturbance to soils, coupled with wild pigs as seed dispersers, may increase opportunities for non-native plant species to invade the forests (Wehr et al., 2018; Dovrat et al., 2012; Fujinuma and Harrison, 2012; Yong et al., 2010).

Wild pigs generally have diverse omnivorous diets including a large proportion of plant matter (Senior et al., 2016). Many studies outside of Singapore showed that wild pigs prefer certain types of plants (e.g., oak, legumes, agricultural crops), which is largely influenced by food availability, energy and nutrient content (Kim et al., 2019; Lee & Lee, 2019; Luskin et al., 2017; Rivero et al., 2017; Ballari & Barrios-García, 2014; Giménez-Anaya et al., 2008; Schley & Roper, 2003). Previous work in the nearby Pasoh forest (Pennisular Malaysia) found that wild pig habitat preferences and disturbances strongly altered tree diversity and favoured lianas over trees (Luskin et al., 2021; Luskin et al., 2019; Ickes et al., 2005). However, those studies focused on

the family-level plant composition and did not investigate differences in specific plant genera or non-native versus native plant species. In this study, we investigated if particular types of plants were associated with wild pigs foraging sites in Singapore's secondary forests. Specifically, we explored whether they prefer a specific genus or genera of plants over others, and non-native over native plant species.

Our work is situated within secondary forests so that the knowledge gained can help inform Singapore's substantial reforestation efforts and specifically help to restore or protect habitats from wild pig degradation.

Methods

Study Area

Singapore comprises of 19.64% young secondary forest and 1.37% old secondary forests in terms of land area (Yee et al., 2011). It is estimated that non-native species account for 44% of the total vascular flora in Singapore, with 18% growing in the wild and 12% being regarded as fully naturalised (Nghiem et al., 2015; Chong et al., 2009).

Our work documenting the flora nearby pig foraging sites occurred in a mosaic of secondary forests (native-dominated forests and abandoned-land secondary forests) in the Bukit Timah Nature Reserve, Central Catchment Nature Reserve and Pulau Ubin island in December 2020 (Figure 2). We surveyed 2-3 randomly located 6 m (W) × 1000 m (L) straight-line transects in each of the three areas (eight in total).

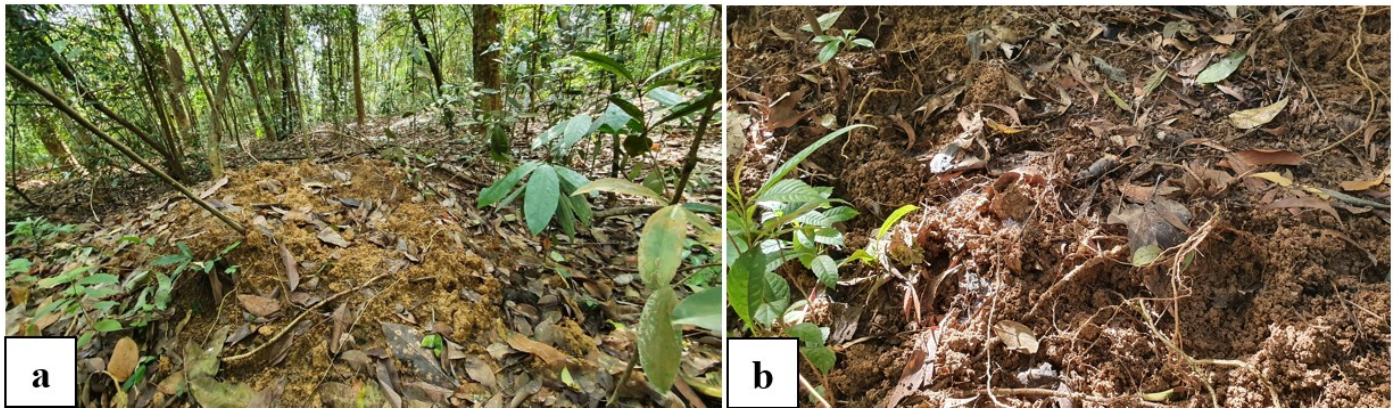

Fig. 3: Examples of a wild pig foraging sites, which are characterised by the exposed soil and roots. We assessed the plant community within a 1-m radius of foraging sites (a). Most foraging activities observed appeared to target roots (b). Photos: C. Yong.

Study species

Wild pigs (also called wild boars) are common throughout Southeast Asia. Their recent population rise in Singapore is partly due to the absence of tigers (Panthera tigris), their natural apex predator (Khoo et al., 2021; Koh et al., 2018; Yong et al., 2010). Additionally, Singapore's ban on hunting also strongly supports pig densities, similar to nearby areas of Malaysia and Indonesia where hunting is limited due of the Halal diet restrictions on pork (Luskin et al., 2014). This leaves Singapore's pig populations to be largely limited by the availability of food and suitable habitat (Khoo et al., 2021). These factors are not independent; predator loss, low hunting, and anthropogenic food subsidies act synergistically to determine pig densities. For example, the wild pig density in Southeast Asian forests that lack large predators, like Singapore, was projected to be ten times that of forests with large predators (Yong et al., 2010; Ickes et al., 2005). However, in

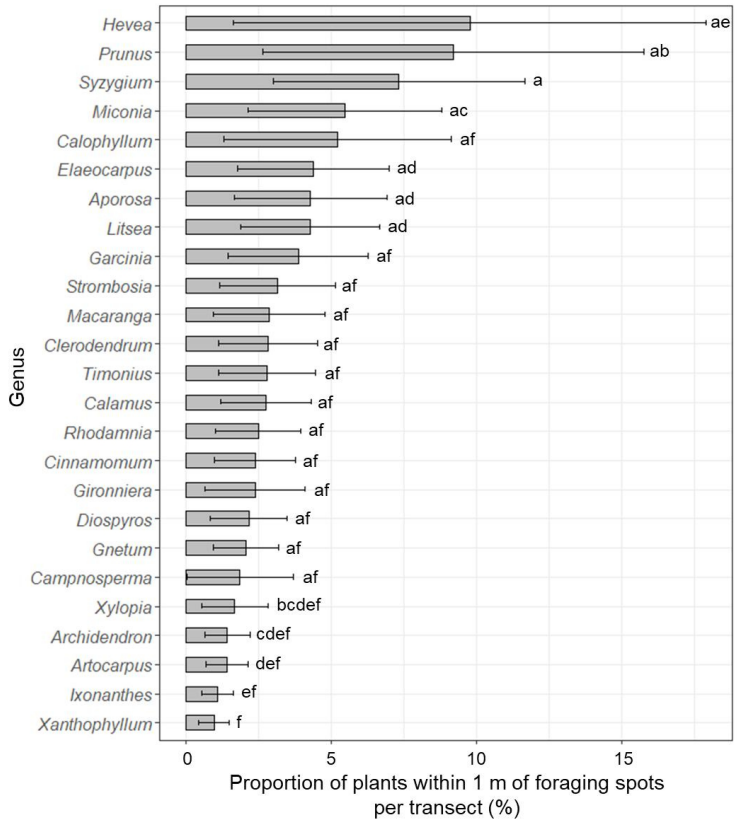

Fig. 4: Percentage of individuals of common plant genera recorded within 1-m radius of wild pig foraging sites. Bars are means and error bars represent 95% confidence intervals from a linear mixed effects model (Table 1. Different letters across genera indicate significant differences (post hoc Tukey test, $P \leq 0.05$).

forests without tigers, where pig hunting is limited, and where pigs can access food subsides like crops or trash, pig densities can increase 100-fold relative to intact or hunted forests (Luskin et al., 2017). Soil disturbance by wild pig foraging behaviour is characterized by uneven surfaces of loose soil that have no litter layer or vegetation cover left from pigs turning the soil over (Figure 3). Singapore does not have any other animals that disturb the soil in this particular manner.

Flora associated with pig disturbances

We recorded all signs of foraging activity by wild pigs along randomly located 1 km straight-line transects with a 6 m wide observation window (3 m left and right). We recorded the plants within a 1 m radius of each foraging site, identified to genus and, if possible, species level. We calculated the percentage of each genus and the native versus non-native plants out of the total plant individuals per transect. We assumed that understorey plants in the pig foraging sites may have contributed towards the wild pig diet.

Statistical Analysis

We used linear mixed-effects models (LME) (Pinheiro & Bates, 2000) to compare differences in the proportion of plants near/within foraging sites among the selected common plant genera, with 'plant genus' treated as the fixed factor and the 'transect location' as a random factor. Additionally, LME models were used to compare differences in the proportion of native and non-native species found near/within foraging sites, with 'plant origin status' as the fixed factor and the 'transect location' as a random factor.

To ascertain model assumptions, standardised residuals were plotted and visually inspected. The model with the most appropriate variance structure was selected using sample-size adjusted Akaike Information Criterion values and likelihood-ratio tests (Zuur et al., 2009). Post hoc Tukey tests were conducted when the factor of interest of the selected LME model showed significant differences (Hothorn et al., 2008). All statistical analyses were conducted using 'R' version 4.0.5 (R Core Team, 2021) using 'NLME' (Pinheiro et al., 2014) and 'MULTCOMP' (Hothorn et al., 2008) packages.

Results

In total, 96 plant genera were recorded within 1 m of wild pig foraging sites across all eight

transects. Twenty-five plant genera were recorded in at least four of the eight transects, but all 25 genera showed low occurrences (below 10% of individuals) and most showed statistically similar occurrences to each other (Figure 4; Table 1).

Native plants accounted for 89% of plant individuals (Figure 5; Table 1). The most common non-native species documented near foraging sites were hairy clidemia (*Miconia crenata*, syn. *Clidemia hirta*) and rubber (*Hevea brasiliensis*).

Tab. 1: Test statistics of one-factor linear mixed-effects models (LME) to test for the differences in percentages of plant individuals occurring near foraging sites among different common plant genera (a) and between native and non-native plants within a transect (b). Transect location was considered as a random factor for each model. Significant P values ($P \leq 0.05$) are presented in bold.

	d.f. $_{(n, d)}$	F-value	P-value
(a) Proportion of common plant genera	24, 120	3.0310	**< 0.001**
(b) Proportion of native/non-native plants	1, 7	319.814	**< 0.001**

Discussion

Comparison across common plant genera

We found no patterns in plant associations with wild boar disturbances. This may differ from studies in other countries that found plant associations within wild pig diets. For example, pigs preferred oak over conifers in Korea (Lee & Lee, 2019), leguminous plants over grasses in Chile (Rivero et al., 2017), and agricultural crops (e.g., oil palm) over forest species in Malaysia (Luskin et al., 2017). The low density of energy-rich plants (e.g., legumes, oil palm) within our surveyed transects may have led pigs to to utilise all possible nearby food sources and consume readily available subsurface material.

Many of the common plant species recorded in our study are also commonly found in previous vegetation surveys of Singapore's young and old secondary forests, which can be further classified into native-dominated and abandoned-land forests (Yee et al., 2016; Chua, 2014; Neo et al., 2014). Hence, our results may be reflective of the vegetation composition of Singapore's secondary forests rather than indicative of any plant preference by the pigs. Moreover, wild pigs may have adapted to utilising energy-rich urban plants, such as yam, tapioca and oil palm, which are more abundant at the urban-forest interface outside of our study area (NSS, 2012). As such, future studies could analyse wild pig faecal samples for plant DNA composition and seed content to give a more accurate representation of what they prefer to eat, and this would serve to remove the spatial constraints of line transect sampling.

Comparison across native and non-native plants

The high occurrence of hairy clidemia near or within wild pig foraging sites could be attributed to its inherently invasive nature. Wild pig foraging activities turn over the soil, which facilitates colonisation of the site by this pioneer shrub that is known to prefer disturbed soils and canopy gaps with abundant light (Fujinuma & Harrison, 2012; Peters, 2001). On the other hand, the high occurrence of rubber plants is reflective of how it was the favoured crop for cultivation for the most recent wave of plantation agriculture (Corlett, 1992; Dobby, 1940).

Rubber plants are potentially an important supplementary food source for the wild pigs because mature trees tend to produce high numbers of seedlings and fruits (which are produced twice a year), and their shade-tolerant seedlings show high recruitment rates (Nghiem et al., 2015; Yeang, 2007). Further studies could assess if the removal of rubber trees from secondary forests can indirectly control the wild pig population. However, much care should be taken to ensure that

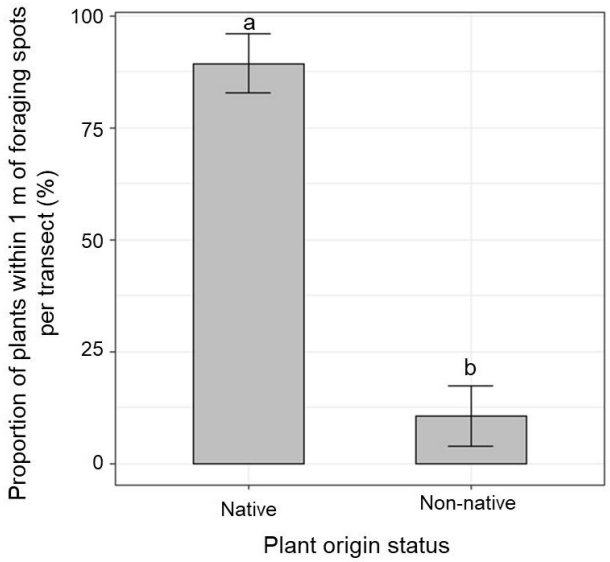

Fig. 5: Percentage of native and exotic plants recorded within 1-m radius of wild pig foraging spots. Bars are means, and error bars represent 95% confidence intervals from a linear mixed effects model. (Table 1. Different letters across genera indicate significant differences (post hoc Tukey test, P ≤ 0.05).

removal of rubber does not adversely impact other animals that also utilise this species, such as the critically endangered banded leaf monkey (*Presbytis femoralis femoralis*) (Srivathsan et al., 2016).

The non-native oil palm (*Elaeis guineensis*) has been shown to be a significant food source subsidy for wild pigs in Pasoh Forest, Malaysia (Luskin et al., 2017), but we were unable to detect this preference of wild pigs in our study. The scarcity of oil palms across our transects could be, in part, attributed to the ongoing management efforts by the local government environmental agency to remove oil palms around the island (MND, 2017).

Our findings could also be confounded by the mosaic of sub-types of secondary forests in Singapore, where some areas are native-dominated and others, such as abandoned plantation forests, show a higher proportion of non-native plant species (Yee et al., 2011, 2016). Future studies could conduct comprehensive vegetation surveys and diet analyses to determine how pigs influence plant composition of non-native species. Finally, with the lethal onslaught of African Swine Fever likely to reach Singapore in the near future, there are opportunities for natural 'before-and-after' studies to examine pigs influence on the environment (Luskin et al., 2020).

Conclusion

Our study provided insights into the foraging habits of wild pigs in Singapore secondary forests. Contrary to studies in other countries that indicated wild pigs show preference for certain types of plants over others, our study found that wild pigs in Singapore showed no distinct preference for any common genus or for non-native or native plants within Singapore secondary forests.

Acknowledgements

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References

Ballari SA and Barrios-García MN. 2014. A review of wild boar *Sus scrofa* diet and factors affecting food selection in native and introduced ranges. Mammal Review 44(2): 124–134.

Chua SC. 2014. Fate, luck or destiny? Regeneration of tropical rainforest in Singapore. University of California Berkeley.

Corlett RT. 1992. The Ecological Transformation of Singapore, 1819-1990. Journal of Biogeography 19(4): 411-420.

Chong KY, Tan HTW and Corlett RT. 2009. A checklist of the Total Vascular Plant Flora of

Singapore: Native, Naturalised and Cultivated Species. Raffles Museum of Biodiversity Research, National University of Singapore.

Dobby EHG. 1940. Singapore: Town and Country. Geographical Review 30(1): 84–109.

Dovrat G, Perevolotsky A and Ne'eman G. 2012. Wild boars as seed dispersal agents of exotic plants from agricultural lands to conservation areas. Journal of Arid Environments 78: 49–54.

Fujinuma J and Harrison RD. 2012. Wild Pigs (*Sus scrofa*) Mediate Large-Scale Edge Effects in a Lowland Tropical Rainforest in Peninsular Malaysia. PLoS One 7(5): e37321.

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

Hothorn T, Bretz F and Westfall P. 2008. Simultaneous Inference in General Parametric Models. Biometrical Journal 50(3): 346–363.

Ickes K, Dewalt SJ and Appanah S. 2001. Effects of native pigs (*Sus scrofa*) on woody understorey vegetation in a Malaysian lowland rain forest. Journal of Tropical Ecology 17(2): 191–206.

Ickes K, Paciorek CJ and Thomas SC. 2005. Impacts of nest construction by native pigs (*Sus scrofa*) on lowland Malaysian rain forest saplings. Ecology 86(6): 1540–1547.

Khoo MDY, Lim BTM, Soh MCK, Loy RHY, Lua HK., Lee BPYH, Loo AHB and Er KBH. 2021. Persistence of a locally endangered mouse-deer amidst the re-emergence of two larger ungulates in small urban rainforest fragments. Global Ecology and Conservation 30: e01807.

Kim Y, Cho S and Choung Y. 2019. Habitat preference of wild boar (*Sus scrofa*) for feeding in cool-temperate forests. Journal of Ecology and Environment 43(3): 297–304.

Koh JJM, Webb EL and Leung LKP. 2018. Using a spatial mark-resight model to estimate the parameters of a wild pig (*Sus scrofa*) population in Singapore. Raffles Bulletin of Zoology 66: 495-505.

Lee SM and Lee EJ. 2019. Diet of the wild boar (*Sus scrofa*): Implications for management in forest-agricultural and urban environments in South Korea, PeerJ 7: e7835.

Luskin MS, Christina ED, Kelley LC and Potts MD. 2014. Modern hunting practices and wild meat trade in the oil palm plantation-dominated landscapes of Sumatra, Indonesia. Human Ecology 42: 35–45.

Luskin MS, Brashares JS, Ickes K, Sun, IF, Fletcher C, Wright SJ and Potts MD. 2017. Cross-boundary subsidy cascades from oil palm degrade distant tropical forests. Nature Communications 8: 2231.

Luskin MS, Ickes K, Yao TL and Davies SJ. 2019. Wildlife differentially affect tree and liana regeneration in a tropical forest: An 18-year study of experimental terrestrial defaunation versus artificially abundant herbivores. Journal of Applied Ecology, 56(6), 1379–1388.

Luskin MS, Meijaard E, Surya S, Walzer C, Linkie M. 2020. African Swine fever threatens Southeast Asia's 11 endemic wild pig species. Conservation Letters e12784.

Luskin MS, Ickes K, Davies S, Johnson D and Leong YT. 2021. Wildlife disturbances as a source of conspecific negative density dependent mortality in tropical trees. Proc. R. Soc. B. 288: 20210001.

Ministry of National Development (MND). 2017. Written Answer by Ministry of National Development on wild boar sightings.

Nature Society (Singapore) (NSS). 2012. Nature Society (Singapore)'s Position Paper on Wild

Pigs in Singapore.
Neo L, Yee ATK, Chong KY, Yeoh YS and Tan HTW. 2014. The vascular plant flora of abandoned plantations in Singapore IV: Windsor Forest. Nature in Singapore 7: 93-109.
Nghiem LTP, Tan HTW and Corlett RT. 2015. Invasive trees in Singapore: Are they a threat to native forests? Tropical Conservation Science, 8(1): 201–214.
O'Bryan CJ, Patton NR, Hone J, Lewis JS, Berdejo-Espinola V, Risch DR, Holden MH and McDonald-Madden E. 2021. Unrecognized threat to global soil carbon by a widespread invasive species. Global Change Biology 28(3), 877–882.
Peters HA. 2001. Clidemia hirta invasion at the Pasoh Forest Reserve: An unexpected plant invasion in an undisturbed tropical forest. Biotropica, 33(1): 60–68.
Pinheiro J, Bates D, DebRoy S, Sarkar D, Heisterkamp S, Van Willigen BV and Ranke J. 2014. nlme: Linear and nonlinear mixed effects models (R package version 3.1 128).
Pinheiro J and Bates D. 2000. Mixed-Effects Models in S and S-PLUS. 1st edn. Springer-Verlag New York.
R Core Team. 2021. R version 4.0.5 (Shake and Throw).
Rivero MJ, Gallardo MA, Marnet PG and Velásquez A. 2017. Dietary preference of European wild boar (*Sus scrofa* L.) grazing grass and legume at two contrasting plant heights: A pilot study. Livestock Science 200: 64–70.
Schley L and Roper TJ. 2003. Diet of wild boar *Sus scrofa* in Western Europe, with particular reference to consumption of agricultural crops. Mammal Review 33(1): 43–56.
Senior AM, Grueber CE, Machovsky-Capuskaa G, Simpson SJ and Raubenheimer D. 2016. Macronutritional consequences of food generalism in an invasive mammal, the wild boar. Mammalian Biology 81(5): 523–526.
Srivathsan A, Ang A, Vogler AP and Meier R. 2016. Fecal metagenomics for the simultaneous assessment of diet, parasites, and population genetics of an understudied primate. Frontiers in Zoology 13(1), 17.
Wehr NH, Hess SC and Litton CM. 2018. Biology and Impacts of Pacific Islands Invasive Species. 14. *Sus scrofa*, the Feral Pig (Artiodactyla: Suidae). Pacific Science 72(2): 177–198.
Williams PJ, Ong RC, Brodie JF and Luskin MS. 2021. Fungi and insects compensate for lost vertebrate seed predation in an experimentally defaunated tropical forest. Nature Communications 12:1650-1671.
Yeang HY. 2007. Synchronous flowering of the rubber tree (*Hevea brasiliensis*) induced by high solar radiation intensity. New Phytologist 175(2): 283–289.
Yee ATK, Corlett RT, Liew SC and Tan HTW. 2011. The vegetation of Singapore - An updated map. Gardens' Bulletin Singapore 63(1 & 2): 205–212.
Yee ATK, Kwek YC, Neo L and Tan HTW. 2016. Updating the classification system for the secondary forests of Singapore. Raffles Bulletin of Zoology 32: 11–21.
Yong DL, Lee BPYH, Ang A and Tan KH. 2010. The status on Singapore Island of the Eurasian Wild Pig *Sus scrofa* (Mammalia: Suidae). Nature in Singapore 3: 227–237.
Zuur AF, Ieno EN, Walker N, Saveliev AA and Smith GM. 2009. Mixed effects models and extensions in ecology with R. Springer Science & Business Media.

Distribution areas of transition of *Phacochoerus africanus* (Gmelin, 1788) and *Potamochoerus porcus* (Linnaeus, 1758) in the different ecosystems of southern Benin

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Abstract

The suids are game of choice providing innumerable ethnobiological values and income to the local population and can be found sharing the same area or living separately. This study objective is to assess the areas sympatric to the red river hog and common warthog in southern Benin. The occurrence points of the both species from the presence indices were recorded and complementary surveys were carried out on the basis of a land cover map designed beforehand to assess past distribution. Their past and current distribution areas were recorded with the Qgis 3.10 software using the polygon entity and node addition tool and also the layout tool. To analyse the temporal constraints in the dynamic distribution areas, land cover classes evolving over 15 years were used following a geometric correction of the layers facilitating geoprocessing. The relative abundance of its presence was also materialised. It is noted that 20% of the distribution area of the both species has shrunk considerably. Currently, no sympatric area can still be observed in their distribution areas as was the case in the past. An allopatrism area was subsequently created in the Benin Plateau department. The distribution areas of both species have so far experienced phenomena of preferential habitat loss. The Lama's gazetted forest recorded the highest abundance of presence indices. We should think about game ranching or suids reintroduction programmes into past distribution areas, reviewing the land use policy, to raise public awareness of the cohabiting importance with animal species, identify and control the different migration corridors and implement projects to restore the most degraded protected areas in the past and present range of the two species.

Key words: area, feral pigs, occurrence, overlap, south Benin.

Introduction

The importance of protected areas, particularly tropical forests, in improving the effects of climate and the long-term preservation of the biodiversity elements is no longer in doubt (Pascal, 2003). Unfortunately, these dynamic ecosystems has so far been faced with a series of anthropogenic activities and climate upheavals (Diallo et al., 2011) threatening the survival of flora and fauna species, particularly large mammals such as the suids. Taking into account abiotic and biotic factors, climatic factors, soil characteristics and water chemistry on the one hand, and competition, predation, parasitism, commensalism, cooperation and mutualism on the other hand influence the existence of animal species (Winterbach et al., 2013). Cases of intra-group competition may therefore arise in species of the same family when resources are shared, thus influencing their dynamics and distribution (de Oliveira et al., 2013). Differential use of its allocations remains a fundamental alternative to compensate for the exclusion of species (Davis et al., 2011) requiring the fulfilment of food functions but above all mutual adoption and habitat sharing (Djagoun et al., 2013). This is how species of the same genus and/or family can be found in related ecosystems, even in similar niches or in habitats that are not too far apart but do not

necessarily hybridise. This is the case of the Albertine Rift where areas of overlap between *Potamochoerus larvatus* (Cuvier, 1822) and *Potamochoerus porcus* (Linnaeus, 1758) with an altitudinal separation (Meijaard et al., 2011). On the other hand, the desert warthog *Phacochoerus aethiopicus* (Pallas, 1766) proved to be closely sympatric with *Potamochoerus larvatus*, which is largely sympatric with the common warthog *Phacochoerus africanus* (Gmelin, 1788). Following the work of Amin et al., (2017).

Phacochoerus africanus, *Potamochoerus porcus* and *Sus scrofa domesticus* are the three species of suids found in Benin (Codjia et al., 2020a). They are highly valued game for hunters and provide enough income for the local population. A severe degradation of the vegetation cover is noted in the southern part of Benin due to a high concentration of more than half of the population (INSAE, 2016). No work in this country and no reliable data yet exist to show whether or not there is a past and present sympatric area with *Phacochoerus africanus*, and *Potamochoerus porcus*, two fairly prolific species that could solve the low zootechnical potential problem of the local pig. It is within this context that the present study aims to assess the red river hog and common warthog sympatric areas in southern Benin. This work is a first step towards a better understanding of these wild pigs species distribution, to investigate the phyto-ecological characteristics of their habitats, their diet and ethology, etc. As assumptions for this study we have: (i) there is still a large distribution of sympatric area for both species; (ii) the loss of preferential habitats remains the main cause of the current virtual disappearance of sympatric areas. We will try to respond to these hypotheses in the remaining results.

Material and Methods

Study area

The study area lies below 8°00' N latitude in Benin and between longitudes 1°36' and 2°48' E (Fig. 1) with a surface area of 22500 Km². This area is characterised by two climatic zones: the Sudano-Guinean transition zone and the Guinean (Guinean-Congolese) zone. The Atlantic, Littoral, Mono, Couffo, Ouémé, Plateau, Zou and partially the Collines are the main departments covering the study area. The study area is bordered to the north by the departments of Borgou and Donga, to the south by the Atlantic Ocean, to the east by the Federal Republic of Nigeria and to the west by the Republic of Togo. A sandy-clay depression contains the Lama gazetted forest with an average altitude of 60 m above sea level (Daouda et al., 2021). The vegetation consists of a mosaic of dense, seasonally swampy forests surrounded by young and old fallows. The average annual temperature varies from 25°C to 29°C but the relative humidity remains fairly high throughout the year. In the Lokoli swamp forest, clay-silt and peat soils (Adomou et al., 2009) are found. The Gbidji swamp meadow is one of the components of the Dévé swamp forest, which is also made up of mosaics of fields and fallow land. It is a particular ecosystem that shelters, among other animal species (apart from the plants dominated by raffia palms), the pangolin, sub-populations of red river hog. With a sub-equatorial climate, the relief of the Dévé swamp forest is an alluvial plain made up of a series of lowlands and swamps. The Gnanhouizounmè community forest consists of 2 forest patches: Zindji (6ha 24a 26ca) and Kassiagbonou (20 ha 46a 32ca) (Mairie de Bonou, 2019), with other patches to be added over time. About plant formations in the Sédjè-Dénou and Houegoudo Complex, there are dry and open forests (Djéhlizoun, Gbéguézoun), wooded savannahs, shrublands and saxicolous savannahs (Akouègninou, 2004), plantations and sometimes forest galleries. In this complex, there are also stretches of marshy grassland and rivers bordering the communes of Bonou and Adjohoun. The gazetted forest of

Dogo-Kétou is located between 2°34' 26" and 2°42' 35" East longitude and between 7°32' 9" and 7°41' 23" North latitude with a surface area of 42,850 hectares (El-hadj & Kakpo, 2009). The Agbé-Mongnigbé complex is located in the Zou department in the south of Benin. The major part of this complex is observed in the Djidja district where Mongnigbé is found and the other part in the Abomey commune, precisely in the Détohou district where Agbé is observed. This complex is located between 7°15' 00" and 7°20' 00" North latitude and between 1°52' 12" and 1°57' 00" East longitude. The Djaloukou Ranch belongs to the wildlife production forest estate created and endowed with a management and development plan by the PAGEFCOM in 2013.

Method of data collection

Before to start our field work, the presence of *Phacochoerus africanus* and *Potamochoerus porcus* was verified by direct observation and by using indirect evidence such as wallows, footprints, lodgings, droppings, swill digging and food remains (Codjia et al., 2009). We used GPS (Global Positioning System) with an accuracy of ±5 m to record the both species occurence points in the field through some line and point transects from 15 December 2019 to 29 March 2020 around nine sites (Fig.1). We then supplemented our investigations with surveys, especially regarding to the past species distribution. Once the informants had recorded the previous presence of the species, we try to see on the land cover map (from Landsat ETM 2004 satellite images) the habitat types that had previously been established. The satellite images used were uploaded to the NASA site (earthexplorer.usgs.gov) in the southern Benin part during january and february of 2020 year. These months are chosen given the cloud cover in the other months of the year, which is not conducive to a good analysis. Thus we compare the results observed on the map to the different habitats where they could be found following the work of Codjia et al., (2020a). In addition, certain socio-professional categories were selected during the survey phases in places in southern Benin where the presence of these two suids was reported. These were: farmer, hunter, trader, logger, processor of agricultural products, veterinarian, ecological

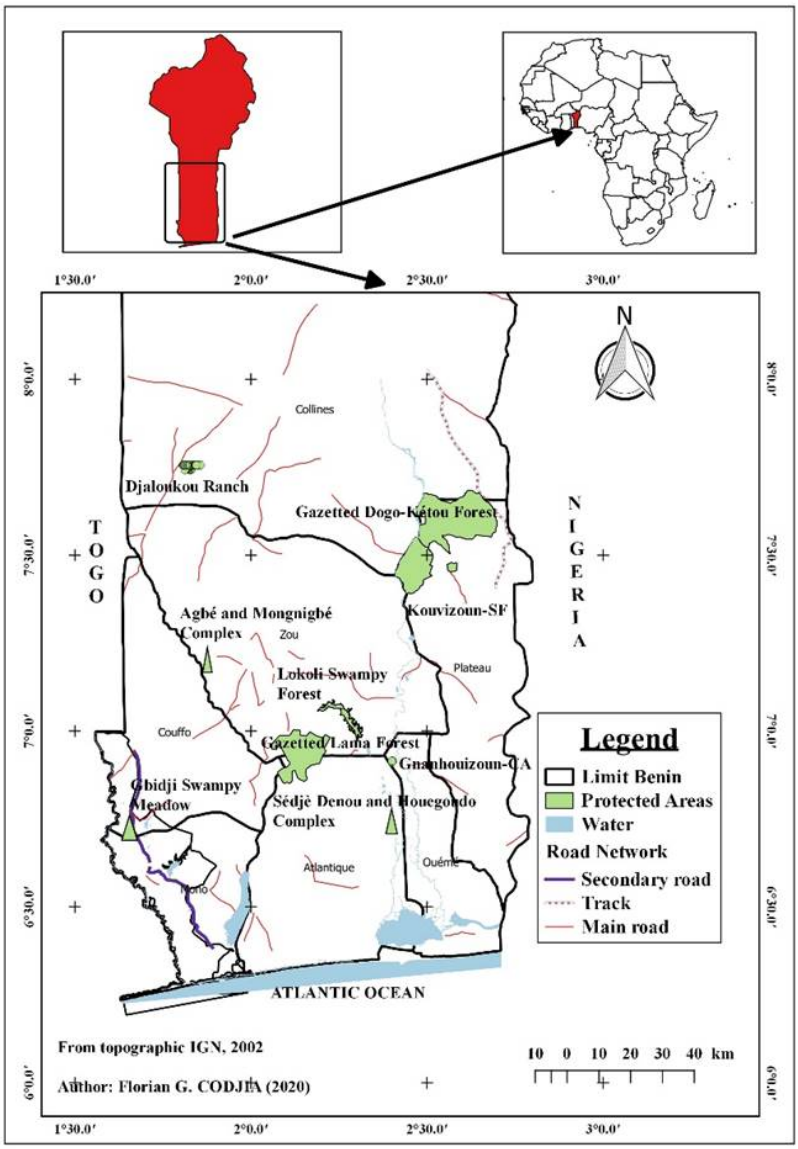

Fig. 1: Study area.

guide and herder. The sample size (n) to be surveyed was calculated using the normal approximation equation of the binomial distribution (Dagnelie, 1998):

$$n = \frac{U^2_{1-\alpha/2} \times p(1-p)}{d^2}$$

where is the sample size per selected village, p = 0.24 is proportion of residents aware of the current suids presence, U1-α / 2 is the standardized value with a probability p equals 1-α / 2 for a probability of 0.95 (with α = 0.05, U1-α / 2 ≈1.64) and d is the margin of error of the measured parameters however a standard error of 6% will be considered for this study. A total of n=138 people from these different socio-professional categories and ethnic groups were interviewed.

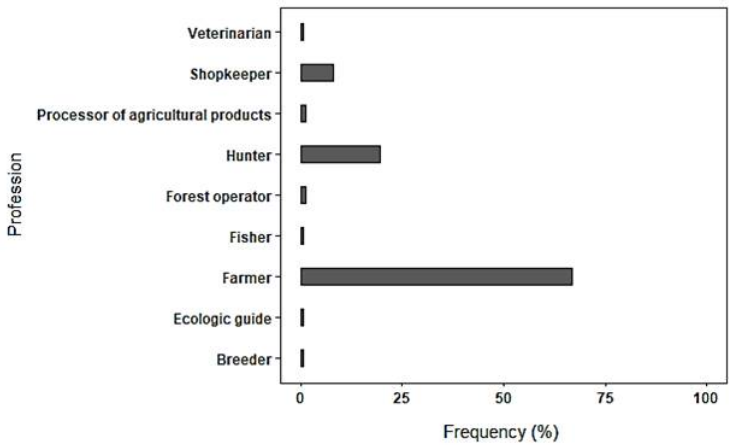

Fig. 2: Persons surveyed by different socio-professional categories.

Data analysis method

The past and present occurrence points of the suids recorded were projected using Qgis 3.10 software to establish the past and present distribution layers of each species with the polygon feature and node tool. The distribution maps were then designed using the layout tool. The land cover maps we produced from Landsat L7 ETM + (Enhanced Thematic Mapper Plus) satellite images from 2004 and Landsat L8 OLI-TIRS (Operational Land Imager and Thermal Infrared Sensor) images from 2019 were used to see the evolution of land cover classes at the level of past and present occurrence areas. Prior to their use and to facilitate geoprocessing, geometric corrections were made through the sub-menu processing, "check validity". A classification in graduation was carried out with regard to the number of presence indices observed at the occurrence sites.

Results

Past and present distribution area

The past and present distribution of common warthog and red river hog is shown in Fig. 3. The distribution area of the common warthog and red river hog has shrunk by 13% and 7% respectively nowadays. Thus in our study area, the common warthog is still found in the Agbé-Mongnigbé complex (commune of Abomey), the Djaloukou ranch (commune of Savalou) and the degraded forest of Dogo-Ketou. The red river hog on the other hand in the Sédjè and Houegoudo complex (commune of Zé and Adjohoun), the gazetted Lama forest, the Gnanhouizounmè community forest (commune of Bonou), the Lokoli swampy forest, the Kouvizoun sacred forest and the Gbidji swampy meadow (commune of Dogbo). The sympathric areas identified in their historical range represented 4% of our study site total area. Allopatrism areas can be observed between the degraded Dogo-Kétou forest and the Kouvizoun sacred forest.

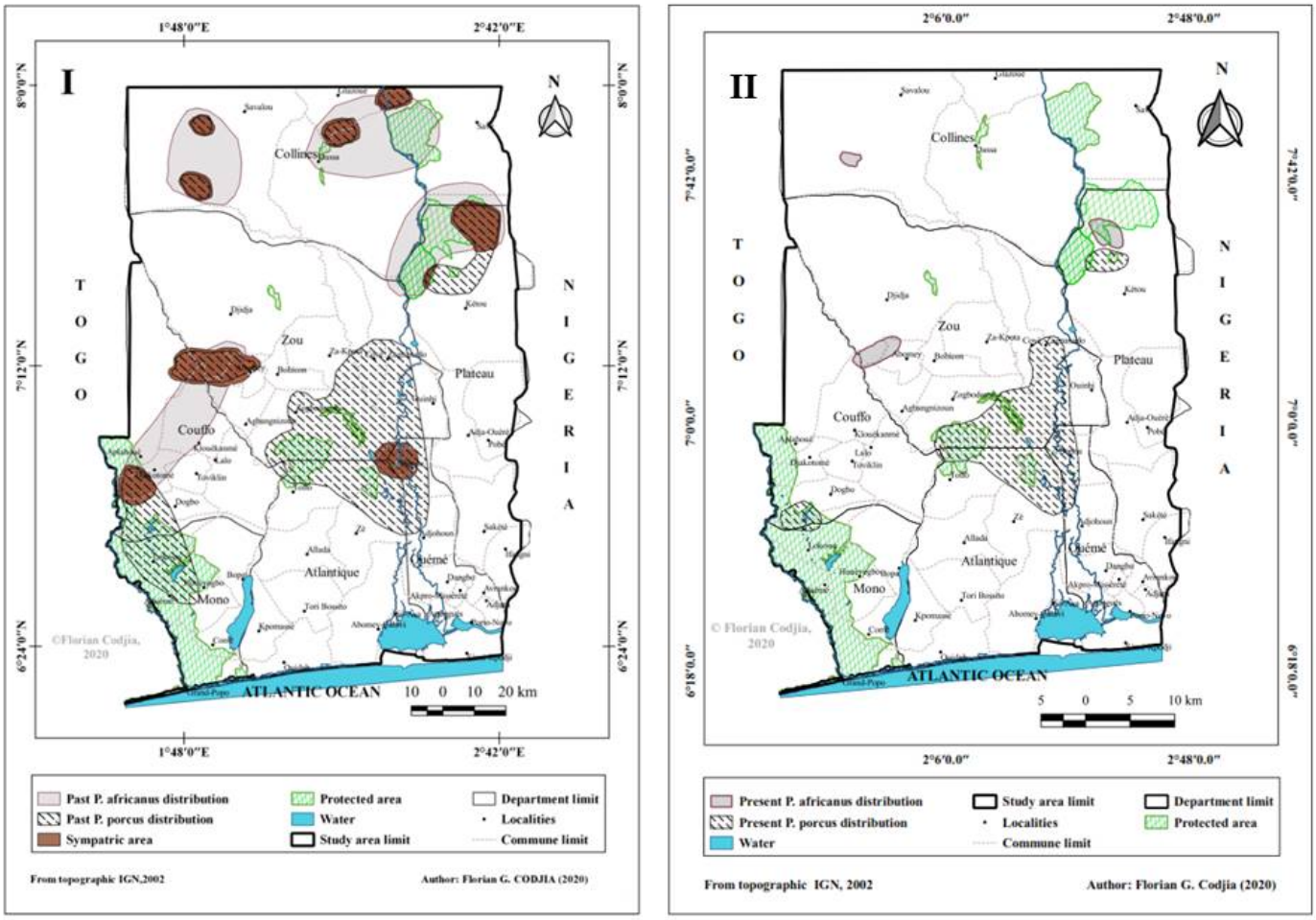

Fig. 3: Past (I) and present (II) distribution area of *Phachochoerus africanus* and *Potamochoerus porcus*.

Distribution area according to land cover

The land cover classes evolution in the past and present distribution areas of the common warthog and red river hog are shown in Fig. 4.

Fig .5 presents a brief summary of the information contained in Fig. 4 to better understand the dynamics of the past and present distribution of the two suids. For common warthog, a regression of the shrubby savannah, open forest and wooded savannah, swamp and under-palm classes towards agglomerates, fields and fallows and gallery forest can be seen. About red river hog, we have a reduction in the classes of swamp, gallery forest, dense forest, open forest and wooded savannah and shrubby savannah for the benefit of field and fallow, agglomeration classes, farms under palm trees and plantations with the appearance of the new bare soil class.

Relative abundance in current range

The relative abundance of occurrence indices in the current range of the common warthog and red river hog is shown in Fig. 6. The relative abundance of presence indices in the common warthog's distribution area is high in the Agbé-Mongnigbé complex and the Djaloukou ranch. In the red river hog, the highest presence indices are found in the Lama classified forest, the Gnanhouizounmè community forest and the Lokoli swamp forest.

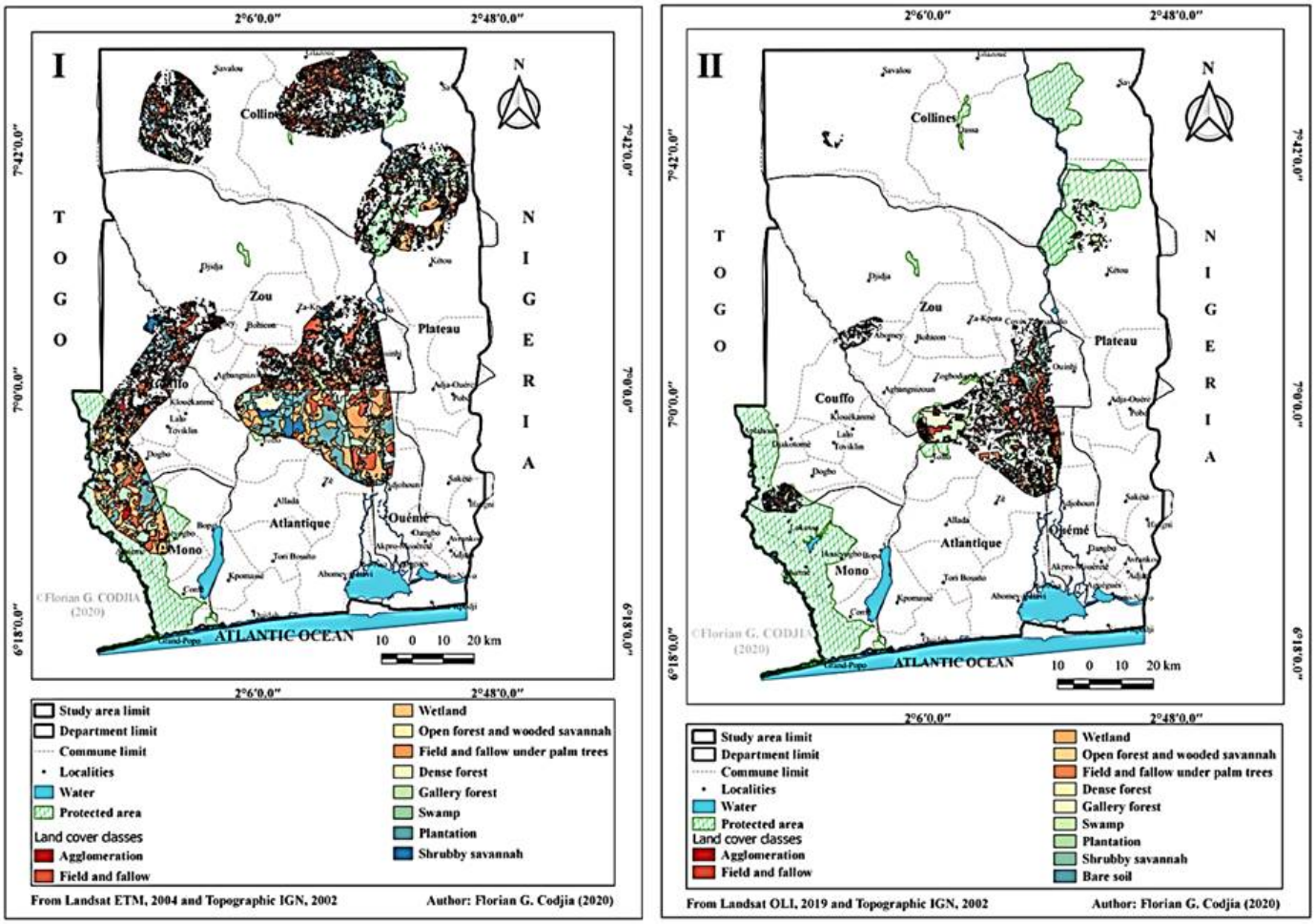

Fig. 4: Land cover classes in the past (I) and present (II) distribution areas of *Phachochoerus africanus* and Potamochoerus porcus in southern Benin.

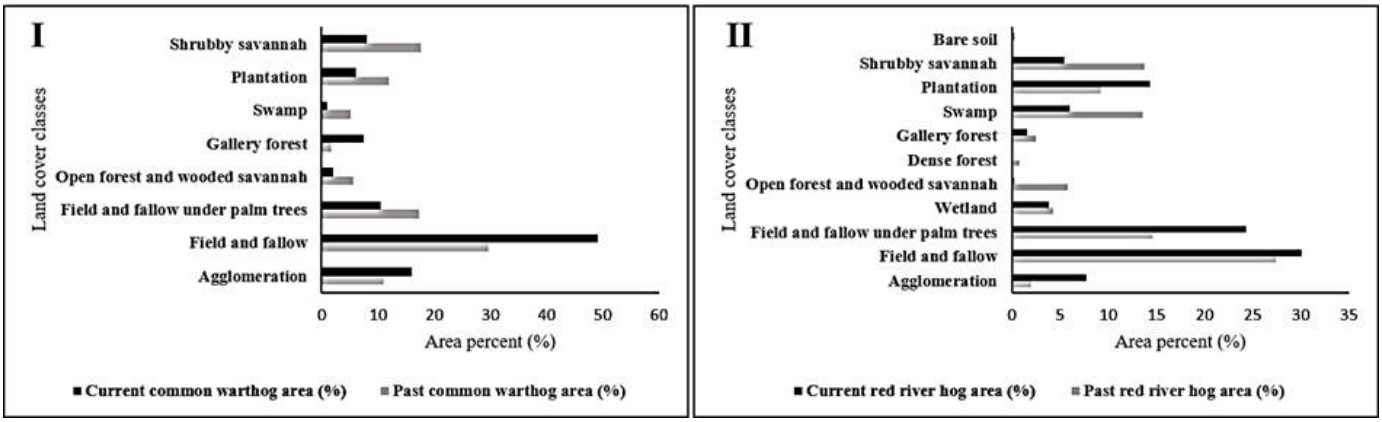

Fig . 5: Land cover classes distribution in the past and present distribution areas of *Phachochoerus africanus* (I) and *Potamochoerus porcus* (II) in Benin.

Discussion

The past and present distribution range of the common warthog and red river hog was addressed in this study in southern Benin. More than 19% of the original distribution areas of the two species in the past have been reduced up until now in our study area. All this makes the possibility of not

having a sympatric area at present. The sympatric speciation observed on them in the past was mainly made possible by the coexistence of allopatric, peripatric and parapatric speciation (Fitzpatrick et al., 2008) being basic categories of the geographic speciation observed in these suids. The gazetted Dogo-Kétou forest and the sacred forest of Kouvizoun cannot be included as part of the current sympatric area, even though they're quite close to each other (Allen & Turelli, 2001) because even though they are situated in the same ecological niche, their areas do not overlap as they did in the past, according to the local population and proven by the present distribution map. This situation is made possible by geographical barriers and the high degree of anthropisation, which has led to the total and very extensive degradation of the gazetted Dogo-Kétou forest, which no longer allows the movement of these suids in their ranges distribution (Meijaard et al., 2011). This is especially true as the sub-populations of the common warthog in Dogo-Kétou are very isolated. Moreover, we were only able to observe common warthog during our investigations in the Agbé and Mongnigbé complex, but the neighbouring population bears witness to the small numbers presence of red river hog in this area threatened by human activities. Long-term investigations with photographic traps are necessary in this complex where both species could a priori live in syntypical habitats. The rapid evolution in the dynamics of the land use classes in the ranges of the common warthog and the red river hog is quite remarkable, indicating advanced anthropisation. Although enormous efforts in terms of conservation actions are being made in the Lama gazetted forest and in the islets of Kassiagbonou and Zindji in Gnanhouizounmè.

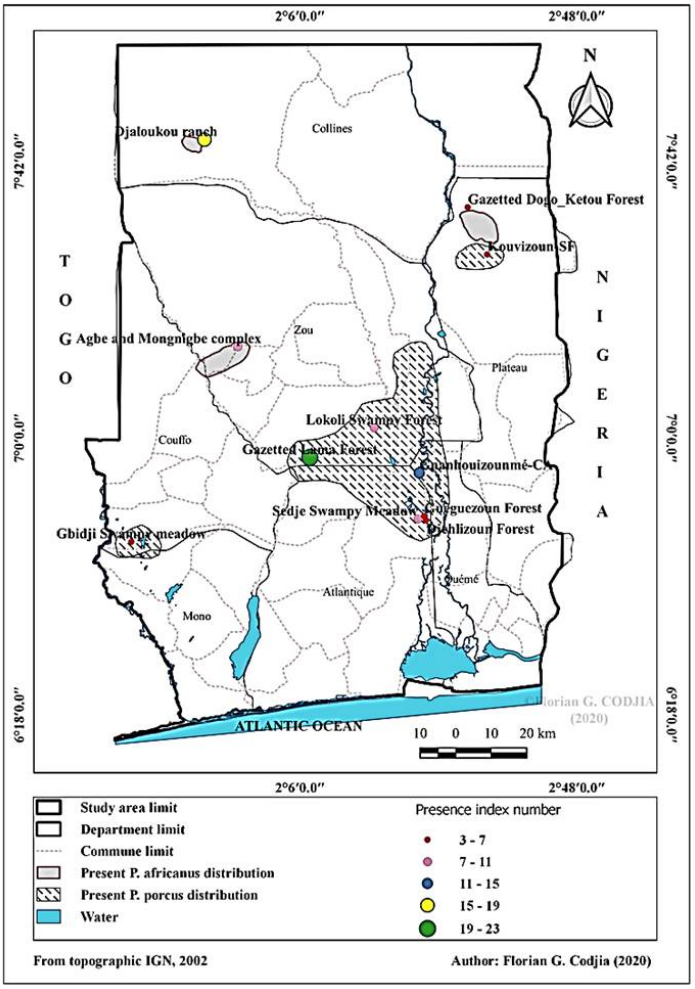

Fig. 6: Relative abundance of occurrence indices in the current distribution areas of *Phachochoerus africanus* and *Potamochoerus porcus*.

Fig. 7: (a): Red river hog trap installed in Sédjè-Denou and Houegoudo complex; (b): common warthog sub-adult individual killed in Agbé and Mongnigbé complex (Agbokpa) after three consecutive hunting days; (c): Yam cultivation in the Gazetted Dogo-Kétou forest.

According to the work of Le-Glaunec, (2006); Codjia et al., (2007); Codjia et al., (2021), the common warthog prefers open forest and wooded savannah, fallow land and generally avoids dense forests. The red river hog on the other hand likes to be found in swampy areas, riverbanks, dense forests, gallery forests but also in secondary habitats such as fields, dry forests and wooded savannahs (Seydack, 1990; Vercammen et al., 1993; Houehounha, 2011; Leus and Vercammen, 2013). Unfortunately, it is these main preferred habitats that are found in the largely reduced land cover classes in benefit to others for common warthog and red river hog in their ranges. Consequently, the ranges of both species suffer from a crucial problem of habitat loss. Some of the causes of this phenomenon are shown in Fig. 7 where 40.61% of the variation in hunting practice (χ^2 (89) = 5.42; P = 1; R^2 = 40.61%) was explained by district (P <0.05). We can always see on this figure the agriculture achievement.

This phenomenon is mainly caused then by the resurgence of human activities (agriculture, hunting, etc.) and the anarchic occupation of protected areas as witnessed in Codjia et al., (2018)'s work and observed in the classified forest of Dogo-Ketou and in the Agbe-Mongnigbe complex. The hypothesis that the loss of preferential habitats remains the main cause of the current disappearance of the sympatric areas in our study area is verified. All this reflects the abundance of presence indices at the current occurrence sites of the two species in southern Benin. The migration effect of the red river hog from the islets of Kassiagbonou and Zindji towards the forests of Djehlizoun, Gbegbezoun and the swampy meadow of Sédjè during the flood period could, in addition to human activities including agriculture and hunting, explain the relative abundance of indices in the community area of Gnanhouizounmè and the Sédjè-houegoudo complex. The gazetted Lama forest and the Djaloukou ranch recorded the highest numbers of clues respectively because of the protection status of this area at Massi, Koto and the new conservation actions in the old Savalou forest, which is now a ranch and where in the past both species were found.

Conclusion

The past and current range of the common warthog and red river hog was identified and then assessed in this study by providing an overview of relative abundance. In sum, the range of both species has shrunk considerably over time. In addition to the investigations that will have to be carried out in the Agbé-Mongnigbé complex, no sympatric area is yet observable in their distribution areas as was the case in the past. The distribution areas of the two species have so far experienced loss of preferential habitat. Apart from the Lama gazetted forest, where great conservation efforts have been perpetuated over time, justifying the relative abundance of the presence indices, we must redouble efforts in the rest of the current distribution areas of two species if we do not want to face the total collapse of these ecosystems in a few more years. Apart from a few scattered groups of individuals, only two viable populations persist in the Lama forest-Lokoli swamp forest block and the Bonou forest-Sédjè Denou Houegoudo complex block.

We suggest to:

-Review the land use policy and, above all, to raise public awareness of the cohabiting importance with animal species;

-Implement projects to restore the most degraded protected areas in their past and present range;

-Regroup the human local population, as was the case in the gazetted Lama forest, in small

fragments scattered throughout the distribution areas of the two species that have been severely degraded;
-Think about game ranching or suids reintroduction programmes into past distribution areas where major conservation efforts are being made and continue to be made;
-Identify and monitor the different migration corridors of the two species in their ranges.

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References

Adjin, C. K., Lougbegnon, T. O., Codjia, J. T. C., & Mensah, G. A. 2011. Distribution, caractérisation écologique de l'habitat et notes sur le régime alimentaire du phacochère commun, *Phacochoerus africanus* (Gmelin, 1788) au Sud du Bénin. Int. J. Biol. Chem. Sci., 5, 1907–1921.

Agassounon, M. D. 2005. Ecologie alimentaire du phacochère (*Phacochoerus africanus*, Gmelin 1788) dans la forêt classée de Wari-Maro au Bénin. Mémoire de 3è cycle DESS/FSA/UAC, Abomey-Calavi. p 85.

Allen, H. O., & Lynne, H. O. 1996. Waiting for Speciation: the Effect of population Subdivision on the Time to Speciation. Society for the Study of Evolution, 50(5), 1742–1749.

Allen, H. O., & Turelli, M. 2001. The evolution of postzygotic isolation: accumulating Dobzhansky-Muller Incompatibilities. Society for the Study of Evolution, 55(6), 1085–1094.

Amin, R., Wacher, T., & Butynski, T. 2017. Sympatry Among Three Suid Species (Family Suidae) On The North Coast Of Kenya. Journal of East African Natural History, 106, 67–78.

Codjia, F. G., Lougbegnon, O. T., Dossou, M. E., & Codjia, J. T. C. 2021. Habitats Selection with *Phacochoerus africanus* (Gmelin 1788) and *Potamochoerus porcus* (Linnaeus 1758) Diet through Local Perception in South of Benin. Animal Biodiversity and Conservation, 17.

Codjia, F. G., Lougbegnon, O. T., Labra, M., & Dossou, M. E. 2020b. Safeguarding of Benin wild pigs habitats to increase the resilience of spontaneous and marginal populations. Moroccan Journal of Agricultural Sciences, 1(6), 305–316. www.techagro.org.

Codjia, F. G., Lougbegnon, T. O., Mensah, A. G., & Codjia, J. T. C. 2020a. Place du potamochère roux et du phacochère commun au Bénin parmi les Suidés : synthèse bibliographique. Bull. Mens. Soc. Linn. Lyon, 89(5-6), 61–87. http://www.linneenne-lyon.org/spip3/spip.php?article1957

Codjia, F. G. (2018). Determinants of the abundance of the common hippopotamus *Hippopotamus amphibius* (Linnaeus , 1758) in the Mono Transboundary Biosphere Reserve. Master Thesis. University of Abomey-calavi, Faculty of Agricultural Science. 53 pages.

Codjia, J. T. C., Ekue, M. R., & Conde, S. K. 2007. L'habitat du phacochère (*Phacochoerus africanus*) dans la forêt classée des Trois Rivières au Bénin. In : Quelles aires protégées pour l'Afrique de l'Ouest ? Conservation de la biodiversité et développement (A. Fournier, B. Sinsin, & G. A. Mensah (eds.); IRD). Marseille, 238-246 pp.

Codjia, J. T. C., Lougbegnon, T., & Adjin, C. K. 2009. Étudier La Distribution Écologique Et Les Facteurs Du Choix De L'habitat Pour La Conservation Des Suidae Phacochère Et Potamochère : l'exemple du Bénin. In: P. Triplet, (eds), Manuel de gestion des aires protégées d'Afrique francophone. Awely, Paris, 1215. https://doi.org/hal-00669157

Dagnelie, P. 1998. Statistiques théoriques et appliquées. Brussels: De Boeck et Larcier.

Davis, M. L., Kelly, M. J., & Stauffer, D. F. 2011. Carnivore co-existence and habitat use in the Mountain Pine Ridge Forest Reserve, Belize. Animal Conservation, 14, 1469–1795.

de Oliveira, T. G., & Pereira., J. A. 2013. Intraguild predation and interspecific killing as structuring forces of carnivoran communities in South America. Journal of Mammal Evolution, 1–10.

Diallo, H., Bamba, I., Barima, Y. S. S., Visser, M., Ballo, A., Mama, A., Vranken, I., Maiga, M., & Bogaert, J. 2011. Effets combinés du climat et des pressions anthropiques sur la dynamique évolutive de la végétation d'une zone protégée du Mali (Réserve de Fina, Boucle du Baoulé). Science et Changements planétaires/Sécheresse, 22(2), 97–107.

Djagoun, C. A. M. S., Kassa, B., Mensah, A. G., & Sinsin, A. B. 2013. Seasonal habitat and diet partitioning between two sympatric bovid species in Pendjari Biosphere Reserve (northern Benin): waterbuck and western kob. African Zoology, 48, 279–289.

Fitzpatrick, B. M., Fordyce, J. A., & Gavrilets, S. 2008. What, if anything, is sympatric speciation? Journal of Evolutionary Biology, 21, 1452–1459.

Houehounha, D. H. M. 2011. Etude de l'abondance et de la répartition géographique de *Potamochoerus porcus* dans la forêt classée de la Lama au Sud du Bénin. Institut Polytechnique Rural de Formation et de Recherche Appliquee (IPR/IFRA) de Katibougou, p 85.

INSAE. 2016. Effectifs de la population des villages et quartiers de ville du Bénin. RGPH-4, 2013, 85.

Le-Glaunec, G. A. L. 2006. Etude épidémiologique du cycle sauvage de la peste porcine africaine dans la région du Sine Saloum au Sénégal. In : Docteur veterinaire. Univ. Paul-Sabatier, Toulouse : 5-140.

Leus, K., & Vercammen, P. 2013. *Potamochoerus porcus*. In: J.S. Kingdon and M. Hoffmann (eds), The Mammals of Africa. Volume 6. Pigs, Deer, Giraffe, Bovids, and Hippos. Bloomsbury Publ., London, 37–40.

Meijaard, E., D' Huart, J., & Oliver, W. 2011. Family Suidae (Pigs) (D. E. Wilson & R. A. Mittermeijer (eds.)). Handbooks of the Mammals of the World. Vol. 2. Hoofed Mammals. Lynx Ed., Barcelona, Espagne: 248-291. ISBN 978-84-96553-77-4.

Pascal, J. P. 2003. Description et Dynamiques des Milieux Forestiers. Notions sur les structure et dynamique des forêts tropicales humides. Rev. For. Fr. LV-Numéro Spécial, 118–130.

Seydack, A. H. W. 1990. The ecology of the bushpig (*Potamochoerus porcus* Linn. 1758) in the Cape Province, South Africa. PhD thesis, Univ. Stellenbosch, Stellenbosch, South Africa.

Vercammen, P., Seydack, A. H. W., & Oliver, W. L. R. 1993. The Bush Pigs (*Potamochoerus larvatus* and *P. porcus*). In: Pigs, Peccaries, and Hippos: Status Survey and Conservation Action Plan (W. L. R. Oliver (ed.)). IUCN/SSC Pigs and Peccaries Specialist Group - IUCN/SSC Hippo Specialist Group, Gland, Switzerland. 93-101.

Winterbach, H. E. K., Winterbach, C. W., Somers, M. J., & Hayward., M. W. 2013. Key factors and related principles in the conservation of large African carnivores. Mammal Review, 43, 89–110.

Playful pool diving by young babirusa

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Abstract

Young Sulawesi babirusa (*Babyrousa celebensis*) were recorded on 80 occasions diving into a temporary pool at Babirusa Park (Bali, Indonesia) over a period of five years from 2005. Based on video footage, this article describes aspects of this observed pool diving behaviour. Pool diving by young babirusa appeared to be a playful behaviour elicited by providing animals with a specially designed pool in tropical climatic conditions. These observations support the provision of relatively large water and mud areas to captive babirusa for animal welfare purposes.

Introduction

It is well known that animals' expressed behaviour whilst in captivity can be affected by a variety of external factors, such as enclosure design (spatial size, structure, and vegetation), surrounding natural environment (weather and climatic conditions), social environment (group composition, as well as the presence of familiar keepers, visitors, and animals of other species), and animal husbandry (diet, feeding methods, and schedules and training set by keepers). Wild pigs, including Sulawesi babirusa (*B. celebensis*), are no exception.

In common with other wild pigs, babirusa like to wallow in mud. Wallowing behaviour is useful for the pigs' thermoregulation, removal of ectoparasites, and skin care (Bracke, 2011). In habitat surveys, detected mud wallows of babirusa are one of the most informative field signs.

Fig. 1: Wallowing of a babirusa pair, the male Indro (background) and the female Priska (foreground). Indro is rubbing his dorsum against a 50-cm-high mud wall, he had dug into the clay over a number of days.

Wallowing behaviour by babirusa has been reported in natural habitats, including North Sulawesi for Sulawesi babirusa (*B. celebensis*) (e.g. Patry et al. 1995; Fig. 6.2 in Macdonald, 2017), Togian Islands for Togian babirusa (*B. togeanensis*) (Fig. 8.6 in Ito & Melletti, 2017), and Buru Island for Moluccan babirusa (*B. babyrussa*) (Deninger, 1910; Verbelen, 2003).

Interestingly, there is a difference in the frequency of sightings of babirusa wallowing in the eastern and western parts of Buru Island, suggesting a correlation with the physical environment (Macdonald & Pattikawa, 2017). Similar mud wallowing of babirusa has also been seen in zoos, where the environmental conditions necessary for this behaviour are met (Fig. 1). It has

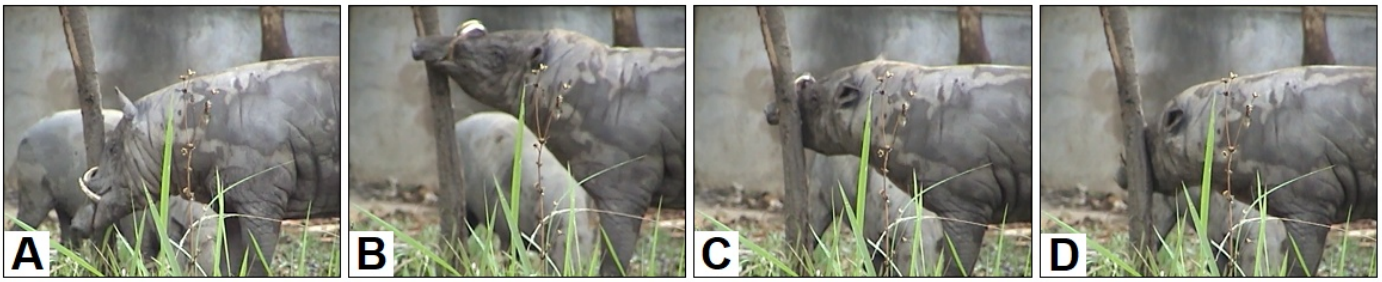

Fig. 2: A babirusa boar, Indro, rubbing his face against a young tree. His head moved up and down with alternately each side of the snout placed in contact with the stem of the young tree. A and B: Rubbing the right side of the face. C and D: Rubbing the left side of the face.

been suggested that the face-rubbing observed in this setting has a scent-marking function (Macdonald et al., 1996; Fig. 2).

Wild pig swimming has been reported worldwide where these animals inhabit. Clearly, babirusa are also strong swimmers. Examples of Togian babirusa (*B. togeanensis*) swimming across the narrow straits within the Togian Archipelago (Selmier, 1983) and Sulawesi babirusa swimming long distances in Lake Poso (Melisch, 1994) have been reported, and such sightings have continued. The outstanding physical capabilities of babirusa are an important factor on the animal side in determining their behavioural range and habitat distribution. Recent observations of babirusa in several zoos have led to a better understanding on how babirusa benefit from lying and swimming in water (Macdonald, 2017).

To gain a greater understanding of the natural behaviour of babirusa in coconut plantations (Selmier, 1983), and to provide them with a place to demonstrate their swimming ability, a captive breeding facility for Sulawesi babirusa imitating such an environment was temporarily set up in rural Bali, Indonesia at the end of 2004, and named Babirusa Park (Ito et al., 2020; Ito et al., 2022). Over a 5-year period, six offspring were born at this facility, giving us the opportunity to observe the strong bonds between mother and young babirusa. The mothers provided meticulous parental care of the singleton or twins when the young babirusa followed her, even when she entered the pool for bathing. Various behaviours of young babirusa were observed in the pool area. The present paper reports on their playful diving into the pool, based on recorded video data.

Table 1 Sulawesi babirusa observed at Babirusa Park.

Shela was the mother of Sherly, Shandro, and twins Shergio and Sherina. Priska was the mother of Karlo and Pindo. All six offspring were sired by Indro. The birth of Pindo and twins Shergio and Sherina in May 2009 was the result of a breeding programme aimed at having Priska and Shela give birth at the same time.

Name	Sex	Date of birth
Indro	M	17 Oct 2001
Shela	F	07 Jan 2003
April	M	23 Apr 2003
Priska	F	10 Oct 2003
Sherly	F	29 Jun 2005
Karlo	M	19 May 2006
Shandro	M	12 Aug 2006
Pindo	M	09 May 2009
Shergio	M	10 May 2009
Sherina	F	10 May 2009

Materials and methods

Study site and animals

Observations were made at Babirusa Park, located in Lodtunduh village, Bali, Indonesia. The subjects were ten individual Sulawesi babirusa, comprising two breeding pairs and six offspring born during the 5-year observation period starting in January 2005 (Table 1). Of the two adult male animals, Indro was dominant and April was

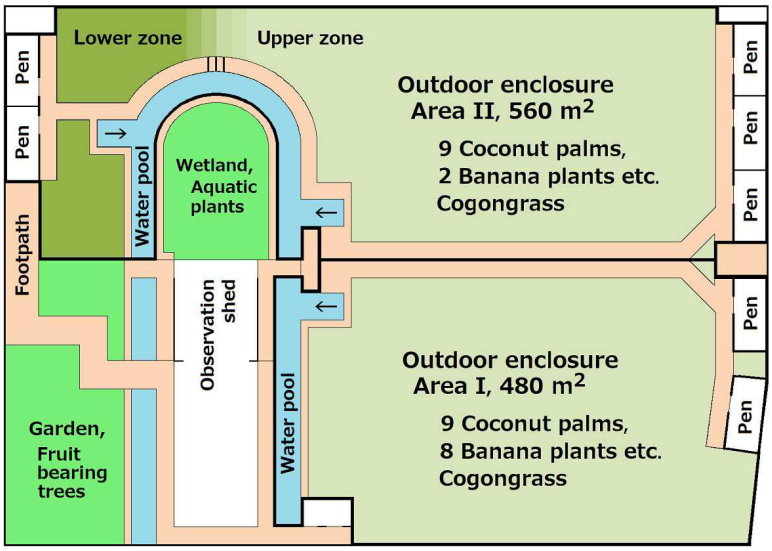

Fig. 3: Diagram of Babirusa Park

Arrows indicate the ramps to the pool. The three vertical bars on the footpath along the U-shaped pool indicate the three steps from the lower zone to the upper zone. Mud wallows dug into the ground by animals are not shown in the diagram, as they varied in location and size depending on the season. The area enclosed by the bold line was accessible to animals.

subordinate. Shela was the dominant adult female, and Priska was the subordinate female.

Enclosures

Animals were kept in two adjacent enclosures: Area I measuring 480 m^2 and Area II measuring 560 m^2 (Fig. 3). Based on a 1 metre difference in ground height, Area II was subdivided into two zones. The lower and upper zones were connected by three steps and a grassy area beside them (Fig. 4A).

Drawing on the results of field studies in North Sulawesi (Patry et al., 1995; Clayton & MacDonald, 1999) and the Togian Islands (Selmier, 1983), both enclosures provided outdoor pools,

Fig. 4: The structure of the side wall of the U-shaped pool and the ramp leading to the pool in Area II of Babirusa Park.

A: The babirusa sow–offspring pair ascending three steps to the upper zone. The young babirusa followed her mother. The babirusa boar, April, was standing on the footpath in the lower zone. The difference in height between the footpath in the lower zone and the water surface was approximately 25 cm.

B: The babirusa boar standing on the footpath in the upper zone. The babirusa sow–offspring pair was standing at the water's edge on the ramp to the pool from the upper zone. The difference in height between the footpath in the upper zone and the water surface was approximately 1 metre.

C: The babirusa boar standing on his hind limbs in the pool and leaning forward on the edge of the pool was foraging for water spinach (*Ipomoea aquatica*) grown in the wetland area surrounded by the U-shaped pool.

mud wallows, and shade under coconut palm trees as well as some tropical fodder trees for the animals. The study site was set up with a 1.6-metre-wide pool constructed through Areas I and II (an upgrade of the existing 1.5-metre-wide pond) with a surrounded observation shed and a wetland area planted with water spinach (*Ipomoea aquatica*). A single 1.6-metre-wide ramp was installed in Area I and a pair of 1.6-metre-wide ramps were installed in Area II, to allow the animals to access the pool from the ground (Fig. 4B). The 35-cm-wide side walls of the pool and

the ramps were constructed from stacked round stones. The tops of the poolside walls and the footpaths were covered with concrete blocks.

Animal husbandry

Keepers were responsible for cleaning the enclosures in the morning and for feeding the animals in the morning and evening. An important proportion of the nutritional intake of the animals was derived from free foraging in the spacious outdoor enclosures, including the pool area (Fig. 4C; Fig. 7 in Ito et al. 2017). Animal handling was kept to a minimum. Faecal ova-parasite examination and regular deworming were carried out approximately every six months.

Behavioural observation

Four sow–piglet pairs of babirusa and one sow–twin piglet group were observed in Area II, where the pool was shallower. We recorded their spontaneous behaviours in the pool area when no visitors were present and no restrictions were placed on the animals. This paper focuses mainly on the behavioural findings in the two different social settings, as follows:

1) The babirusa sow, Shela and her female firstborn, Sherly shared Area II with an unrelated subordinate babirusa boar, April. Photographic information, collected on the 2nd of January 2006 during the wet season, was analysed.

2) Two groups comprising the babirusa sow Priska and her male offspring, Pindo, and sow Shela and her twins (male Shergio and female Sherina), shared Area II with the dominant boar, Indro, who was the father of all three young babirusa. The two groups were also observed when the dominant boar was absent.

Results

Fig. 5: The babirusa sow–offspring pair, Shela and Sherly, descending the ramp leading to the pool from the upper zone.

As has been observed in other zoos, babirusa sows at Babirusa Park diligently cared for their young, both indoors and outdoors. In response, the young babirusa followed their mothers and increased their behavioural repertoire by imitating their mothers' behaviour. Mother-following behaviour by the young babirusa included walking down the ramps installed as guideways to the pool and bathing in the pool (Fig. 5).

One action that caught our attention was the young female babirusa, Sherly, diving into the pool at 6 months of age. When her mother had descended the ramp and started walking into the pool, Sherly was still on the ground some distance away. Sherly did not use the slope to enter the pool, but instead walked in a straight-line onto the poolside footpath closest to her mother.

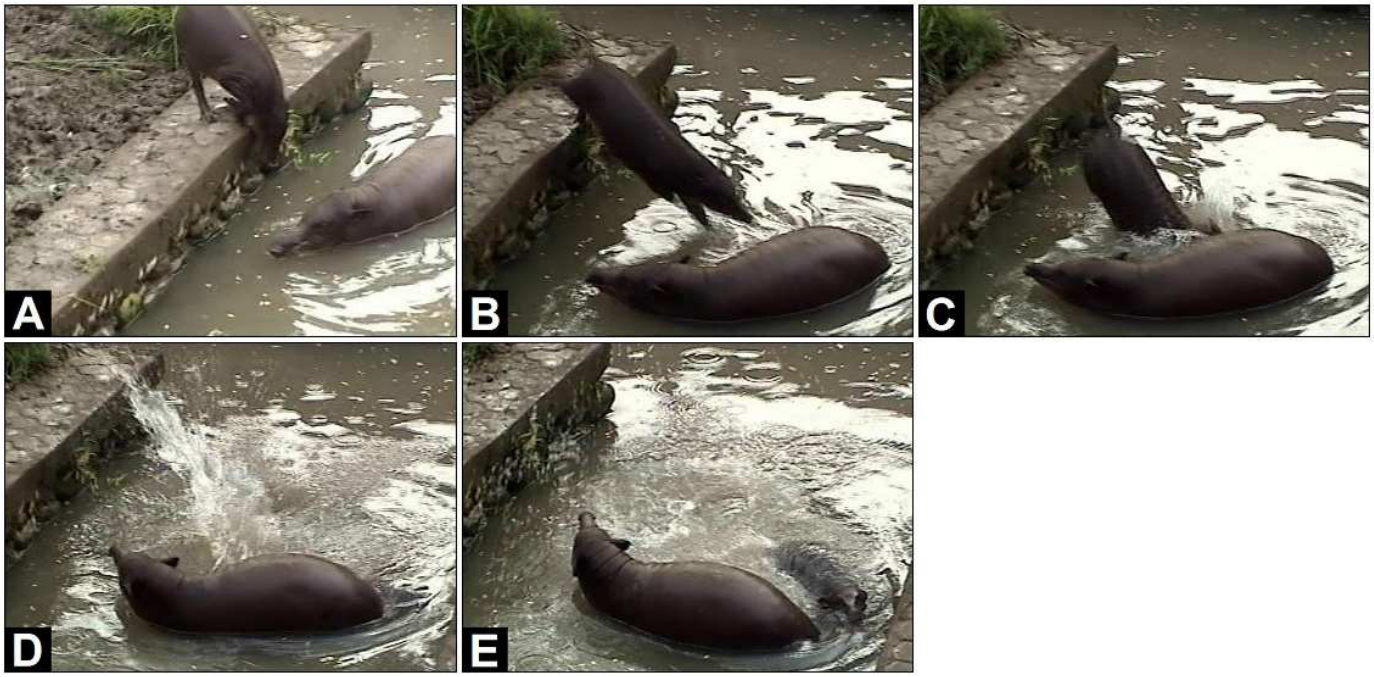

Fig. 6: The young babirusa, Sherly, diving into the pool from the lower zone.

A: The young babirusa, Sherly, standing on the edge of the poolside close to her mother bathing in the pool.

B and C: The youngster diving from the poolside towards her mother in the pool.

D: The large splash made by the youngster landing in the water.

E: The youngster dog-paddling around her mother.

The young babirusa stood on the edge of the 35-cm-wide poolside wall, leaned forward and looked at her mother with her head down (Fig. 6A), dived from the poolside into the water beside her mother (Fig. 6BC). The young babirusa had quickly extended her forelimbs forward before landing in the water and entered the water snout first. After entering the water with a large and loud splash (Fig. 6D), she put her head above the water and started dog-paddling (i.e. swimming with forelimbs and hind limbs ventral to the body and moving alternately reminiscent of a dog swimming; Fish et al., 2020) around her mother (Fig. 6E). She then swam towards the ramp and walked up onto the poolside. She repeated the dive into the pool twice, from approximately the same position. The young babirusa did not subsequently squeal, cower, or show any gestures of pain or other physical problems. She exhibited normal mother-following behaviour after the sow got out of the pool.

Similar dives were also exhibited by the other five young babirusa; the males Karlo, Shandro and Pindo, and the twins Shergio and Sherina, were born in different years at Babirusa Park. A total of 50 dives were recorded overall in Area II, including Sherly's dive (Table 2). These included dives from the upper zone (which was approximately 1 metre higher). Sherly and Karlo were later transferred with April from Area II to Area I to more closely observe this behaviour; they exhibited 24 and 6 additional pool dives, respectively.

The year on Bali is divided evenly into a 4-month dry season, a 4-month rainy season, and two 2-month transition periods (Ito et al., 2019). The expression of pool diving tended to be biased towards the wet season. This behaviour was seen on 12 occasions in the dry season vs. 23

Tab. 2: Group composition of babirusa and the number of pool dives in Area II.

Among the adult male animals, Indro was dominant, and April was subordinate, and either one stayed in Area II. Among females, Shela was dominant and Priska was subordinate. Periods when sow–offspring pairs were housed in indoor enclosures (to avoid physical contact between boars and sows in oestrus) were excluded from these observations. The symbol "–" indicates that the relevant animal was absent in Area II.

Group composition			Number of animals	Number of days observed	Number of pool dives
Sow	Offspring (days of age)	Boar			
Shela	Sherly (88–397)	April	3	298	26
Priska	Karlo (104–205)	Indro	3	78	0
Shela	Shandro (142–794)	Indro	3	444	4
—	Shandro (359–772)	Indro	2	55	0
Priska Shela	Karlo (171–226) Shandro (86–141)	Indro	5	45	2
Priska Shela	Pindo (176–346) Shergio & Sherina (175–345)	Indro	6	87	11
Priska Shela	Pindo (195–343) Shergio & Sherina (194–342)	—	5	80	7

occasions in the transition periods vs. 45 occasions in the wet season.

The dominance status of the adult males cohabiting with their young appeared to play a role. The diving behaviour was expressed more often when the young babirusa was cohabiting with the subordinate male (56 occasions in the presence of the subordinate boar vs. 17 occasions in the presence of the dominant boar vs. 7 occasions in the absence of a boar). As they grew older, the pool jumping behaviours of the young babirusa decreased, and instead, they accessed the pool by walking down the ramp.

In the case of a group in which two sow–piglet groups and the common father of all three piglets were cohabiting, a typical agonistic behaviour was observed during the first 2–3 days, in which the dominant mother bit the subordinate mother's limbs (Macdonald et al. 1993). The subordinate sow–piglet pair tended to choose areas away from the dominant group, not only during free foraging but also during daytime resting and nest-building behaviour in the evening. With the passage of time and their physical growth, the three young babirusa in both groups showed reduced mother-following behaviour.

When both groups were accidentally close together, the young separated from their mothers, and the three young rallied and frolicked together. When the young babirusa were gathered together in the pool area, pool diving behaviour was expressed by all three, in a similar fashion to that described above. Occasionally, the young male babirusa stood up on their hind limbs and engaged in 'boxing' behaviour (Macdonald et al. 1993), as seen between adult males. Gradually, from the stage when the young babirusa from both groups began to play together, the six individuals in Area II were observed to form a loosely knit group.

By way of contrast the four adult animals were seen to dive into the pool on only three occasions. Nevertheless, after walking down the slope they frequently submerged themselves and swam underwater. For example, at midday on the 19th of December 2006, after several days of sunny weather with maximum temperatures exceeding 30°C, we recorded the babirusa boar, Indro (5 years 2 months of age), staying in the pool of Area I for 8 minutes. He completely submerged his head on 11 occasions (submergence duration: M = 17.7 sec, SD = 6.7 sec). This included one occasion in which he spent 30 seconds moving from one end of the 12-metre-long pool to the other end with its entire body fully submerged. When the animal surfaced to breathe, he occasionally appeared to be chewing. On another occasion, the animal spat out what appeared to be pieces of shell from apple snails (*Pomacea canaliculata*) after returning to the poolside.

Discussion

The fact that not only the first babirusa born at Babirusa Park but also the second and subsequent offspring all dived into the pool was a totally unexpected finding for us. This is because the waterfront structures at Babirusa Park were not designed for the type of behaviour reported here.

It is noteworthy that just before the young babirusa dived into the pool, there was enough space behind it (Fig. 6AB), and no other animals or keepers were present. There was no evidence that this behaviour was the result of any accidental fall into the pool. The animal did not dive into the pool because it was being chased by something and had no choice but to escape. It did not fall into the pool after being pushed by another animal. Different young babirusa developed this pool diving behaviour on different occasions. Furthermore, the behaviour was not pre-trained by the keepers. Hence, the piglet clearly appeared to be spontaneously diving to join its mother, who was already bathing in the pool. We concluded that it was a playful behaviour elicited by providing these animals with a specially designed outdoor pool under favourable climatic conditions.

Although daily data on pool depths were not collected during these observations, there was a clear relationship between the rainy season and pool depth. During the rainy season, the inflow of rainwater also reduced the height difference between the poolside and the water surface. Perhaps learned attractiveness of diving into deeper water may help explain the difference in frequency of diving behaviour between rainy and dry seasons.
The small sample size and the range of growth stages of the piglets precluded general conclusions with regard to these observed behaviours. The frequency of diving behaviour appeared to be influenced by factors such as the social environment (i.e. the relationship with cohabiting individuals). The presence of a boar that was intolerant or aggressive towards other individuals appeared to have the potential to compromise the behaviour of sow–offspring pairs (Ito et al., 2021).

The reason why adult animals rarely jumped into the pool may have been due to the size of the pool. The pool may have been too small for adult animals to enjoy pool diving. Its width of 1.6 metres was only 1.5 times the body length of an adult animal. This may also have been true for the depth of the pool water in Area II. In short, this observation suggests that adult babirusa have the appropriate judgement to choose a safe way to reach their destination, even if it was a somewhat roundabout way of entering the pool from the slope. Babirusa cognition and the resulting behavioural choices are interesting topics that should be investigated in the future.

This study supports the suggestion that the daily range of activities of babirusa in zoos could be improved by providing them with a relatively large area of water and a mud area for non-drinking purposes. It also raised the question of what other kinds of playful behaviours are currently being displayed by young babirusa in zoos around the world where the varied structural and environmental conditions in animal enclosures enable them to be exhibited.

Acknowledgements

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References

Bracke MBM. 2011. Review of wallowing in pigs: description of the behaviour and its motivational basis. Applied Animal Behaviour Science 132: 1–13.

Clayton L and MacDonald DW. 1999. Social organization of the babirusa (*Babyrousa babyrussa*) and their use of salt licks in Sulawesi, Indonesia. Journal of Mammalogy 80(4): 1147–1157.

Deninger K. 1910. Über Babyrussa. Berichte der Naturforschenden Gesellschaft zu Freiburg i. Br. 18, 122.

Fish FE, DiNenno NK and Trail J. 2021. The “dog paddle”: Stereotypic swimming gait pattern in different dog breeds. Anatomical Record 304: 90–100.

Ito M, Macdonald AA, Balik IW, Arimbawa IWGB and Hasegawa Y. 2022. Observation of mandibular yaw movement in the Sulawesi babirusa (*Babyrousa celebensis*). Suiform Soundings 20(2): 15–23.

Ito M, Macdonald AA, Leus K, Atmaja IDGA and Balik IW. 2017. Food preparation behaviour of babirusa (*Babyrousa celebensis*). Journal of Zoo and Aquarium Research 5(2): 97–103.

Ito M, Macdonald AA, Leus K, Balik IW and Arimbawa IWGB. 2019. Effects of Meteorological Factors on the Expression of Nesting Behaviour in the Sulawesi babirusa (*Babyrousa celebensis*). Japanese Journal of Zoo and Wildlife Medicine 24(2): 73–84.

Ito M, Macdonald AA, Leus K, Balik IW and Arimbawa IWGB. 2021. Father-son relationship of Sulawesi babirusa (*Babyrousa celebensis*). Malayan Nature Journal 73: 7–18.

Ito M, Macdonald AA, Leus K, Balik IW, Arimbawa IWGB, Hasegawa Y and Atmaja IDGA. 2020. Coconut Feeding of the Babirusa (*Babyrousa* spp.). Japanese Journal of Zoo and Wildlife Medicine 25(3): 91–100.

Ito M and Melletti M. 2017. Chapter 8. Togian Babirusa *Babyrousa togeanensis* (Sody, 1949). Pp. 76–84 in: Melletti M and Meijaard E (eds.) Ecology, Conservation and Management of Wild Pigs and Peccaries. Cambridge University Press, Cambridge.

Macdonald AA. 2017. Chapter 6. Sulawesi Babirusa *Babyrousa celebensis* (Deninger, 1909). Pp. 59–69 in: Melletti M and Meijaard E (eds.) Ecology, Conservation and Management of Wild Pigs and Peccaries. Cambridge University Press, Cambridge.

Macdonald AA, Bowles D, Bell J and Leus K. 1993. Agonistic behaviour in captive Babirusa (*Babyrousa babyrussa*). Z Säugetierkunde 58: 18–30.

Macdonald AA, Leus K, Florence A, Clare J and Patry M. 1996. Notes on the behaviour of Sulawesi Warty pigs *Sus celebensis* in North Sulawesi, Indonesia. Malayan Nature Journal 50: 47–53.

Macdonald AA and Pattikawa MJ. 2017. Babirusa and other pigs on Buru Island, Maluku, Indonesia – new findings. Suiform Soundings 16(1): 5–18.

Melisch R. 1994. Observation of swimming babirusa *Babyrousa babyrussa* in Lake Poso, Central Sulawesi, Indonesia. Malayan Nature Journal 47: 431–432.

Patry M, Leus K and Macdonald AA. 1995. Group structure and behaviour of babirusa (*Babyrousa babyrussa*) in Northern Sulawesi. Australian Journal of Zoology 43: 643–655.

Selmier VJ. 1983. Bestandsgröße und Verhalten des Hirschebers (*Babyrousa babyrussa*) auf den Togian Inseln. Bongo 7: 51–64.

Verbelen F. 2003. Short communication: Babirusa sightings on Taliabu and Buru. Asian Wild Pig News 3: 13.

Rome residents impose curfew after spate of wild boar attacks

https://www.theguardian.com/world/2022/may/03/rome-residents-curfew-wild-boar-attacks
by Angela Giuffrida, 3 May 2022

Nightly restriction in north comes as woman says boar 'was on top of my head' during encounter on Sunday.

Residents in several neighbourhoods in northern Rome have imposed a nightly "curfew" after a spate of attacks by wild boar, which for years have roamed the Italian capital.

In the most recent encounter, a woman said a boar "was on top of my head" after she was pushed to the ground during an attack on Sunday night. The incident prompted exasperated residents of Balduina and six other districts to impose an 8.30pm curfew.

"On the [social media] chats between people in the district, and especially in group chats between people who have dogs, it is advised not to go out after 8.30pm," Gianluca Sabino, a Balduina resident, told La Repubblica newspaper. "Because at night, if somebody falls over or is hurt and nobody is around to help, then they could remain on the ground for who knows how long."

Franco Quaranta, the president of a residents' activist group in Aurelio, described the curfew as an act of "self-protection" by citizens because the authorities had failed to take effective measures. "This time the victim was an adult – but what if it happens to a child? With [the boars'] teeth, even just a bite to the leg is enough to jeopardise someone's life," he said.

Giovanni Mantovani, who runs a similar organisation in Monte Mario, said: "These animals are getting closer and closer to people, and it's not just at night – they are walking the streets at all hours of the day."

The latest victim was Marta Santangelo, a psychotherapist, who was attacked by a boar beside a bin while walking her dog. "It was just before 11pm … I was carrying a bag of rubbish and by the bin I noticed boar cubs. The mother was fixating on me. I understood that maybe she was scared and so picked up my dog and ran for cover."

But as she tried to flee, Santangelo said she was attacked by the mother boar and fell to the ground. "She was on my head … I screamed and my dog defended me. There were seven piglets close by but they didn't attack."

Santangelo was picked up by a motorist and taken to hospital, where she was treated for minor injuries to her face and knee.

In response to the attack, Rome authorities announced anti-boar measures, including fencing-off areas of natural park where the animals enter the city, and regularly collecting rubbish, particularly bins in areas close to the animals' main entrance points.

Massimo Vetturi, the director of the wild animals unit at the animal rights organisation LAV, said boar attacked humans only if they felt there was a threat to their offspring or source of food.

"These are the two critical elements that can unleash an attack, from any wild animal, not just boar," he said. "But if a boar is close to an overflowing bin and a human approaches, it will act in a way to remove the threat to its essential food source. The real problem in Rome is that there has been no management of the problem."

Pig grunts reveal their emotions

https://www.sciencedaily.com/releases/2022/03/220307082325.htm
by University of Copenhagen - Faculty of Science, 7 March 2022

We can now decode pigs' emotions. Using thousands of acoustic recordings gathered throughout the lives of pigs, from their births to deaths, an international team of researchers has translated pig grunts into the emotions they appear to express.

Is a pig grunt worth a thousand words? Perhaps so. In a new study, an international team of researchers from Denmark, Switzerland, France, Germany, Norway and the Czech Republic have translated pig grunts into emotions. The findings have been published today in Scientific Reports.

Using more than 7000 audio recordings of pigs, the researchers designed an algorithm that can decode whether an individual pig is experiencing a positive emotion ('happy' or 'excited'), a negative one ('scared' or 'stressed') or somewhere in between. The recordings were collected in a wide range of situations encountered by commercial pigs, both positive and negative, from when they are born until their deaths.

"With this study, we demonstrate that animal sounds provide great insight into their emotions. We also prove that an algorithm can be used to decode and understand the emotions of pigs, which is an important step towards improved animal welfare for livestock," says Associate Professor Elodie Briefer of the University of Copenhagen's Department of Biology at the University of Copenhagen, who co-led the study.

Short grunts are 'happy' grunts.

The researchers recorded pig sounds in both commercial and experimental scenarios, which based on the behavior of the pigs, are either associated with a positive and negative emotion. Positive situations included, for example, those when piglets suckle from their mothers or when they arere united with their family after being separated. The emotionally negative situations included, among others, separation, fights between piglets, castration and slaughter.

In experimental stables, the researchers also created various mock scenarios for the pigs, designed to evoke more nuanced emotions in the middle of the spectrum. These included an arena with toys or food and a corresponding arena without any stimuli. The researchers also placed new and unfamiliar objects in the arena for the pigs to interact with. Along the way, the pigs' calls, behavior and heartrates were monitored and recorded when possible.

The researchers then analyzed the more than 7000 audio recordings to see if there was a pattern in the sounds as a function of the emotions, and if they could discern the positive situations and emotions from the negative ones. As already revealed in previous research, the researchers collected more high-frequency calls (such as screams and squeals) in negative situations. At the same time, low-frequency calls (such as barks and grunts) occurred both in situations where the pigs experienced positive or negative emotions.

The situations between the extremes were particularly interesting. With an even more thorough analysis of the sound files, the researchers found a new pattern that revealed what the pigs experienced in certain situations in even greater detail.

"There are clear differences in pig calls when we look at positive and negative situations. In the positive situations, the calls are far shorter, with minor fluctuations in amplitude. Grunts, more specifically, begin high and gradually go lower in frequency. By training an algorithm to recognize these sounds, we can classify 92% of the calls to the correct emotion," explains Elodie Briefer.

Farmers can monitor animal emotions.
The study of animal emotions is a relatively new field that has come about over the last 20 years. Today, it is widely accepted that the mental health of livestock is important for their overall well-being. Nevertheless, today's animal welfare focuses primarily on the physical health of livestock. Indeed, several systems exist that can automatically monitor an animal's physical health for a farmer.
Analogous systems to monitor the mental health of animals have yet to be developed. The researchers of the study hope their algorithm might pave the way for a new platform for farmers to keep an eye on their animals' psychological well-being.
"We have trained the algorithm to decode pig grunts. Now, we need someone who wants to develop the algorithm into an app that farmers can use to improve the welfare of their animals," says Elodie Briefer.
She adds that, with enough data to train the algorithm, the method could also be used to better understand the emotions of other mammals.

Facts:
The researchers recorded 7414 sounds from 411 pigs in different scenarios, from birth to death.
A machine learning algorithm was trained to decode whether pig calls can be classified as a function of positive or negative emotions.
The researchers defined the emotions of pigs based on how they naturally react to various positive and negative external stimuli, and whether stimuli can improve (positive) or threaten (negative) their lives.
For example, typical signs of negative emotions in pigs are that they stand still, emit a lot of vocalizations, and try to escape, while positive ones include exploring their surroundings and having their ears postured forward.
Positive situations included huddling with littermates, nursing, positive conditioning, enrichment, reunion with the mother, and freely running. Negative situations included, among others, missed nursing, short social isolation, piglet fights, piglet crushing by the mother, castration, and handling and waiting in the slaughterhouse.
Sixteen researchers from Denmark, Switzerland, France, Germany, Norway and the Czech Republic participated in the study.

Journal Reference:
Elodie F. Briefer, Ciara C. -R. Sypherd, Pavel Linhart, Lisette M. C. Leliveld, Monica Padilla de la Torre, Eva R. Read, Carole Guérin, Véronique Deiss, Chloé Monestier, Jeppe H. Rasmussen, Marek Špinka, Sandra Düpjan, Alain Boissy, Andrew M. Janczak, Edna Hillmann, Céline Tallet. Classification of pig calls produced from birth to slaughter according to their emotional valence and context of production. Scientific Reports, 2022; 12 (1) DOI: 10.1038/s41598-022-07174-8

Hungry javelina, trapped in car, goes for a drive in Arizona

https://www.theguardian.com/us-news/2022/apr/12/javelina-trapped-car-goes-for-drive-arizona
by Associated Press, 12 Apr 2022

Animal jumped in car to get a bag of Cheetos, and then knocked car into neutral causing it to roll

down driveway and across the street.
A hungry javelina ended up going for a drive in Arizona when it became trapped inside an empty car and bumped it into neutral.
Javelinas are pig-like animals that are native to desert environments. Deputies in Yavapai county responded to a call last week in Cornville, a community 10 miles south of Sedona, about a javelina stuck in a Subaru station wagon.
After speaking with the car's owner and other residents, they determined the car's hatchback had been left open overnight. The javelina jumped in to get to a bag of Cheetos. The hatch then closed, trapping the animal inside.
Authorities say the javelina ripped off a portion of the dashboard and the inside of a door in an attempt to escape.
The animal then managed to knock the car into neutral, causing it to roll down the driveway and across the street. The Subaru came to a rest, and the javelina was not injured.
A deputy opened the hatch, and the javelina was able to run back into the wilderness.

Call for hippos to join list of world's most endangered animals

https://www.theguardian.com/environment/2022/aug/02/call-for-hippos-to-join-list-of-worlds-most-endangered-animals-aoe
by Patrick Greenfield, 2 Aug 2022

New classification would mean a total ban on international trade in the animal's body parts, as climate crisis and poaching hit populations.
Hippos could be added to the list of the world's most endangered animals because of dwindling populations caused by the climate crisis, poaching and the ivory trade.
The semi-aquatic mammals are found in lakes and rivers across sub-Saharan Africa, with an estimated population of 115,000-130,000. As well as the trade in ivory – found in its teeth – and animal parts, they are threatened by habitat loss and degradation, and the effects of global heating.
Hippos are also legally traded for commercial purposes and hunting trophies under Cites, the Convention on International Trade in Endangered Species of Wild Fauna and Flora.
Ahead of the next Cites Cop in Panama in November this year, 10 west African countries, including Togo, Gabon and Mali, have proposed that hippos be given the highest protection under Cites by listing them under appendix I of the convention. Hippos are already listed as an appendix II species, which means they are not necessarily threatened with extinction but could become so if their trade is not regulated.
If approved, it would mean a total international ban on the trade in hippo body parts and ivory to help avert the decline of the species. It is estimated that at least 77,579 hippo parts and products were legally traded from 2009 to 2018.
In 2016, hippos were classified as vulnerable to extinction on the IUCN red list with local declines, particularly in west Africa, raising fears about the survival of the species in some of the 38 African countries where it is found.
The hippopotamus is one of the world's heaviest land animals; males can weigh as much as 1,800kg, and they are often found in large groups. The animals are especially vulnerable to overexploitation due to their long gestation periods of eight months, and females not reaching

sexual maturity until nine or 10 years.
Rebecca Lewison, co-chair of the IUCN SSC hippo specialist group, said hippos have been overlooked as a species of conservation concern due to their high population densities, which can give the impression that there are plenty of them in the wild. But populations have declined substantially over the last 20 years.
“The biggest threat to hippos is habitat loss and degradation. Common hippos rely on fresh water to survive, and that often puts them in conflict with local communities who also need fresh water for agriculture, energy, fishing and residential development,” she said.
“Hippo-human conflicts are on the rise, particularly in west Africa, where common hippo populations are declining rapidly. Hippo-human conflicts unfortunately result in both hippo and human fatalities and have contributed to a related problem of unregulated hunting for hippo meat and ivory, which is found in their canine teeth,” she added.
The proposals are unlikely to affect a small population of hippos found in Colombia, which has grown from the private collection of drug lord Pablo Escobar. Many ecologists say these are an invasive species and should be culled.
Following the proposal, the Cites secretariat will provide an assessment to see whether hippos meet the appendix I criteria and produce a recommendation based on expert evidence.
Keenan Stears, a University of California Santa Barbara ecologist who is based part of the year in Kruger national park, South Africa, said he supported the proposed listing because of the important role hippos play in ecosystems. “A large proportion of hippos are in rivers that are experiencing significant reductions in river flow. Threats like habitat destruction for agriculture are a huge issue,” he said.
But given the right conditions, Stears said, populations could stabilise. “They can recover pretty quickly with enough vegetation. Any kind of protected area would be perfectly fine for the population to increase rapidly.”
John Scanlon, secretary general of Cites from 2010 to 2018, said the upgrading to appendix I would involve the prohibition of all commercial trade in hippos, but would not outlaw bushmeat hunting. “It’s meat, teeth or skin: any commercial international trade would be prohibited.
“A number of organisations will be offering their views on the proposal, and I suspect it will be a big deal,” he added. “There are only about 1,500 species that are classified on appendix I.”

In Colombia, Escobar’s hippos spawn another problem: Wildlife trafficking

https://news.mongabay.com/2022/02/in-colombia-escobars-hippos-spawn-another-problem-wildlife-trafficking/
by Diana María Pachón on 8 February 2022, translated by Maria Angeles Salazar

An attack on a man in rural Colombia last October has highlighted the little-known trafficking of Colombia’s notorious, and non-native, hippos.
The roughly 70 hippos in the wild in Colombia today all originate from four animals brought over by the late drug kingpin Pablo Escobar.
The town of Doradal near Escobar’s fabled ranch is a center of the hippo-trafficking trade, which targets calves and sells them to wealthy ranch owners as a status symbol.
Mongabay Latam investigated how the illegal sale of hippo calves works from the inside.
The way John Aristides Saldarriaga tells it, he was out for a routine day’s fishing with friends on a

The trafficker's daughter and the hippo calf spend long days swimming in a pond close to the house. Photo: M. Pachón

lake about a mile from the fabled ranch of the late Colombian drug lord Pablo Escobar.

It was Halloween, Oct. 31, 2021, and the lake near Doradal in the department of Antioquia was a known haunt of the feral hippos (Hippopotamus amphibius) that had spawned from the four hippos that Escobar had shipped over from Africa

"You don't disturb me, I won't disturb you," was Saldarriaga's philosophy to fishing in the midst of the hippos, as he tells it to me.

On that day, however, one particular hippo — a mother with a young calf — must have felt sufficiently disturbed that, as Saldarriaga puts it, she ambushed him as he was coming out of the lake. The 2-ton animal chased him down until he fell. Then it chomped down on his arm and flung him into the air.

Saldarriaga's friends rushed him to the nearest health center, from where he was transferred to a larger hospital about 170 kilometers (106 miles) away.

"If it had wanted, it could have crushed me and … goodbye life," Saldarriaga says today of the abrupt end to the hippo's attack. "But it was looking at me as if it was saying, 'I forgive you this time, but if you come back, I'll kill you.'"

Hippo trafficking allegations

For many people in Doradal, Saldarriaga's hometown, the fishing story is just that: a tall tale. The prevailing rumor is that Saldarriaga had been trying to capture the hippo calf to sell. It's public knowledge in the area that wildlife traffickers trade in hippos, but the police deny it; they say they haven't received any reports of such incidents. However, according to one of the traffickers, at least six calves hidden in trucks have passed right in front of the police station.

I contacted the Colombian Ministry of Environment and Sustainable Development, but it declined to comment on the issue and referred me to the Alexander Von Humboldt Biological Resources Research Institute. Also known as the Instituto Humboldt, this is an independent center under the auspices of the environment ministry. An expert there tells me that the institute's focus on the hippos extends to understanding the animals' impact on local ecosystems and communities. The Regional Autonomous Corporation for the Negro and Nare River Basins, or Cornare, the local environmental authority, says it has complained about hippo trafficking to the Doradal police, but that they haven't taken any action.

Fishing isn't common in the lake where Saldarriaga was attacked. The water there is dense and calm, and seasoned fishers prefer going to the local stretch of the Magdalena River, which crosses almost the entire length of Colombia.

David Echeverry, a biologist with Cornare, says there would have been very few fish to catch in the lake, thanks to the contamination by the non-native hippos.

"The hippo feces together with their going in and out of the lake increase the organic load and can accelerate the eutrophication process," he says.

In other words, the animals have turned the water into a thick green soup due to the excess of nutrients in their droppings. As a result, many of the native fish species have died off.

Echeverry also says that Sadarriaga was "very brave to fish in that lake where there is a female with a calf."

The mother and the calf have since moved to another lake nearby, which is also home to four

other hippos. When the mother goes underwater, so does the calf. At night, they roam the dry land nearby, and at dawn they return to the lake. The mother appears to be on constant alert for humans.

There aren't any security forces preventing entry to the lake, just some rickety road signs installed a decade ago with a now-blurry image of a hippo and the word "danger."

It was in the early 1980s when Escobar gave the order to have a male and three female hippos brought over to his ranch from Africa to complete his dream of having the biggest zoo in the world. When he died in 1993, the abandoned hippos, with no walls to contain them and with the perfect climate to thrive in, multiplied and colonized other lakes up to hundreds of miles away. Experts estimate there's a population of around 70 hippos in the Colombian wild today.

While the animal is notorious in its native Africa as one of the most dangerous to humans, there haven't been any deaths attributed to hippo attacks in Colombia. But the risk is always there. On May 20, 2020, a hippo attacked Luis Enrique Díaz, also in Doradal. According to Díaz, he was filling a water pump to fumigate when the hippo emerged from the water and ran him down.

More than a year later, he only leaves his house to get a few moments of sunlight before quickly disappearing back inside to avoid the curious stares of those who want to see what such an attack does on a person. He can't work. His brother protects him from interviews and so our conversation is short. Díaz says he remembers the weight of the hippo's legs on his body, the broken ribs, the pierced lung and the fractured leg.

In October 2021, Cornare launched its latest plan to get the wild hippo population under control: treating the animals with GonaCon, a contraceptive for both males and females. Twenty-four hippos have since been dosed using darts, according to Echeverry. They join 11 that have been chemically castrated since 2014.

GonaCon has been used in veterinary applications in China, Australia and the United States, and was donated by the latter's Department of Agriculture for use in Colombia. While the pilot scheme has shown positive results, experts are mulling the need for a third dose for each hippo to guarantee its effectiveness. That won't be an easy task, given the risks to the team members and the high cost of around $6,400 to $7,700 per operation.

Nataly Castelblanco, a biologist and co-author of a 2021 study on the persistence and dispersion of hippos in Colombia, says she welcomes Cornare's initiative. But given the large number of hippos already living in Colombia, sterilization and contraception strategies alone aren't enough to solve the problem, she says. She calls for a combination of strategies, including culling some of the animals, even if this remains a highly controversial approach for some animal rights activists.

Castelblanco says hippos live for a long time, up to 70 years, and over the decades can have massive impacts on the ecosystem and native species.

In an interview with Mongabay Latam, biologist Germán Jiménez, another co-author of the 2021 study, says the majority of hippos' time is spent in the water, where they eat, sleep, urinate and defecate, which causes oxygen depletion. "Fish start dying and plants too," he says. Hippos also displace other herbivorous species, like manatees, and their stomping affects the soil and plant species that grow in the ecosystems of the Magdalena Medio region.

'Buy the hippo'

In a café in the central square of Doradal, a trafficker speaks about having a hippo at home, with no apparent concern about being overheard. I ask if he's not scared of speaking so openly about doing something illegal.

"Everyone here knows who I am. I offered the beast to everyone and no one wants to buy it," he

says. “By the way, wouldn’t you like to take it?” I smile as if it were a joke. “You could keep it in a big house. If there’s a pond, that’s enough.”
“I live in Bogotá, I’d have to keep it in the bathtub,” I say.
“Give me 7 million pesos” — about $1,800 — “and if you want, I can take care of it until you find a place for it.”
“It really is impossible. Also, I’m a journalist.”
“What’s that got to do with anything? Find a partner and you split the payment. No one needs to know.”
The man appears desperate. He’s never had to keep a hippo for so long. Back in June 2021, he says, someone called him asking him to deliver a calf urgently. The trafficker knew of a female hippo that had recently given birth. So he went out to the lake with his wife — the same lake where Saldarriaga was attacked — and looked for the calf. When they spotted it, they used their usual technique of throwing stones at the mother so that she would abandon the still slow-moving calf and they could capture it.
This method isn’t always effective, the trafficker says. Sometimes, instead of getting spooked and running away, the female will get angry and charge at them. They know the dangers, he says, but it’s good money, especially in a region where even the minimum monthly wage of $234 is considered a luxury.
After the trafficker had successfully captured the calf, he contacted the buyer by phone, only to be told the deal was off.
“‘Brother, seriously, I’m sorry for you but I can’t buy it. I sold my ranch,’” the trafficker says the buyer told him.
He says he didn’t try to push the deal, because in a region of big ranches and eccentric owners, someone else would surely want a hippo. So he’s been left taking care of the animal, but it’s hard to pay for the costs of caring for such an exotic beast.
The trafficker says the calf drinks $100 of milk monthly. That’s a lot of money; an entire family of four or more can subsist on that monthly sum in this part of Colombia.
Locals say there are perhaps just three people in the area who are familiar with the dangerous job of capturing hippo calves. They say they’ve also heard of others who do the same in rivers 20 km (12 mi) away.
At the café, the trafficker gets closer and lowers his voice: “Miss, come to meet it and you’ll see how you fall in love. If you have kids, it would be the best present.”
Swimming with a dangerous creature
To reach the trafficker’s ranch requires crossing a maze of muddy trails. Next to the house is a pond of still green water, but the calf isn’t there.
A petite teenage with big black eyes emerges from a corridor.
“Are you looking for Campanita?” she asks. I look at her confused. “I named her Campanita.”
The girl seems excited to have a visitor she can finally talk to about her new secret pet. She takes my hand and leads me to her room.
“Campanita, love, come here,” she says, then repeats it. There’s a noise from under the bed, followed by the appearance of a dinosaur-like leg full of folds. Another leg emerges, then the head. When the hippo calf sees me, it goes back into hiding. The girl drags it out. The calf wiggles its ears in apparent distress.
Here, on this ranch in rural Colombia, a hippo calf lives with a human family, sharing a room with a teenager whom it already outweighs.

I stroke it. Its skin is cold, thick and gray. It's like stroking a leather sofa. The calf trundles clumsily toward the girl. She's become the animal's maternal figure after her father's illegal actions took it away from its real mother.

When it's not under the bed, it follows the girl around the house, like a spoiled dog, sometimes rubbing its muzzle on her legs and seemingly demanding to be petted. The girl bends down and hugs it.

"Do you want it to go somewhere else?" I ask.

"It's time. If it doesn't leave, I don't know what will happen."

"What do you mean?"

"It can't grow here and it's impossible to take it back to its mother."

For all of the girl's life, hippos have simply been transient beings: orphans who come for a bit and then leave. Her house is a transit point for these animals rendered motherless because of the illegal trade. No one knows if any of the calves that once passed through here are still alive today, or if they ended up in a special dish after they left. As far as the girl knows, hippos are small and playful things. She's had Andy, Joaco, Estrella, Magola (who she thought was a female and turned out to be a male), one that never got a name because it was sold very fast, and now Campanita.

By the time of my visit in late 2021, Campanita was the second hippo the girl had lived with that year. The previous hippo had been there three months and was sold in March for $1,540. The buyer was a rancher who paid for all the food expenses while the animal lived on the trafficker's farm. He also covered all of the veterinary bills and paid an extra $50 monthly for taking care of the animal.

There's no such rich patron on Campanita's horizon. The calf eats and grows, and there's still no prospect of finding a buyer.

The trafficker says he's only had one offer since June: renting out the hippo to a nearby spa to be the main attraction. He says they offered him $130 a day. He thought about it, he says, but turned them down after considering the risks. A hippo in a spa next to a swimming pool with tourists from all over the world, each of them with their phones taking pictures, would spread the story to every corner of the world in minutes. Then the police, Cornare and the media would arrive. And worst of all, he says, he'd end up in prison with the owner of the spa, serving a sentence of four to nine years. He'd never make that mistake, he says.

"Let's go to the water," the girl says. Campanita follows her to a lake on the property, bigger and clearer than the pond next to the house. The girl runs and the hippo follows. The animal knows where they're going, and its gait becomes lighter in the pasture. It stops by the edge of the water. The girl pushes with all the strength of her thin arms until the calf falls into the water. Campanita disappears underwater and then resurfaces. Human and animal follow each other and play.

"Let's go, Campanita," the girl says. The animal, instead of walking, lies on the ground looking at the lake, still happy to keep splashing around. Hippos have evolved to spend up to 14 hours a day in the water, until dusk when they head for dry land in search of fodder. In the wild, these urges are dictated by hunger and heat; here, by the humans who traffic them.

"Do your friends know you have a hippo?" I ask the girl.

"What a thing to say … Besides, I don't have any friends."

"How come?"

"I don't go to school, my only friend is Campanita."

The hippo calf and the girl came together because of the vicissitudes of an illegal business. The

first one, if it's lucky, will find a home with a private pond on some faraway farm. The second one will say goodbye without crying so that the buyers aren't scared off — until her father brings home the next temporary pet.
In the meantime, the animal keeps eating and growing. Although the family still see it as a pet, as it gains weight and grows, the danger of an attack increases. It's a ticking time bomb living inside the house of an underserved family in Doradal.

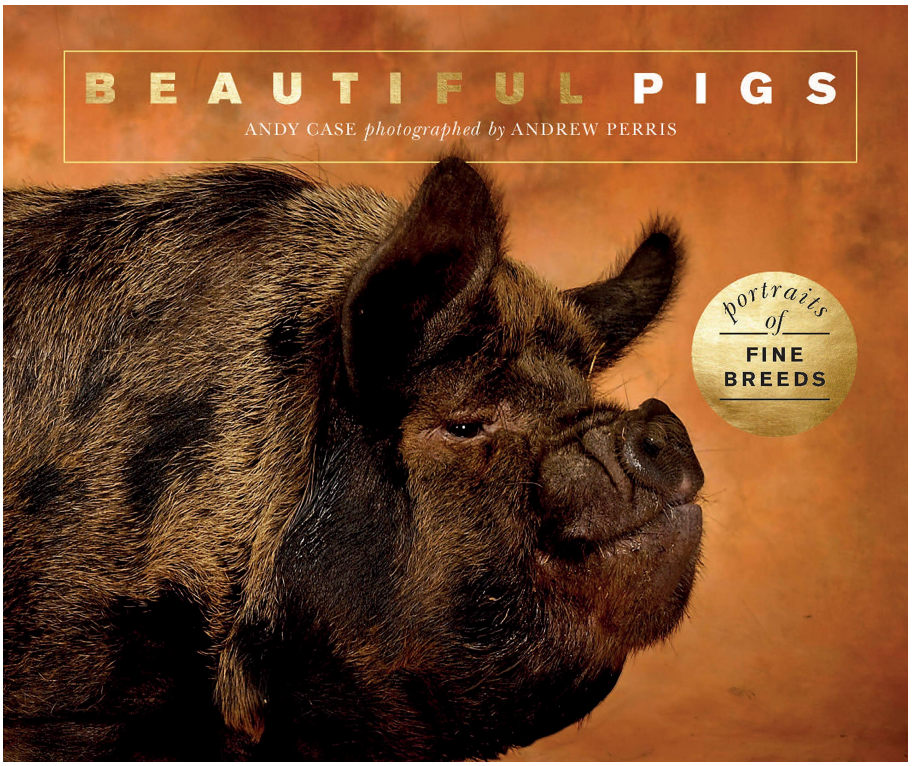
Colombia sterilizes 24 hippos on former estate of drug lord Escobar

https://www.news24.com/news24/world/news/colombia-sterilizes-24-hippos-on-former-estate-of-drug-lord-escobar-20211016
by AFP, 16 Oct 2021

Twenty-four out of 80 hippos that roamed the former ranch of late drug lord Pablo Escobar, in northwestern Colombia, were sterilized due to the "uncontrolled" growth of this "invasive" species, authorities reported. Photo: CORNARE/AFP.

Twenty-four out of 80 hippopotamuses roaming on the former ranch of the late Colombian drug kingpin Pablo Escobar were sterilised due to the "uncontrolled" spreading of this "invasive" species, authorities said on Friday.
Before he was shot dead by police in 1993, the notorious Escobar had purchased a number of exotic animals to live on his ranch, including flamingos, giraffes, zebras and kangaroos.
After his death, all but the hippopotamuses were sold to zoos.
Escobar originally acquired a single male and female hippos.
They were left to roam on his Hacienda Napoles estate, which has since been converted into a theme park, as they were considered to large to try to move, but since then their numbers have multiplied.
The hippos were shot with darts to inject them with a medicine called GonaCon, according to a bulletin by Cornare, a regional environmental protection organization in the northwest of Colombia.
"It's a contraceptive that is effective in males and females" and cheaper than surgical sterilization, said Cornare.
"However, it's complicated because experts suggest giving three doses."
Another 11 hippos were previously sterilised by more traditional means.
Experts believe this to be the largest herd of hippopotamuses outside of Africa and it has led to problems.
"The presence of these animals in an ecosystem that is not their own, brings consequences such as the displacement of local fauna," said David Echeverri, a Cornare expert quoted in the bulletin.
The hippos are also responsible for "changing ecosystems" and attacks on local fishermen.
Escobar became one of the richest men on the planet, according to Forbes, thanks to the drug trafficking empire he built.
Almost 30 years since his death, Colombia remains the largest producer of cocaine in the world, much of it smuggled to the United States.

Beautiful Pigs – Portraits of Fine Breeds



There are many different domestic pig breeds around the world and even new breeds are being developed (see editorial of this issue). This book covers a variety of them. The introduction offers the marvellous quotation by Winston Churchill, “I like pigs. Dogs look up to us. Cats look down on us. Pigs treat us as equals.” The subsequent short chapters are about pigs in civilization, development of the breeds, an introduction to breeds, breeds around the world, the early years of agricultural shows, summer shows, the preparing of pigs for shows, what the judges look for, keeping pigs and caring for pigs.

The main section of the book presents many of the pig breeds, which are separated in historic breeds like Neapolitan, Old Berkshire, Siamese, champion breeds like Oxford Sandy & Black, British Saddleback, Chato Murciano or Duroc and exotic breeds like Blonde Mangalitsa and Kunekune. Each breed portrait offers a description of its origin, its distinguishing features, size, use, related breeds, distribution map and photo of the breed taken in a studio. These photos are even funny, as the pigs are presented like models!

There are many more breeds around the world. This easy reading coffee-table book offers a selection of famous breeds mainly anglophon ones. It shows their variety, their many different appearances and their beauty.

Reviewed by Thiemo Braasch

Beautiful Pigs – Portraits of Fine Breeds
by Andy Case, photographed by Andrew Perris
70 pages, Ivy Press Press 2020
ISBN: 978-1-78240-778-2 (Softcover Edition)

General articles about Suiformes

Guidelines on the hygienic management of wild meat in Japan
Takai, S. 2022
Meat Science 191: 108864, doi: 10.1016/j.meatsci.2022.108864
The density and distribution of wild ungulates, especially sika deer (*Cervus nippon*) and wild boar (*Sus scrofa*), have increased across the Japanese archipelago in the last two decades. The tradition of consuming wild game meat has been inherited in limited areas in Japan, but recently, the use of wild animals for food has increased. Game meat has become popular at local restaurants and retail meat shops. However, fundamental knowledge of game meat hygiene and health risks has not been fully established among hunters, meat processors, restaurant operators, and consumers. Moreover, game meat-borne illnesses have been reported occasionally. Unlike domesticated livestock, wild animals are not inspected for diseases when being butchered for food, and the meat obtained is at a high risk of being unhygienic. The Guidelines on the hygienic management of wild meat were established in 2014 to ensure the safety of wild meat in Japan. This study describes the situation regarding wild animals and game meat in Japan.

Public perceptions and attitudes toward urban wildlife encounters-A decade of change
Basak, S.M., Hossain, M.S., O'Mahony, D.T., Okarma, H., Widera, E. and I.A. Wierzbowska 2022
Science of the Total Environment 834: 155603, doi: 10.1016/j.scitotenv.2022.155603
Europe is currently undergoing dynamic land use changes causing the expansion of urban habitat, which is driving wildlife species to colonise conurbations, resulting in an increased likelihood of human-wildlife conflict (HWC). Understanding people's attitudes toward wildlife is essential to manage these conflicts. This study assessed people's attitudes toward urban wildlife, the types of conflicts that existed, preferences for managing conflict situations, and determined any changes in perceptions of urban wildlife over a decade. A questionnaire survey of residents of Krakow, the second-largest city in Poland, was conducted in 2010 (n = 721) and repeated in 2020 (n = 887). We found that encounters with certain urban wildlife such as wild boars, red squirrels, roe deer, brown hares, and red foxes had increased significantly in 2020 compared to 2010. Respondents reported that wild boar and beavers did not show fear when encountering humans. Stone martens were considered the most nuisance wildlife species in 2010, while in 2020 wild boar were the most conflictual wildlife species. There were additional reports of conflicts with roe deer and red foxes. The most frequent HWC responses were personal anxiety, intrusion into property and destruction of crops, which increased significantly over the decade, independent of respondents' gender. Respondents preferred nonlethal methods to mitigate conflicts. The study provides valuable information and knowledge on changes in people's attitudes toward urban wildlife that can help with wildlife management in urban areas. Incorporating perception and attitude data from the public, along with a multi-stakeholder approach that includes wildlife professionals, in the planning and design of future urban environments is critical to minimise HWC.

Does mast seeding shape mating time in wild boar? A comparative study
Cachelou, J., Saint-Andrieux, C., Baubet, E., Nivois, E., Richard, E., Gaillard, J.M. and M. Gamelon 2022

Biology Letters 18(7): 20220213, doi: 10.1098/rsbl.2022.0213
In seasonal environments, the timing of reproduction often matches with the peak of food resources. One well-known effect of global warming is an earlier phenology of resources, leading to a possible mismatch between the timing of reproduction for consumers and food peak. However, global warming may also change the dynamics of food resources, such as the intensity and frequency of pulsed mast seeding. How quantitative changes in mast seeding influence the timing of reproduction of seed consumers remains unexplored. Here, we assess how yearly variation in mast seeding influences mating time in wild boar (*Sus scrofa*), a widespread seed consumer species. We took advantage of the intensive monitoring of both female reproduction (1636 females) and acorn production over 6 consecutive years across 15 populations of wild boar in the wild. We found that mating time occurs earlier when acorn production increases in most but not all populations. In two out of 15 populations, heavy females mated earlier than light ones. Our findings demonstrate that mast seeding advances the mating time in some populations, which could perhaps impact how boars respond to climate change.

The wild boar *Sus scrofa* in northern Eurasia: a review of range expansion history, current distribution, factors affecting the northern distributional limit, and management strategies

Markov, N., Economov, A., Hjeljord, O., Rolandsen, C.M., Bergqvist, G., Danilov, P., Dolinin, V., Kambalin, V., Kondratov, A., Krasnoshapka, N., Kunnasranta, M., Mamontov, V., Panchenko, D. and A. Senchik 2022

Mammal Review, doi: 10.1111/mam.12301

The wild boar *Sus scrofa* is one of the most widely distributed large mammal species in the world, existing on all continents except Antarctica. In the late 20th Century, its geographical range expanded naturally and through intentional releases. Despite the environmental, social, and economic importance of the wild boar, its current distribution in northern Eurasia remains uncertain, and the factors that limit and promote expansion in northern ecosystems are unknown. We aimed to summarise the history of wild boar range expansion and current distribution in the countries of northern Eurasia. We also assess the relative importance of climate (both harshness and warming), habitat (both current diversity and possible change), predators, releases, supplementary feeding, and hunting in limiting or promoting the distribution and range expansion of the species. We review hunting management and other regulations that may affect further northward expansion. Information on wild boar expansion and distribution was collated from available scientific publications, official statistics, volunteer reports, and expert knowledge. The effects of natural factors (climate harshness, habitat variation, predators) and anthropogenic factors (climate warming, habitat change, releases, supplementary feeding, hunting) on wild boar distribution were assessed using estimates (scores) provided by experts from the target regions. The wild boar in Europe is distributed up to 64 degrees N. In Asia, the northern distributional limit is up to 61 degrees N. The species' northern distributional limit is further north in the west than in the east of the geographic range. Experts regarded climate harshness, habitat, and hunting as the most important factors limiting wild boar distribution. Important factors that promote the expansion of the wild boar's range include climate warming and supplementary feeding. Our analysis of the official approaches to wild boar management suggests that the northern Eurasian countries do not have a united approach to the challenge of wild boar expansion. Collaboration between managers, policymakers, and researchers is needed for monitoring the wild boar distribution and range expansion throughout northern Eurasia. This data collection is especially

important now, as parts of Europe and Asia are facing the challenge of African swine fever as well as other human-wildlife conflicts related to increasing wild boar populations.

The importance of fine-scale predictors of wild boar habitat use in an isolated population
Bacigalupo, S.A., Chang, Y.M., Dixon, L.K., Gubbins, S., Kucharski, A.J. and J.A. Drewe 2022
Ecology And Evolution 12(6): e9031, doi: 10.1002/ece3.9031
Predicting the likelihood of wildlife presence at potential wildlife-livestock interfaces is challenging. These interfaces are usually relatively small geographical areas where landscapes show large variation over small distances. Models of wildlife distribution based on coarse data over wide geographical ranges may not be representative of these interfaces. High-resolution data can help identify fine-scale predictors of wildlife habitat use at a local scale and provide more accurate predictions of species habitat use. These data may be used to inform knowledge of interface risks, such as disease transmission between wildlife and livestock, or human-wildlife conflict. This study uses fine-scale habitat use data from wild boar (Sus scrofa) based on activity signs and direct field observations in and around the Forest of Dean in Gloucestershire, England. Spatial logistic regression models fitted using a variant of penalized quasi-likelihood were used to identify habitat-based and anthropogenic predictors of wild boar signs. Our models showed that within the Forest of Dean, wild boar signs were more likely to be seen in spring, in forest-type habitats, closer to the center of the forest and near litter bins. In the area surrounding the Forest of Dean, wild boar signs were more likely to be seen in forest-type habitats and near recreational parks and less likely to be seen near livestock. This approach shows that wild boar habitat use can be predicted using fine-scale data over comparatively small areas and in human-dominated landscapes, while taking account of the spatial correlation from other nearby fine-scale data-points. The methods we use could be applied to map habitat use of other wildlife species in similar landscapes, or of movement-restricted, isolated, or fragmented wildlife populations.

Genomic tools reveal complex social organization of an invasive large mammal (*Sus scrofa*)
Titus, C.L., Bowden, C.F., Smyser, T.J., Webb, S.L. and J.C. Beasley
Biological Invasions, doi: 10.1007/s10530-022-02840-4
A comprehensive understanding of sociality in wildlife is vital to optimizing conservation and management efforts. However, sociality is complicated, especially for widely distributed species that exhibit substantive behavioral plasticity. Invasive wild pigs (*Sus scrofa*), often representing hybrids of European wild boar and domestic pigs, are among the most adaptable and widely distributed large mammals. The social structure of wild pigs is believed to be similar to European wild boar, consisting of matriarchal groups (sounders) and solitary males. However, wild pig social structure is understudied and largely limited to visual observations. Using a hierarchical approach, we incorporated genomic tools to describe wild pig social group composition in two disparate ecoregions within their invaded range in North America. The most common social unit was sounders, which are characterized as the association of two or more breeding-aged wild pigs with or without dependent offspring. In addition to sounders, pseudo-solitary females and male-dominated bachelor groups were observed at a greater frequency than previously reported. Though primarily composed of close female kin, some sounders included unrelated females. Bachelor groups were predominantly composed of young, dispersal-aged males and almost always included only close kin. Collectively, our study suggests social organization of wild pigs in

their invaded range is similar to that observed among wild boar but is complex, dynamic, and likely variable across invaded habitats.

The Visayan Warty Pig (*Sus cebifrons*) Genome Provides Insight Into Chromosome Evolution and Sensory Adaptation in Pigs

Liu, L.Q., Megens, H.J., Crooijmans, R.P.M.A., Bosse, M., Huang, Q.T., van Sonsbeek, L., Groenen, M.A.M. and O. Madsen 2022

Molecular Biology and Evolution 39(6): msac110, doi: 10.1093/molbev/msac110

It is largely unknown how mammalian genomes evolve under rapid speciation and environmental adaptation. An excellent model for understanding fast evolution is provided by the genus Sus, which diverged relatively recently and lacks postzygotic isolation. Here, we present a high-quality reference genome of the Visayan warty pig, which is specialized to a tropical island environment. Comparing the genome sequences and chromatin contact maps of the Visayan warty pig (*Sus cebifrons*) and domestic pig (*Sus scrofa*), we characterized the dynamics of chromosomal structure evolution during Sus speciation, revealing the similar chromosome conformation as the potential biological mechanism of frequent postdivergence hybridization among Suidae. We further investigated the different signatures of adaptive selection and domestication in Visayan warty pig and domestic pig with specific emphasize on the evolution of olfactory and gustatory genes, elucidating higher olfactory diversity in Visayan warty pig and positive and relaxed evolution of bitter and fat taste receptors, respectively, in domestic pig. Our comprehensive evolutionary and comparative genome analyses provide insight into the dynamics of genomes and how these change over relative short evolutionary times, as well as how these genomic differences encode for differences in the phenotypes.

Combining hunting and intensive carcass removal to eradicate African swine fever from wild boar populations

Gervasi, V. and V. Guberti 2022

Preventive Veterinary Medicine 203: 105633, doi: 10.1016/j.prevetmed.2022.105633

African Swine Fever (ASF) is a highly lethal viral disease, which affects different species of wild and domestic suids. After its human-caused introduction in Georgia in 2007, the ASF virus has found a new ecological reservoir in the large and continuous wild boar (*Sus scrofa*) populations of Eurasia, spreading both eastward and westward. ASF has also breached into the intensive pork meat production system. Although the disease has no zoonotic potential, its consequences on wild boar populations and the economic losses for the pig industry have been dramatic. As no vaccine or effective medical treatment is available to reliably protect wild boar or domestic pigs against ASF, eradication efforts are mainly based on intensive wild boar hunting and on removing a significant portion of the infected wild boar carcasses, which are the main environmental virus reservoir. Both strategies have produced poor results, so far, and ASF is becoming endemic. We compared wild boar hunting and carcass removal as alternative and combined strategies for the eradication of ASF in its endemic state, using a spatially explicit individual-based model, which incorporated the demography and spatial dynamics of a wild boar population, the spatial epidemiology of ASF in its endemic phase, and a management system acting for the eradication of the disease from the population. When no eradication effort was simulated, ASF exhibited a clear and strong tendency to persist and remain endemic in the wild boar population. Both hunting and carcass removal, when used alone, provided either a low power to remove the virus from the

population, or required unrealistic field effort. The best performing scenario corresponded to the combined use of a 30% annual hunting rate and of an intensive carcass removal, during a 2-month period in late winter (February-March). Eradicating ASF from wild boar populations remains a hard task. Managers should promote a drastic increase in the effort dedicated to systematically identify and remove as many infected wild boar carcasses as possible from the affected areas, with at least 5-15 carcasses removed for each 100 hunted wild boars.

Stable carbon and nitrogen isotope values in hair reveal management differences and hidden practices in wild boar populations

Vedel, G., de la Pena, E., Moreno-Rojas, J.M., Gomez, J.C.M. and J. Carranza 2022

Science of the Total Environment 823: 154071, doi: 10.1016/j.scitotenv.2022.154071

The analysis of stable isotopes in different tissues has been widely used to obtain information on the ecology and nutritional patterns of wildlife. The isotope ratios of the stable isotopes of carbon and nitrogen (delta C-13 and delta N-15) analysed in different tissues are directly related to the animal's diet and, to some extent, to the environment where the individual has growth. Specifically, this type of analysis in hair samples has become relevant as it provides information on the quality and long-term composition of the diet that produced the isotope accumulation during the tissue growth. We took samples of wild boar (Sus scrofa) hair from 7 different populations in the south-west of Spain (Mediterranean habitats), in the 2018/2019 hunting season. The main objectives of this study were (i) to investigate the use of hair stable isotopes to reveal differences in composition and quality of the diet of wild boar within the same population or between populations, and (ii) to use hair isotopes as a tool to uncover hidden management practices that may occur in hunting areas associated with the use of supplementary feeding or even captive breeding and release. Each animal had a hair (long 10 cm) analysed in duplicate, previously cut into parts of equal size (from the oldest part of the hair to the most recent part), that were analysed separately. We found differences in delta C-13 and delta N-15 between hair parts and populations, which can be related to management actions at different times during the hair growth. Moreover, the use of corn, a type of plant not occurring naturally in the study area, can be documented with the isotope analysis to prove unauthorized supplementary feeding or captive origin of wild boar in hunting areas.

Multiple aspects of the maternal reproductive investment in a polytocous species: what do mothers really control?

Brogi, R., Chirichella, R., Merli, E. and M. Apollonio 2022

Current Zoology, doi: 10.1093/cz/zoac034

One of the factors facilitating the expansion and proliferation of wild boar *Sus scrofa* is the plasticity of its reproductive biology. Nevertheless, the real influence of maternal and environmental factors on number and sex of the offspring is still controversial. While the litter size was shown to be related with the maternal condition, the strength of this relation remains to be understood, together with the possible role played by environmental conditions. Analogously, it is unclear whether wild boar females can adjust their offspring sex. We investigated multiple aspects of wild boar maternal investment by means of a 10-year dataset of female reproductive traits and a set of biologically meaningful environmental variables. The maternal condition slightly affected the litter size but not the offspring sex, and environment did not affect the litter size or the offspring sex. Moreover, mothers did not cope with the higher costs entailed by producing sons by

placing them in the most advantageous intrauterine position, nor by allocating less resources on daughters. Our set of results showed that the female reproductive investment is quite rigid in comparison with other aspects of wild boar reproductive biology. Wild boar females seem to adopt a typical r-strategy, producing constantly large litters and allocating resources on both sexes regardless of internal and external conditions. Such strategy may be adaptive to cope with environmental unpredictability and an intense human harvest, contributing to explain the extreme success of wild boar within human-dominated landscapes.

Contribution of acorn masting to food composition and body condition of and crop damage by wild boars (*Sus scrofa*) inhabiting evergreen forests in Japan
Omori, A. and E. Hosoi 2022
Mammal Study 47(2): 65-75, doi: 10.3106/ms2021-0024
We analyzed the stomach contents of wild boars (*Sus scrofa*) inhabiting evergreen forests in western Japan and found that they were dependent on the masting of acorns of *Castanopsis cuspidata*. The increased availability of *C. cuspidata* acorns positively affected their consumption by wild boars. In the good mast years, wild boars consumed *C. cuspidata* acorns from November to June of the following year. No significant annual variation in body condition was detected, suggesting that alternative food resources (e.g., bamboo shoots) may have maintained the body condition of wild boars, even in poor mast years. A strong negative correlation was found between the consumption of *C. cuspidata* acorns and the amount of crop damage to vegetables. This study revealed the wild boar as a pulsed food resource feeder, which has not yet been identified in Japan, and emphasized the importance of considering *C. cuspidala* masting for designing effective strategies for mitigating crop damage.

Differences in reporting human-wild boar interactions in Chinese and English news media
Wang, Y.F. and H. Mumby 2022
Human Dimensions of Wildlife, doi: 10.1080/10871209.2022.2057623
Human-wildlife interactions generate public interest and attract substantial media attention. This becomes particularly interesting in regions where different languages are used by media reports, creating the opportunity to investigate associations between language and the perspectives presented in the reports. In this article, we used 207 English articles (from 2006 to 2019) and 721 Chinese articles (from 2016 to 2019) on human-wild boar interactions in Hong Kong to analyze the gaps and differences in how the interactions are presented in the Chinese and English language media. Although English and Chinese news reporting on interactions follow similar geographical patterns, they differed significantly in terms of the content included, the identity of interviewees, the management strategies mentioned and the reported causes of conflict. The distinct presentation of human-wild boar interactions in English and Chinese news has the potential to contribute to diverging public attitudes toward the wild boar and policy development.

Wild boar foraging and risk perception-variation among urban, natural, and agricultural areas
Davidson, A., Malkinson, D. and U. Shanas 2022
Journal of Mammalogy, doi: 10.1093/jmammal/gyac014
When making foraging decisions, animals evaluate the risk of being preyed upon or hunted. This applies particularly to large-bodied, long-lived species with a long evolutionary history of human

persecution, such as wild boars (*Sus scrofa*). Wild boar populations are rapidly expanding throughout natural, agricultural, and urban areas worldwide, thus escalating human-wild boar conflicts. Most of these conflicts are associated with crop and garden damages by foraging wild boars. To study the foraging behavior of wild boars across a gradient of human risk, we evaluated the combined effects of hunting, land use type, and wild boar group size and structure on boar use of feeding devices. We installed corn-supplemented feeding devices in four land-use types and hunting combinations: urban areas with and without hunting, rural areas (namely, agricultural areas with hunting), and nature reserves without hunting. Our results show that rural areas and urban areas were the most important predictors of the wild boars' decision to eat or not and the time it took them to start eating from the moment they arrived at the feeding device (TBE-Time Before Eating). In addition, our study suggests that the TBEs of urban boars were significantly lower compared to boars from nature reserves. We further found that TBEs of urban boars were significantly lower than TBEs of boars in nature reserves. Our results suggest that the foraging behavior of wild boars varies spatially, corresponding to the different land-use types. We propose that the readiness of boars to forage in urban areas results from their habituation to human presence and lower perception of risk.

Wild Boar Survives in a Landscape That Prohibits Anthropogenic Persecution
Fu, Y.W., Tan, M.Y., Gong, Y.A., Zhao, G.J., Ge, J.P., Yang, H.T. and L.M. Feng 2022
Frontiers In Ecology and Evolution 10: 820915, doi: 10.3389/fevo.2022.820915
Geopolitical borderlands are politically sensitive areas and biodiversity hotspots, strictly controlled by the government and military. How to ensure political security, while protecting the biodiversity in borderlands is a problem for ecologists and governments. In this study, the nest site selection of the wild boar Sus scrofa was a case study in the Sino-Russia borderland to understand the survival strategy of wild life under anthropogenic pressure. We investigated (a) how the spatial distribution of anthropogenic pressure and wild boar nests in the borderland and (b) how anthropogenic pressure and the border influence on the wild boars' nest site selection. The Getis-Ord Gi* analysis was used to analyze the distribution patterns of wild boar nest sites and anthropogenic pressures in the borderland, the Structural Equation Models was used to explore the influence of border, roads, settlements, agricultural land, grassland and anthropogenic pressure on wild boars' nest site selection. The results indicated that wild boar nest sites are close to the border, roads and agricultural land and away from settlements and grassland. Regardless of the combination of anthropogenic pressure, wild boars make the most advantageous choice and prefer to be closer to the borderland. We speculated that military control played a vital role in borderlands for animal protection under anthropogenic pressure. Wild boars benefit from the prohibition of anthropogenic persecution due to military control. Compared with existing measures, we suggest a different protection/wildlife management strategy, what we need to do may be to prohibit anthropogenic persecution rather than perform other human interventions to protect animals. However, for a species with trouble potential, we need to base our conservation strategies on the recovery of top predators, and play the community control role of top predators to avoid the occurrence of trouble.

Ecological relationships among habitat type, food nutrients, parasites and hormones in wild boar *Sus scrofa* during winter
Liu, D.Q., Li, Z.Y., Hou, Z.J., Bao, H., Luan, X., Zhang, P., Liang, X., Gong, S., Tian, Y.M., Zhang,

D., She, W., Yang, F.F., Chen, S.Y., Nathan, J.R. and G.S. Jiang 2022
Wildlife Biology 2022(3): e01020, doi: 10.1002/wlb3.01020
Habitat quality and parasite assembly influence wildlife health, and they are key indicators of health and survivability of wildlife populations. To investigate the potential ecological relationships among habitat type, food nutrients, parasites and hormones in wild boar *Sus scrofa*, we collected samples of wild boar feces and available plants in their habitat by line transects during winter. Along transects, we identified the composition of plants foraged by wild boar and measured the content of nutrients in available plants to estimate nutrient intake. We also quantified parasites and hormones in wild boar fecal samples. We compared food nutrients among different forest types and explored possible relationships among estimated nutrient intake, parasites and hormones. We found coniferous forest had positive effects on estimated fat intake and negative effects on estimated protein and fiber intake by wild boar. Furthermore, we revealed that estimated fat intake was negatively correlated with Metastrongylus elongatus parasites and positively correlated with triiodothyronine (T3). In contrast, estimated protein intake was positively correlated with M. elongatus and negatively correlated with T3. Finally, we found negative relationships between T3 concentrations and loads of Ascaris suum parasites and between cortisol (COR) and loads of Trichuris suis parasites. These insights on ecological relationships help identify potential dietary parameters in winter that could help predict and manage parasite and hormone responses for wild boar population recovery.

Seasonal variation in space use and territoriality in a large mammal (*Sus scrofa*)
Schlichting, PE; Boughton, RK; Anderson, W; Wight, B; VerCauteren, KC; Miller, RS; Lewis, JS 2022
Scientific Reports 12(1): 4023, doi: 10.1038/s41598-022-07297-y
An individual's spatial behavior is shaped by social and environmental factors and provides critical information about population processes to inform conservation and management actions. Heterogeneity in spatial overlap among conspecifics can be evaluated using estimates of home ranges and core areas and used to understand factors influencing space use and territoriality. To understand and test predictions about spatial behavior in an invasive large mammal, the wild pig (*Sus scrofa*), we examined variation in space use between sexes and seasons. We predicted that if animals were territorial that there would be a reduction in space-use overlap when comparing overlap of home ranges (HR-HR), to home ranges and core areas (HR-CA), and in-turn between core areas (CA-CA). Home ranges and core areas were estimated for 54 wild pigs at Buck Island Ranch, FL from GPS telemetry data. Overlap indices were calculated to estimate the strength (space-use overlap) and number of potential interactions within three wet seasons (June-October) and two dry seasons (December-April). Among sexes, home range size did not vary seasonally, and males exhibited larger home ranges compared to females (M = 10.36 +/- 0.79 km(2) (+/- SE), F = 3.21 +/- 0.16 km(2)). Strength of overlap varied by season with wild pig home ranges overlapping more during the dry season. Males interacted with a greater number of individuals of both sexes, compared to females, and exhibited greater strength of overlap during the dry season. Consistent with our predictions, wild pigs appeared to exhibit territorial behavior, where strength of overlap decreased when comparing HR-HR to HR-CA and HR-CA to CA-CA. Our framework can be used to understand patterns of space use and territoriality in populations, which has important implications in understanding intraspecific interactions and population processes, such as how pathogens and parasites might spread within and among populations.

Could the re-emerging practice of wild boar hunting linked to the recent economic crisis lead to new outbreaks of trichinellosis in Lebanon?
Khalil, G., Marty, P., Hage, K., Sfeir, S., El Hage, J., Assi, T.B., Rassam, M., Pomares, C. and E. Mikhael 2022
Parasite 29: 11, doi: 10.1051/parasite/2022011
Background: Documented trichinellosis outbreaks in Lebanon date back to the late 19th century. The first published outbreaks were attributed to the consumption of wild boar meat, while those that followed incriminated pork. The practice of hunting wild boar is currently re-emerging in Lebanon given the recent economic crisis that has limited the purchase of livestock meat. Results: In Lebanon, at least 15 outbreaks of trichinellosis have been reported since 1870. We report an outbreak in January 2019, where five of the fifteen people present at a barbecue party were diagnosed with trichinellosis after wild boar meat consumption. Two subspecies of wild boar, Sus scrofa libycus and Sus scrofa scrofa, are commonly targeted by hunters. Hunters and consumers are sometimes unaware of the ineffectiveness of freezing meat and cooking over a wood fire to avoid trichinellosis. Unexpectedly, the National Center for Zoonosis Control receives every year 4 samples of wild boar meat, all free of Trichinella sp. larvae. Conclusion: Trichinellosis, a zoonosis typically unrecognized or undeclared, still represents a risk linked to the consumption of meat from wild animals, especially wild boar. Consumers, hunters, veterinarians, and butchers need to be further educated. Government regulation of wild boar hunting should be implemented to prevent further outbreaks.

A review of the impacts of invasive wild pigs on native vertebrates
McDonough, M.T., Ditchkoff, S.S., Smith, M.D. and K.C. Vercauteren 2022
Mammalian Biology 102(2): 279-290
The wild pig (*Sus scrofa*) is a successful invasive species that has become well established outside of its native range in Eurasia. The invasive wild pig is the result of released or escaped domesticated livestock becoming feral, or Eurasian boar introduced for hunting purposes. The global spread of wild pigs has recently been exacerbated in some areas, such as the USA, by anthropogenically assisted dispersal. Once established in novel ecosystems, wild pigs have the potential to have significant negative impacts on the ecosystem, and the scientific literature is replete with examples. It is generally accepted that wild pigs negatively impact native fauna where they have become established, yet the degree to which they impact faunal communities has not been well described. This paper serves as a review of the information to date on the implications of wild pig invasions and impacts they have on terrestrial vertebrates in their invasive range. In addition, the review highlights our need for more research in this area, particularly regarding declining species.

The effect of hunter-wild boar interactions and landscape heterogeneity on wild boar population size: A simulation study
Lee, S.H. and C.M. Park 2022
Ecological Modelling 464: 109847, doi: 10.1016/j.ecolmodel.2021.109847
In recent years, wild boar (*Sus scrofa*) populations have increased rapidly, causing serious problems such as crop damage and disease transmission. In the present study, we built an individual-based model to explore how heterogeneous landscapes and the interactions of wild

boars and hunters affect wild boar population control. The simulated wild boars in the model move on a heterogeneous landscape. To make the movement more realistic, we included randomness in the simulated boar behavior. The simulated hunters either walk to move one site during a one-time step or jump to move multiple sites at once. Simulation results showed that the randomness positively contributed to the increase in population size, while the remaining variables contributed negatively. The randomness had the greatest impact on population size, followed by the landscape heterogeneity and the hunting success probability. On the other hand, the jumping movement probability had the least effect. Interestingly, the effect of jumping on the population size could be understood as a result of two effects cancelling one another; the hunters are trapped in the preferred area, and the hunters move to another area without removing all simulated boars gathered in the preferred area. Furthermore, we briefly mentioned which ecological approaches can be used to control wild boar population growth with regard to our simulation results and proposed some ideas to improve the model and make it more realistic.

Summer Habitat Selection of Wild Boar *Sus scrofa* Linnaeus, 1758 (Mammalia: Suidae) in mountainous regions in Beijing, China

Bu, X.L., Xu, Y.Y., Wang, J., Shrestha, T.K., Wu, J.Y., Xiang, R.W., Zhu, Y.J., Zeng, F.G., Sheng, Y., X.X. Meng 2021

Acta Zoologica Bulgarica 73(4): 547-556

Based on the sampling of wild boars preferred habitat in north-eastern of Taihang Mountains around Beijing, China, we analysed the factors affecting their habitat selection using resource selection functions (RSFs) and principal component analysis (PCA). The results showed that the number of stumps (2.22 +/- 0.62) in used sites was significantly higher (0.95 +/- 0.27) ($P < 0.05$) than in the random sample plots, while the ground plant cover was significantly lower (35.26 +/- 6.56 %, 61.04 +/- 2.92 %, P 0.05). In addition, wild boar preferred the mid-altitude (500-1000 m) habitat with more arbours (81.48 %, 50-100), away from the community (500 m, 66.70 %) and far anthropogenic dispersion (1500 m, 51.85 %). The selection and preference of habitat factors reflect the ecological needs for food, water and shelter. In order to reduce the intrusion of wild boars in forest and farmland areas, we propose to change the distribution of water sources and remove nearby key water source sites if necessary, which can also reduce human wildlife conflicts and economic losses.

A Manual for Monitoring Wild Boars (*Sus scrofa*) Using Thermal Infrared Cameras Mounted on an Unmanned Aerial Vehicle (UAV)

Kim, M., Chung, O.S. and J.K. Lee 2021

Remote Sensing 13(20): 4141, doi: 10.3390/rs13204141

This study proposes monitoring methods of wild boars in plains or mountain forest areas using unmanned aerial vehicles (UAVs) equipped with infrared cameras. It is recommended to monitor in winter when the canopy layer is thin and the temperature difference between the ambient temperature and the body temperature of the wild boar is distinct, so that the infrared camera can better detect the wild boars. In flat land, the plane movement of the UAV can be easily monitored using the line transect, the point count survey, the plot sampling method, and the belted transect. In the mountain forest, there are variations in elevation due to slopes. Therefore, we introduced the WAYPOINT function to reflect the difference in altitude. After the investigator designates the waypoint, various information can be modified according to the terrain, and the WAYPOINT can

be transmitted to other UAVs, so the utilization is high. In this method, once a route is created using the WAYPOINT, there is no need for additional operation after the start of the flight, and it helps to re-monitor the site by using the WAYPOINT record repeatedly. Therefore, this technical note provides a more repeatedly sustainable and scalable monitoring method than the conventional UAV method.

It is time to mate: population-level plasticity of wild boar reproductive timing and synchrony in a changing environment

Brogi, R., Merli, E., Grignolio, S., Chirichella, R., Bottero, E. and M. Apollonio [no year]
Current Zoology [no vol issue], doi: 10.1093/cz/zoab077

On a population level, individual plasticity in reproductive phenology can provoke either anticipations or delays in the average reproductive timing in response to environmental changes. However, a rigid reliance on photoperiodism can constraint such plastic responses in populations inhabiting temperate latitudes. The regulation of breeding season length may represent a further tool for populations facing changing environments. Nonetheless, this skill was reported only for equatorial, nonphotoperiodic populations. Our goal was to evaluate whether species living in temperate regions and relying on photoperiodism to trigger their reproduction may also be able to regulate breeding season length. During 10 years, we collected 2,500 female reproductive traits of a mammal model species (wild boar Sus scrofa) and applied a novel analytical approach to reproductive patterns in order to observe population-level variations of reproductive timing and synchrony under different weather and resources availability conditions. Under favorable conditions, breeding seasons were anticipated and population synchrony increased (i.e., shorter breeding seasons). Conversely, poor conditions induced delayed and less synchronous (i.e., longer) breeding seasons. The potential to regulate breeding season length depending on environmental conditions may entail a high resilience of the population reproductive patterns against environmental changes, as highlighted by the fact that almost all mature females were reproductive every year.

Do boars compensate for hunting with higher reproductive hormones?

Davidson, A., Malkinson, D., Schonblum, A., Koren, L. and U. Shanas 2021
Conservation Physiology 9: coab068, doi: 10.1093/conphys/coab068

The predation-stress hypothesis has been proposed as a general mechanism to explain the negative effect of predation risk on reproduction, through a chronic activation of the stress response. However, in some cases, stress appears to augment the reproductive potential of mammals. Wild boar (*Sus scrofa*) populations are on a rise worldwide, despite the high hunting pressure that they are exposed to. This hunting pressure instigates, among other effects, earlier sexual maturity in juvenile females, leading to the shortening of wild boars' generation time. The mechanism that underlies this earlier sexual maturity under high hunting pressure has not been examined to date. To explore the physiological effects that hunting has on the reproductive system and whether the stress response is involved, we examined steroid hormone levels in the hair of female wild boars in northern Israel, comparing populations exposed to high and low hunting pressure. Furthermore, we compared steroid levels in the hair of female wild boars that were roaming alone or as a part of a group. We found no hormonal signs of stress in the hunted boars. Cortisol levels were low in both the high and low hunting-pressure groups. Yet, progesterone levels were higher in females that were exposed to high hunting pressure. Females

roaming in a group also had higher progesterone levels compared to females that were alone, with no distinguishable differences in cortisol levels. These elevations in reproductive hormones that were associated with hunting may lead to a higher reproductive potential in female wild boars. They further show that high hunting pressure does not necessarily lead to chronic stress that impairs the reproductive potential of female wild boars. This data suggests that a reproductive hormonal response may be one of the factors leading to the rapid wild boars population growth worldwide, despite the high hunting pressure.

The possibilities and limitations of thermal imaging to detect wild boar (*Sus scrofa*) carcasses as a strategy for managing African Swine Fever (ASF) outbreaks

Hohmann, U; Kronenberg, M; Scherschlicht, M; Schonfeld, F 2021

Berliner Und Munchener Tierarztliche Wochenschrift 134, doi: 10.2376/1439-0299-2020-46

The removal of wild boar carcasses is one of the first important countermeasures after an ASF outbreak. Thermal imagers that visualise body temperature are already in use for selective carcass detection. In addition to carrion-specific infrared radiation (IR-radiation) derived from natural body temperature or decay heating, non-carrion specific heat sources such as the absorption of sunlight, limit detection selectivity. To understand the influence of different heat sources on the IR-radiation phenology of carcasses better, we monitored the internal temperature of nine culled wild boar (Sus scrofa) during decomposition using dummies as a control. Culling took place between June and November and the objects were placed in fenced-off areas. Some of them were exposed to direct sunlight throughout, while others remained in the shade. For detection, we used both stationary and helicopter mounted thermal imagers. As expected, all culled boar had cooled down approximately two days after death. In summer, in culled boar that were placed at ambient temperatures above 10 degrees C, decay-heating started after 3-7 days and lasted up to four weeks. In the carcasses that were exposed to direct sunlight, absorption had a similar effect on IR-radiation as is normally observed from internal heating. In boar culled during November-December at an ambient temperature below 10 degrees C, we found no signs of decomposition or decay-heating. Solar absorption was the main source of IR-radiation after algor mortis. We therefore conclude that thermal imaging will be less efficient for detecting carcasses during colder seasons (empty set <10 degrees C; November-March) and at other times of the year on sunny days and the subsequent nights following such days. Considering the highlighted challenges relating to the detection of wild boar carcasses using IR-radiation, and the fact that moribund boar prefer places with IR-shielding vegetation to die, the continued reliance on a ground search approach for detecting infected carrion is still inevitable at present.

Population density and distribution of common warthog (*Phacochoerus africanus* Gmelin, 1788) in Dabena Valley Forest, Western Ethiopia

Edossa, A., Bekele, A. and H. J. Debella 2022.

African Journal of Ecology 60: 386– 397, doi: https://doi.org/10.1111/aje.13010.

A study about the spatial distribution and density of common warthog (*Phacochoerus africanus*) was conducted in two focal areas in Dabena Valley Forest, Western Ethiopia, from May 2016 to June 2018. These were Gassi Controlled Area (GCHA) in the southwestern part and Haro Aba Diko Controlled Hunting Area (HADCHA) in the northeastern part of the Valley. Population abundance and densities were analysed using distance sampling method. A total of 246 and 652 warthogs were counted in GCHA and HADCHA, respectively. The two study areas were

significantly different during the wet season and during the dry season in the number of common warthog population per transect. During the dry season, HADCHA possessed more mean of cluster density (5.18/km2) than the GCHA (2.37/km2). Common warthog encounter rate ranged from 1.1 to 3.73/km during the wet season in both study areas. The two study areas did not show significant variation ($\chi 2 = 0.188$, df = 1, $p = 0.05$) in the clusters of common warthog sightings. A high number of common warthog population are threatened by increasing anthropogenic activities. Common warthog's natural habitats and their buffer zones should be properly monitored: Cattle grazing and human encroachment should be prohibited.

Why the long teeth? Morphometric analysis suggests different selective pressures on functional occlusal traits in Plio-Pleistocene African suids

Yang, D., Pisano, A., Kolasa, J., Jashashvili, T., Kibii, J., Gomez Cano, A., Viriot, L., Grine, F. E. and A. Souron 2022.

Paleobiology: 1-22, doi: https://doi.org/10.1017/pab.2022.11.

Neogene and Pleistocene African suids displayed convergent evolutionary trends in the third molar (M3) morphology, with increasingly elongated and higher crowns through time. While these features can prevent premature loss of masticatory functionality and potentially increase long-term reproductive success, changes in dental occlusal traits such as enamel complexity and thickness can also improve chewing efficiency and increase short-term energetic return. While both long-term and short-term benefits can contribute to the thriving of a lineage, the selective pressures associated with each category can be different. To examine how crown elongation correlates with these functional occlusal traits, we selected M3s of *Kolpochoerus*, *Notochoerus*, and *Metridiochoerus* from Kenya and South Africa, dated between 3.0 Ma and 0.4 Ma. To account for dental wear, we used micro-computed tomography imaging of unworn/slightly worn M3s to simulate wear progression within each tooth. We compared morphometric representatives of occlusal enamel complexity and thickness among the specimens following their respective wear trajectories. We found that M3 elongation correlates with higher occlusal complexity and thinner enamel in *Notochoerus* and *Metridiochoerus* lineages through time. In *Kolpochoerus*, enamel complexity and thickness were generally maintained through time, despite M3 elongation. The differences in M3 morphometric trends suggest that *Kolpochoerus* likely experienced a different set of selective pressures on functional occlusal traits compared with *Notochoerus* and *Metridiochoerus*. The shared evolutionary trends of M3 specialization among *Notochoerus* and *Metridiochoerus* suggest similar selective pressures on their chewing efficiency and the possibility of a dietary niche overlap in more xeric habitats.

Warthog-human conflicts in Borgu sector of Kainji Lake National Park, Nigeria

Adeola, A.J., Akande, O.A., Onihunwa, J.O., Sulyman, A., Adeniji, O.A. and P. O. Olaifa 2022.

FUDMA Journal of Sciences 6(2): 88-95, doi: https://doi.org/10.33003/fjs-2022-0602-927.

This study assessed the impacts of common Warthogs (*Phacochoerus africanus*) on farm crops around Borgu sector of Kainji Lake National Park, Nigeria. Data was obtained with the aid of structured questionnaire in six communities which were purposively selected (Woro, Kemenji, Worumakoto, Maji, Venira and Kanikoko) and questionnaire was randomly administered to the identified farmers. The sample size was put at one hundred and twenty (120) respondents, of which eighty one (81) questionnaires were retrieved. The demographic characteristics of the respondents indicated that age group 31-40 years recorded the highest (39.5%). The finding

further revealed that 64.2% of the respondents are Muslim and 65.4% are married. Also majority of the respondents (53.1%) had stay in the study area between 6-10 years. Majority of the respondents agrees that there is presence of Warthog around their farms. The types of crops cultivated by the respondents are Maize, Guinea corn, Rice etc. Majority of the respondents indicated that they have experience crop raiding by Warthog. Types of crops preferred by Common Warthogs showed that Maize is the most preferred. The season of intense crops raiding is the raining season. The various preventive method used by the respondents to prevent Warthogs crop raiding are watch guarding, scare crow and fire/smoke. The possible solution as suggested on how to prevent Warthog-farmers conflicts are compensation and employment. This study confirms that Warthog has an impact of farm lands in the study area by causing much damage on farmers crops.

Disappearance of an ecosystem engineer, the white-lipped peccary (*Tayassu pecari*), leads to density compensation and ecological release

Whitworth, A., Beirne, C., Basto, A., Flatt, E., Tobler, M., Powell, G., Terborgh, J. and A. Forsyth 2022.

Oecologia, doi: https://doi.org/10.1007/s00442-022-05233-5.

Given the rate of biodiversity loss, there is an urgent need to understand community-level responses to extirpation events, with two prevailing hypotheses. On one hand, the loss of an apex predator leads to an increase in primary prey species, triggering a trophic cascade of other changes within the community, while density compensation and ecological release can occur because of reduced competition for resources and absence of direct aggression. White-lipped peccary (*Tayassu pecari*—WLP), a species that typically co-occurs with collared peccary (*Pecari tajacu*), undergo major population crashes—often taking 20 to 30-years for populations to recover. Using a temporally replicated camera trapping dataset, in both a pre- and post- WLP crash, we explore how WLP disappearance alters the structure of a Neotropical vertebrate community with findings indicative of density compensation. White-lipped peccary were the most frequently detected terrestrial mammal in the 2006–2007 pre-population crash period but were undetected during the 2019 post-crash survey. *Panthera onca* (jaguar) camera trap encounter rates declined by 63% following the WLP crash, while collared peccary, puma (*Puma concolor*), red-brocket deer (Mazama americana) and short-eared dog (*Atelocynus microtis*) all displayed greater encounter rates (490%, 150%, 280%, and 500% respectively), and increased in rank-abundance. Absence of WLP was correlated with ecological release changes in habitat-use for six species, with the greatest increase in use in the preferred floodplain habitat of the WLP. Surprisingly, community-weighted mean trait distributions (body size, feeding guild and nocturnality) did not change, suggesting functional redundancy in diverse tropical mammal assemblages.

Ultrasound evaluation of fetal bone development in the collared (*Pecari tajacu*) and white-lipped peccary (*Tayassu pecari*)

De Souza Pereira, T.H., Barros Monteiro, F.O., Pereira da Silva, G., Rodrigues de Matos, S.E., El Bizri, H.R., Valsecchi, J., Bodmer, R.E., Pérez Peña, P., Nassar Coutinho, L., López Plana C. and P. Mayor 2022.

Journal of Anatomy 241: 741–755, doi: https://doi.org/10.1111/joa.13724.

The study of fetal development allows for evaluating the different strategies adopted by mammal

species to maximize neonatal survival. Autonomous locomotion is fundamental for newborns to perform foraging activities and increases newborn survival from predation. In this study, we assess the gestational bone development of 53 collared (CP, *Pecari tajacu*) and 61 white-lipped (WLP, *Tayassu pecari*) peccaries, collected through the collaboration of subsistence hunters in the Amazon. The bone mineralization and biometry of the axial and appendicular skeleton were assessed by ultrasound examinations, and the timing of the main bone developmental events was calculated in relation to the total dorsal length (TDL) and the percentage of the total gestational period (GP). The first US signs of mineralization of the axial skeleton in CP and WLP were observed in fetuses with 3.4 cm (42 gestation days, 30% GPCP) and 5.1 cm (51 gestation days, 32% GPWLP). The early development of the appendicular skeleton was observed by the synchronic appearance of the mineralized scapula, humerus, radius, ulna, ilium, ischium, femur, tibia, and fibula at 36% GPCP (50 gestation days), and 35% GPWLP (56 gestation days). The pubis was mineralized in fetuses at 55% GPCP (75 gestation days) and 59% GPWLP (94 gestation days). The mineralization was observed in all autopod bones at 79% GPCP (109 gestation days) and 67% GPWLP (106 gestation days). All primary ossification centers in long bones of thoracic and pelvic limbs were mineralized in advanced fetuses (GPCP and GPWLP ≥75%). The mineralized patella was not observed in advanced fetuses in either species. Secondary ossification centers first appeared at the distal epiphysis of the femur in the CP (99 gestation days, 72% GPCP) and the distal epiphysis of the radius, femur, and tibia in the WLP (106 gestation days, 67% GPWLP). Advanced fetuses of CP and WLP presented 60% (15/25) and 68% (17/25) of the total secondary ossification centers observed present in the adult domestic pig, while newborns from the domestic pig presented 52% (13/25). The early intrauterine development of the skeletal system in both peccary species suggests a precocial development strategy, which likely correlates with neonatal ability to escape predators and reduces the dependence on parental care.

Hunting and water scarcity affect habitat occupancy by peccaries (*Tayassu pecari* and *Pecari tajacu*) in Calakmul, Mexico

Briceño-Méndez, M., Naranjo, E. J., Altrichter, M. and Y. Contreras-Perera 2022.
Mammalia, doi: https://doi.org/10.1515/mammalia-2021-0029.

The white-lipped peccary (WLP; *Tayassu pecari*) and the collared peccary (CP; *Pecari tajacu*) are social ungulates of huge ecological and economic importance. We determined the habitat occupancy for peccaries in a rural community bordering the Calakmul Biosphere Reserve in Campeche, Mexico. Twenty-eight stratified sampling points were randomly placed in the study area during a rainy and a dry season, where the presence of both peccary species was measured in relation to three ecological variables (habitat type, presence of natural predators, and water availability) and one anthropogenic variable (hunting). Ten sampling points were established with camera traps (total days/camera traps = 2268), and 18 sampling points were plots of 20 m2 to detect feces and/or footprints. To assess the relationship between both species' presence and the selected variables, models of habitat occupancy were constructed using a binary matrix of detection/non-detection using the PRESENCE program. For WLP and CP, the respective estimated occupancy probabilities were 30 and 40% in the rainy season and 88 and 44% in the dry season. Our results suggest that occupancy by WLP is affected by habitat type and predators in the rainy season and by water availability and hunting in the dry season. Conversely, for CP, occupancy is affected by water availability and hunting in the rainy season,

and by habitat type and predators in the dry season. Thus, hunting negatively affects the way that WLP occupy specific habitats, such as floodplain forest and medium sub-deciduous forest, particularly during periods of water scarcity when the species is more vulnerable to hunting.

Use of habitat and activity patterns of white lipped (*Tayassu pecari*) and collared (*Pecari tajacu*) peccaries in cattle ranching environments of the Dry Chaco, Paraguay
Zaldivar, B., Chavez, K., Valiente, E., RamoS, Y., Salinas, P. and A. Weiler 2022.
Reportes científicos de la FACEN 13(1): 20-27, doi: http://doi.org/10.18004/rcfacen.2022.13.1.20.
The white lipped peccary is gregarious with herds of up to 300 individuals and it lives in humid and xerophytic forests. The collared peccary forms groups of up to 50 individuals and shows great ecological plasticity due to the variety of environments it lives in. Both species are seed predators and natural prey for carnivores. They are faced by threats such as loss and fragmentation of habitat and poaching. This investigation's objectives were: (1) to contribute to the knowledge on the distribution and occupation of T. pecari and P. tajacu in relation to landscape characteristics, (2) to describe activity patterns in productive landscapes in the Paraguayan Dry Chaco. 45 sampling stations were established at Estancia Montania (Boquerón Department, Paraguay). A camera trap was placed at each station from 2015 to 2017. Each camera was placed on a wildlife trail. The photographs obtained were classified and analyzed using program (DataOrganize and DataAnalyze). T. pecari registered greater use in places with more forest coverage due to the higher availability of food. P. tajacu did not demonstrate significant differences in habitat use with respect to forest coverage. The behavioral patterns of the species do not show temporal segregation.

Habitat use and activity patterns of ungulates in a tropical rainforest of southern México
Falconi-Briones, F. A., Naranjo, E. J., Reyna-Hurtado, R., Spínola, M., Enríquez-Rocha, P. and R. A. Medellín 2022.
THERYA 13(2):171-182, doi:10.12933/therya-22-1167.
Baird's tapir (*Tapirella bairdii*), white-lipped peccary (*Tayassu pecari*), and collared peccary (*Dicotyles tajacu*) sympatrically occur in the Lacandon Forest of Chiapas, México. These species contribute to maintain ecosystem dynamics through herbivory, seed dispersal, and seed predation, constituting important prey for large carnivores and hunters. We analyzed activity patterns and habitat use of the three focal species to assess the degree of temporal and spatial habitat segregation among them in Montes Azules Biosphere Reserve (REBIMA) and surrounding communities. Between February and October 2015 we deployed camera-traps during 8,463 camera-trap days to estimate the presence and activity of tapirs and peccaries in two habitat types: "conserved" (REBIMA), and "transformed" (community forests; AFC). Habitat use and activity patterns of tapirs and peccaries were assessed through logistic regression models. We found that Baird's tapir was almost exclusively nocturnal with a trend towards crepuscular activity, while both peccary species were diurnal, therefore showing a high daily temporal segregation from the tapir. Both peccary species were similarly active in the two study sites, while tapirs were more active in continuous forest within the protected area. The occurrence of tapirs and white-lipped peccaries depended on the presence and proximity of water sources and roads. Our results suggest that spatial segregation of the habitat allows coexistence of both peccary species in the study area. AFC have potential for maintaining populations of tapirs and peccaries in the Lacandon Forest. Conserving these forests by local communities is essential to ensure the persistence of these mammals.

Dietary expansion facilitates the persistence of a large frugivore in fragmented tropical forests

Magioli, M., Villar, N., Jorge, M.L., Biondo, C., Keuroghlian, A., Bradham, J., Pedrosa, F., Costa, V., Moreira, M.Z., de Barros Ferraz, K.M.P.M. and M. Galetti 2022.

Animal Conservation 25: 582-593, doi: https://doi.org/10.1111/acv.12766.

How species persist in fragmented habitats is essential to understanding species resilience in response to increasing anthropogenic pressures. It has been suggested that expansion in dietary niche allows populations to persist in human-modified landscapes, yet this hypothesis has been poorly tested in highly diverse ecosystems such as tropical forests where frugivory is ubiquitous. Here, we measured dietary niche expansion of a large forest-dwelling mammal, the white-lipped peccary (*Tayassu pecari*), in the Atlantic Forest, Brazil, by comparing its diet using stable carbon (δ13C) and nitrogen (δ15N) isotopes. We collected hair of white-lipped peccaries in three continuous and three fragmented forests and compared δ13C and δ15N values, resource use and isotopic niches among populations and between forest types. We also tested the relationship between isotopic values of the populations and the forest cover percentage. White-lipped peccaries fed mainly on forest sources (C3 resources), especially in continuous forests, but 28% of the individuals in fragmented sites also incorporated C4 resources to some extent. In fragmented forests, the populations had isotopic niches from 3- to 3.6-fold the size of those in continuous forests. This niche expansion was due to the consumption of food items with higher δ15N values and C4 crops. Differences among populations were larger among fragmented forests, suggesting variable site-specific strategies to cope with habitat loss. The mean isotopic values of white-lipped peccary populations were negatively correlated with the loss of forest cover. Some small forest fragments might still retain relatively high habitat quality, and white-lipped peccaries might be able to capitalize on such variety of resources, shifting their diets from those observed in continuous forests. We suggest that high dietary flexibility and dietary expansion toward consumption of non-forest resources might facilitate the persistence of large frugivores in fragmented habitats.

Heterospecific infanticide among sympatric peccaries in Costa Rica

Carrillo, E. and T. K. Fuller 2022.

Biotropica 54: 284– 288, doi:https://doi.org/10.1111/btp.13060.

We observed white-lipped peccaries (*Tayassu pecari*) killing infant collared peccaries (*Pecari tajacu*) on the Osa Peninsula of Costa Rica. Camera trap data indicated high overlap of peccary activity periods, but spatio-temporal avoidance of white-lipped peccaries by collared peccaries. Heterospecific infanticide is unknown among ungulates but could be an important factor in reinforcing niche partitioning.

Hunting sustainability within two eastern Amazon Extractive Reserves

De Paula, M., Carvalho Jr, E., Manos Lopes, C. K., de Alencar Sousa, R., Pereira Maciel, E. L., Wariss, M., Leitão Barboza, R. S., de Araújo Braga, F. C., Félix-Silva, D., Peres, C. A. and J. C. B. Pezzuti 2022.

Environmental Conservation 49 (2): 90-98, doi:10.1017/S0376892922000145.

Subsistence hunting provides an important food source for rural populations in tropical forests but can lead to wildlife depletion. Management of wildlife resources depends on assessments of hunting sustainability. We assessed the sustainability of subsistence hunting in two Amazonian

Extractive Reserves. We examined hunting data from a community-based monitoring programme conducted in 30 communities during 63 consecutive months to address temporal trends in hunting yields in terms of catch per unit of effort of all game species and the six most hunted species. We also assessed the prey profiles across different communities. Game species composition did not differ between monitored communities, and the most hunted species were Tayassu pecari, large cracids, Cuniculus paca, Mazama spp., Tapirus terrestris and Pecari tajacu. Catch per unit of effort was stable for all game species and each of the most hunted species, indicating that hunting was generally sustainable. These findings reflect the exceptionally low human population density and continuous forest cover of the study landscape, and long-term hunting sustainability and local protein acquisition will depend on maintaining these social and environmental settings. The results also show that large Sustainable Use Protected Areas can help foster sustainable game management and should thus be included in public policies.

From the forest to the coast: the wild meat trade chain on the Coast of Guyana
Nathalievan,V., Puran, A., Oswin, D. and N.Robert 2022.
Ethnobiology and Conservation 11, doi: https://doi.org/10.15451/ec2022-08-11.17-1-13.
In the Caribbean region, very little is known about wild meat use and trade. To contribute to this knowledge gap, we studied the wild meat trade chain on the coastal area of Guyana, which geographically and culturally connects the Caribbean and the Amazon Region. In Guyana, the wildmeat sector is legal and in the process of being regulated. Our study shows that the market chain on the coast of Guyana is a short and direct market chain where the harvester most often sells directly to the consumer or through one level of intermediary (market vendors, home-based traders, roadside traders, restaurants, food stalls or rum shops). In coastal Guyana, wild meat can be considered a luxury, rather than a necessity: the price is higher compared to other alternative sources of meat and demand rises for special events. The topmost sold species are *Cuniculus paca*, *Mazama americana*, *Tapirus terrestris*, *Dicotyles tajacu*, *Tayassu pecari*, and *Hydrochoerus hydrochaeris*. The volumes traded to the coast of Guyana are equivalent to 361 tons of wild meat sold per year. Considering the population size on the coast of Guyana, this amount is equivalent to 1,4 g/capita/day and 4% of the protein intake from animal origin. These values are below those observed in urban towns from Central Amazonia in Brazil where wild meat consumption per capita equals to 18 g/capita/day. From a one health perspective, further attention is required with regards to food safety aspects along this legal trade chain.

Aguadas de la Selva Maya: Santuarios de vida silvestre que unen esfuerzos de conservación internacional
Reyna Hurtado, R. A., García Anleu, R., Garcia Vetorazzi, M., Sanchez Pinzón, K., Slater, K., Barão Nobrega, J., Contreras, F., Mendez Saint Martin, G., Sima Panti, D., Martínez, W., Cal, R., and G. Ponce 2022.
Ciencia Nicolaita, 84, doi: https://doi.org/10.35830/cn.vi84.610.
En el sureste de México, norte de Guatemala y noreste de Belice se encuentra la Selva Maya, un bosque trinacional considerado el macizo forestal tropical más extenso en Mesoamérica, con más de 30,000 km2 bajo alguna categoría de protección. En la Selva Maya el agua se acumula en pequeños reservorios conocidos como “aguadas”. Se ha documentado que las aguadas son esenciales para la conservación de varias especies de fauna en peligro de extinción, por ejemplo, los jaguares, tapires, pecaríes labios blancos, y zopilote rey que son sus visitantes

asiduos. En 2015, investigadores de fauna silvestre de México y Guatemala decidieron de manera informal crear un grupo internacional para compartir datos que ayudaran a monitorear las aguadas y su fauna a nivel de toda la Selva Maya. En 2016, gracias al proyecto “Fomento del Monitoreo de Biodiversidad y Cambio Climático en la Selva Maya” de la Cooperación Técnica Alemana - GIZ, se incluyó a Belice para conjuntar los esfuerzos de fototrampeo en cuerpos de agua entre instituciones de los tres países que conforman la Selva Maya. Desde 2018 se ha generado información más completa y robusta que ha permitido la conservación de los cuerpos de agua y su fauna silvestre asociada en los tres países. En el 2022, el grupo internacional de monitoreo de aguadas de la Selva Maya sigue vivo y trabajando dinámicamente para la conservación de las aguadas y su fauna asociada. Dentro de los principales logros se tiene un protocolo para compartir datos que luego se traduce en un reporte anual compartido entre todos los involucrados. Cada año se realizan seminarios o talleres para hacer llegar la información a tomadores de decisiones de los tres países, miembros de comunidades, personal del gobierno, y académicos relacionados.

Landscape drivers of mammal habitat use and richness in a protected area and its surrounding agricultural lands

Bellón, B., Henry, D. A. W., Renaud, P. C., de O. Roque, F., Cavalcante Santos, C., Melo, I., Arvor, D. and A. de Vos 2022.

Agriculture, Ecosystems & Environment 334, doi: https://doi.org/10.1016/j.agee.2022.107989.

Protected areas (PAs) are key to conserving biodiversity and ecosystem services globally, but their effectiveness increasingly depends on the ability of the surrounding agricultural areas to support biodiversity and secure connectivity at the landscape level. This requires monitoring the broader multi-use landscapes in which PAs exist and identifying the landscape characteristics that support rich, functional wildlife communities. Here, we investigated the species richness and habitat use patterns of a mammal community in relation to different landscape variables and land use and land cover (LULC) types in a PA and its surrounding agricultural lands in the Cerrado. We first used a hierarchical multi-species occupancy model with input camera trap data and eight landscape variables (vegetation productivity, phenology, and heterogeneity, distance to water, roads and settlements, and the PA, slope, and elevation) to estimate the species richness and habitat use of 29 mammal species across the landscape. We then analyzed the relationships between the species richness and habitat use and the landscape variables at the site level, as well as the distribution of species at the landscape level in relation to the different natural and agricultural LULC types. We found that most species are present in the native forest areas across the landscape and that many species are also present in the croplands surrounding the PA. The results also showed that species’ habitat use was especially determined by the productivity and heterogeneity of the vegetation cover, with a particularly strong positive relation in grasslands and pastures. These results suggest that the private properties surrounding the PA might be playing an essential role in supporting biodiversity in this region and provide insights on management practices that could largely contribute to maintaining or promoting a multifunctional landscape, such as maintaining the remaining forests or increasing the productivity and the heterogeneity (e.g., by increasing tree cover) in pastures.

Entre jabalíes de labios blancos y puercos de blancos y puercos de monte en Calakmul

Briceño-Méndez M. and S. Montiel 2022.

THERYA ixmana 1(3): 95-97, doi:10.12933/therya_ixmana-22-249.
Cuando uno piensa en jabalíes y puercos de monte, probablemente nos viene a la mente un grupo de animales de pelaje obscuro, bajitos y algo robustos, parecidos a los cerdos, que merodean entre la vegetación selvática, generalmente en busca de alimento.

Use of wildlife as an alternative protein source: Collared peccary meat
dos Santos Morais, B. H., de Lima Cardoso, D., da Silva Costa, J., Mayor, P., Inagaki de Albuquerque, N., Campos Chisté, R. and D. A. de Araújo Guimaraes 2022.
Meat Science 192, doi: https://doi.org/10.1016/j.meatsci.2022.108895.
Knowledge on the nutritional and sensory characteristics of wild meat provides a better basis for its use as food, ultimately expanding studies in gastronomy areas and stimulating the development of new products. This review aims to present information on the use of wild meat, with a focus on collared peccaries (*Pecari tajacu*). The biological characteristics of collared peccaries are discussed, with a focus on the main aspects of their meat. Collared peccary meat has excellent nutritional value due to its high protein levels (18.25%), unsaturated fatty acids (51.6–57.8%), and tenderness, similar to other domestic animals, thereby stimulating the interest of a new product market. Despite the demand for this product, collared peccary meat is scarce and not readily available for commercialization. Further, public policies are needed to encourage the management of this species to add value to the development of a production chain.

Less than six generations to save the chacoan peccary
Camino, M., Thompson, J., Velasco-Aceves, P. A., Cirignoli, S., Tiddi, R., Cortez, S., Matteucci, S. D. and M. Altrichter 2022.
Biodiversity and Conservation 31: 413–432, doi: https://doi.org/10.1007/s10531-021-02337-x.
Abstract
The Dry Chaco has one of the highest deforestation rates of the world. The chacoan peccary (*Catagonus wagneri*; ChP) is endemic to the forests of this region and faces a high risk of extinction. However, we lack sufficient information about this species to develop effective conservation actions. This is the first study to determine the relevance of primary and secondary forest as habitat for the species and to address opportunities for conservation. We used occupancy modelling to study habitat selection. Using additional information on the species and the region, we then estimated the time left before the ChP's habitat outside of protected areas is completely lost, and the number of ChP generations likely to exist before this happens. Finally, we identified protected areas that can sustain viable populations, and estimated the number of individuals that can survive within them. We found that the ChP occupies both primary forests and secondary forests. Also, that if deforestation rates remain consistent, the habitat for the ChP outside protected areas will have disappeared before 2051 (< 6 peccary generations). Furthermore, we found that most protected areas are too small and isolated to sustain viable populations. Our results have great management implications. Well-managed forests may allow the conservation of the ChP. Initiatives focused on forest conservation should increase, alongside the restoration of degraded and deforested areas. We also recommend the creation of new protected areas and wildlife corridors, and working horizontally with local communities.

Responses of *Hippopotamus amphibius* to environmental changes at Bui National Park, Ghana

Bempah, G., Wiafe E. D., Nartey, M. A., Messenger, K. and C. Lu 2022.
Acta Ecologica Sinica, doi: https://doi.org/10.1016/j.chnaes.2022.02.003.

Many researchers have adopted the use of indicator species to detect changes in the environment and predict future ecological modifications. Irrespective of the popularity of indicator species concept among scientists in recent times, there is less studies on the use of mega semi-aquatic mammals as indicator species, especially in Africa. This study determined the ecological role of *Hippopotamus amphibius* and how the mammal respond to environmental changes in an aquatic ecosystem, focusing on changes in biological diversity (fish and phytoplankton) and environmental factors (temperature, pH, dissolved oxygen, conductivity, total dissolved solids, hydrogen isotope, and oxygen isotope) by comparing pools harboring *H. amphibius* and pools without *H. amphibius* at the Bui National Park, Ghana. The results show that *H. amphibius* play an important ecological role by indicating high productivity in aquatic ecosystem and serving as influencers of the aquatic food web at Bui National Park. The results found significantly higher concentrations of dissolved oxygen in *H. amphibius* pools than pools without *H. amphibius*. Significantly higher diversity of fish and phytoplankton species were recorded in pools with *H. amphibius*. Common fish species identified during this study include, *Oreohromis niloticus*, *Labeo coubie*, *Alestes dentex* and *Labeo senegalensis*. Phytoplankton communities were dominated by Chlorophyceae (37.26%), Cyanophyceae (25.21%), and Bacillariophyceae (21.53%). The study results also showed that *H. amphibius* are sensitive to changes in depth of water, preferring areas with shallow pools. Managerial options for *H. amphibius* populations require strong support because of their socio-ecological benefits including potential ecosystem effects, increasing fishing and tourism value at the Bui National Park.

Common hippopotamus in the upper Dhidhessa River and its conflicts with Arjo-Dhidhessa Sugar Factory, Ethiopia

Teshome, K. and M. G. Erena 2022.
Conservation Science and Practice, doi: https://doi.org/10.1111/csp2.12790.

Due to the loss of wetlands, land-use change, and confrontations with humans, the common hippopotamus (*Hippopotamus amphibius*) is one of the largest land mammals currently threatened and classified as vulnerable by the International Union for Conservation of Nature (IUCN). The common hippo is found in protected and unprotected habitats, marshes, and inland major rivers of Ethiopia. However, little is known about the population status of hippos in the country. Hence, this study aimed to reveal the current population size of hippos and its conflicts with sugarcane plantation in Arjo-Dhidhessa Sugar Factory. Data on population size, diet composition, and potential hippo conflicts was also collected from August 2020 to February 2021. The complete on-foot count method was used to estimate the hippo population during the wet and dry seasons. The backtracking approach was used to determine the hippo's diet, which involved identifying and quantifying foraged species using quadrats. The total sugarcane stalk damage was counted in the sampled fields to determine sugarcane damage. Direct observation and interviews with sugarcane guards were used to identify mitigation methods employed to prevent hippo attacks. During the wet and dry seasons, a total of 96 and 182 hippos were documented in the upper Dhidhessa River, respectively. Hippos ate 23 plant species from 11 different families. The Poaceae family made up 51.32% of the hippo's diet. During the wet and dry seasons, a total

of 662 (36.5%) and 1156 (63.5%) sugarcane stalks/ha were damaged, respectively. The best mitigation techniques against hippo assaults in the area were guarding, fencing, trenching, and burning fire. A sound conservation action plan for hippos along the Dhidhessa River and associated banks must be developed. Furthermore, while hippos are encircled by the Arjo-Dhidhessa sugarcane irrigation scheme, modern mitigation measures and corridors for hippos should be implemented.

Inundation area drives hippo group aggregation and dispersal in a seasonal floodplain system

Fritsch, C. J. A., Plebani, M. and C. T. Downs 2022.
Mammalian Biology, doi: https://doi.org/10.1007/s42991-022-00286-8.

Common hippopotamus (*Hippopotamus amphibius*) (hereafter hippos) are iconic and understudied ecological engineers in African aquatic and terrestrial systems. Temporal changes in hippo group size in response to changes in wading areas have been described in river systems, but hippo group dynamics remain generally understudied and have not been quantified in a seasonal floodplain. We used monthly census data collected with an unmanned aerial vehicle between August 2016 and July 2017 to identify changes in hippo distribution, density, and group size at the most used wading areas in the seasonal floodplain in Ndumo Game Reserve, South Africa. We found that hippos congregate into large groups when the wading area decreases in seasonal floodplain systems, similar to perennial river systems. Moreover, as the inundation area increased, overall individual and group density decreased, hippo abundance decreased, and the mean distance between groups increased. Periods of low water availability tend to coincide with periods of food scarcity; thus, competition for water may compound with competition for food, likely affecting cycles of population growth or decline. Increased unpredictability in seasonal and annual rainfall patterns because of climate change will affect the predictability and availability of hippo wading areas, which will likely affect the distribution, size, and persistence of hippo populations. The results of our study provide additional information necessary for the conservation and management of hippos in seasonal floodplain systems in the context of climate change.

Temporal and spatial patterns of common hippopotamus populations in the Okavango Delta, Botswana

Inman,V. L., Bino, G., Kingsford, R. T., Chase, M. J. and K. E. A. Leggett 2022.
Freshwater Biology 67: 630– 642, doi: https://doi.org/10.1111/fwb.13868.

Conservation requires reliable estimates of a species' population and their spatial distribution. Knowledge of large-scale habitat use and population trends in common hippopotamus (*Hippopotamus amphibius*; hereafter hippo) in wetland ecosystems is limited, with no studies of hippo populations in the Okavango Delta (the Delta), Botswana.

1. We examined the drivers of long-term trends and spatial patterns in the Delta's hippo population, using 13 years of aerial surveys (1996–2018) informing on the potential impacts of changes in inflow, flooding patterns and rainfall on hippo populations.
2. We estimated temporal changes in hippo populations and relationships with rainfall and inflow. We also examined how spatially explicit hippo counts related to flood and surface water extent and vegetation class at different scales.
3. The Delta's hippo population has increased, probably due to increasing long-term rainfall and

inflow, following a period of severe drought/low flooding. Hippos were positively associated with areas with high variation in flooding and negatively associated with broad-scale surface water extent, indicating hippos avoided permanent swamps and main channels, probably due to water depth, lack of nearby grazing, and thick riparian vegetation. At a fine scale, hippos relied on large lagoons for daytime refuge.
4. The most recent population estimate indicates that Botswana has the third highest hippo population in Africa, reflecting the importance of the Delta. Reductions in inflow and rainfall from climate change and water resource development would threaten these hippo populations by reducing grazing availability, lagoon sizes, and seasonal swamps. Ongoing monitoring of hippos should continue as they represent a good indicator for the entire floodplain ecosystem.

Voice-mediated interactions in a megaherbivore
Thévenet, J., Grimault, N., Fonseca, P. and N. Mathevon 2022.
Current Biology 32 (2), doi: https://doi.org/10.1016/j.cub.2021.12.017.
Planet Earth is becoming increasingly difficult for large animal species to inhabit. Yet, these species are of major importance for the functioning of the biosphere and their progressive disappearance is accompanied by profound negative alterations of ecosystems1 (Supplemental information). To implement effective conservation measures, it is essential to have a detailed knowledge of the biology of these species. Here, we show that the hippopotamus *Hippopotamus amphibius*, an iconic African megaherbivore for which little is known about social communication, uses vocal recognition to manage relationships between territorial groups. We conducted playback experiments on groups of hippos and observed their response to vocalizations from an individual of the same group (familiar), a group from the same lake (neighbor) and a distant group (stranger). We found that stranger vocalizations induced a stronger behavioral reaction than the other two stimuli. In addition to showing that hippos are able to identify categories of conspecifics based on vocal signatures, our study demonstrates that hippo groups are territorial entities that behave less aggressively toward their neighbors than toward strangers. These new behavioral data suggest that habituation playbacks prior to conservation translocation operations may help reduce the risk of conflict between individuals that have never seen each other.

Observation of twins in hippopotamus in Nigeria
Usman, A., Farinelli, S. M. and L. R. Baker 2022.
Oryx 56 (3): 333-333, doi:10.1017/S0030605322000230.
The large hippopotamus *Hippopotamus amphibius* is categorized as Vulnerable on the IUCN Red List. In West Africa, threats to the species are exacerbated by high human population densities and significant habitat degradation and loss. In Nigeria, Africa's most populous nation, many hippopotamus populations occur outside protected areas, in lakes, inland rivers and reservoirs; the largest populations yet recorded occur in large reservoirs in the country's northern region (Baker et al., 2020, Aquatic Conservation, 30, 1996–2003).
In October 2021, we conducted a census of hippopotamuses at the 300 km2 Dadin Kowa Dam Reservoir, on the Gongola River in northeastern Nigeria. Most of the reservoir lies in Gombe State, with smaller areas in Yobe and Borno States. As part of the survey, funded by The A.G. Leventis Foundation, we investigated reports from local farmers of several sightings of a ‘mom and two babies’. On two occasions, we observed a single adult female with two calves in flooded farmland along the western side of the reservoir; we also captured the trio in a drone video. On

the second visit, one calf was initially resting under a tree c. 150 m from the female and second calf, both of which were mostly submerged in aquatic grasses. At the time of our study, the area around the reservoir was widely covered by farmland, notably guinea corn Sorghum bicolor. Local farmers reported observing the trio leave the water to forage in farmland during the day. We did not observe other hippopotamuses in proximity to the female and two calves.
Twins are rare in hippopotamuses. According to data from the Association of Zoos and Aquariums (AZA), of the 561 recorded births among hippopotamuses in AZA institutions from 1880 to 2021, only 6 (1%) were twins. In European zoos from 1850 to 2020, twins were reported < 1% of the time: 11 twins in 1,562 births (data from the European Association of Zoos and Aquaria). Given the precarious status of hippopotamuses in Nigeria, our observation of twins is encouraging. The most recent reports received from local people, in mid December 2021, indicated that both calves had survived, but that the trio may have moved elsewhere because of receding water levels.

Human-Hippo Relationship in Selected Communities around Kainji Dam in New-Bussa, Niger State, Nigeria
Adeola, A. J., Sulyman, A., Babatunde, K. O., Onihunwa, J. O., Mohammed, H. I., Joshua, D. A. and O. A. Adeniji 2022.
Journal of Appied Sciences and Environmental Management 26 (4):769-774, doi: 10.4314/jasem.v26i4.29.
Human-wildlife conflicts have become a significant issue in conservation and land management of a protected area. The study examines Hippo-Human relationship in selected communities around Kainji dam in New Bussa, Niger State, Nigeria. Data for the study was collected through pre tested structured questionnaires and analyzed using descriptive statistics. Findings from the results revealed that male Hippopotamus is the highest with 75.0% and that 37% were 50 years and above. Majority of the respondents had no formal education (42.0%). 79% of the respondents recorded that Hippopotamus was present in the study area while 82.0% have had to encounter Hippopotamus attack. The crops that are mostly grown by the respondents in the study area are Maize, Beans, Millet, Guinea corn, Rice and Groundnut. In which maize is the mostly grown and raided by Hippopotamus. The findings revealed that 69.0% of the respondents state that crop raiding is the major conflict. Various preventive measures undertaken include: fire and smoke, watch guarding, trapping, scare crow, thorn fencing and hunting, with fire and smoke being the most preferred by the respondents. The victims of these attacks are willing to prevent the attacks with fire and smoke as against killing the Hippopotamus, they should be encourage by factoring compensation into conservation policy to promote the conservation of this species in the study area.

Diseases

Gut microbiota reveals the environmental adaption in gastro-intestinal tract of wild boar in karst region of Southwest China
Cao, H.Q., Yang, X.W., Peng, C.C., Wang, Y.Y., Guo, Q.Y. and H.J. Su 2022
Annals of Microbiology 72(1): 9, doi: 10.1186/s13213-022-01669-5
Background Gut microbes has become one of the research hotspots in animal ecology, playing an important role in monitoring dietary adaptation and health status of host. However, there are

few studies on the gut microbiota in the stomach, small intestine (ileum), and large intestine (cecum, colon, and rectum) of wild boar. Results Alpha diversity and Beta diversity showed there were significant differences in the abundance and distribution of microbes in gastrointestinal tract of wild boar. Firmicutes and Bacteroidetes were the most dominant phyla in stomach, cecum, colon and rectum of wild boar, while Proteobacteria and Firmicutes were the most dominant in ileum. At genus level, there were different leading genera in stomach (Prevotella and Lactobacillus), small intestine (Escherichia-Shigella and Lactobacillus), and large intestine (Ruminococcaceae UCG-005, Christensenellaceae R-7 group, and Escherichia-Shigella). PICRUSt function predictive analysis suggested that there were significant differences in microbial metabolic pathways among five locations of wild boar. Conclusions This study comprehensively revealed the differences in composition of microbial community in gastrointestinal trac of wild boar. Future work links microbes with the metabolites to accurately reveal the health of wild boar.

Genetic characterization of hepatitis E virus from wild boar in China

Gong, W.J., Du, H.Y., Sun, X.F., Sun, H.T., Peng, P., Qin, S.Y., Geng, H.D., Zeng, Z., Liang, W.W., Ling, H.Q., Tu, C.C. and Z.Z. Tu 2022

Transboundary and Emerging Diseases, doi: 10.1111/tbed.14633

Hepatitis E virus (HEV), the causative agent of hepatitis E (HE), is classified into four major genotypes (1-4), with wild boar being the main natural reservoir for genotypes 3 and 4. However, little is known about the prevalence of HEV infection in wild boars in China. In this study, RT-nested PCR and RT-quantitative PCR were used to detect the HEV RNA in tissue samples taken from 331 free-ranging wild boars collected between 2018 and 2020 from 24 regions across China, and the partial ORF2 genes or complete genomes of the positive samples were sequenced. Furthermore, antibodies against HEV in 216 serum samples from wild boars were tested by ELISA. As a result, HEV RNA was detected in nine out of 331 liver samples of wild boars (2.72%), which were distributed in eight regions. Genetic and evolutionary analysis of partial ORF2 sequences indicated that the HEV strains identified in this study share 83.9%-100% nucleotide sequence identity and belong to subtypes 4d (n = 6), 4g (n = 2), and 4h (n = 1), and similar phylogeny was obtained using the complete genome sequences of seven wild boar HEV strains. Additionally, the HEV viral loads were higher in the liver than in other tissues and blood. Moreover, 61 out of 216 sera (28.2%) from wild boars tested positive for anti-HEV antibodies. To our knowledge, this is the first study to report the epidemiological situations of HEV infections in free-ranging wild boars in China, and the obtained data are valuable for prevention and control of HE.

Salmonella in Wild Boars (*Sus scrofa*): Characterization and Epidemiology

Petrovic, J., Mirceta, J., Babic, J., Malesevic, M., Blagojevic, B., Prodanov Radulovic, J. and D. Antic 2022

Acta Veterinaria-Beograd 72(2): 184-194, doi: 10.2478/acve-2022-0015

The large study on Salmonella spp. in the population of wild boars from twelve hunting estates in the South-West Vojvodina, Serbia was conducted with the aim to investigate the prevalence of *Salmonella* spp. in wild boars and to trace *Salmonella* sources. The hunting estates had similar epidemiological characteristics, i.e. lowland regions with an intensive management system of wild boars. The prevalence of *Salmonella* in wild boars was determined and the examination of

molecular similarities of strains isolated from wild boars and domestic animals (pigs and poultry from nearby farms) was performed. The total number of 425 wild boars (25.3% of total population), shot on official hunts, were sampled (425 feces and 425 mesenteric lymph nodes samples) and examined by standard ISO protocols. Subtyping of the isolates was performed and compared by Pulsed-field gel electrophoresis (PFGE). The *Salmonella* prevalence in the fecal samples was 3.1% and in the lymph nodes was 0.2%. Salmonella Enteritidis was the most dominant serotype. A high molecular similarity was found between *Salmonella* isolates from wild boars and domestic animals. The proximity of communities and domestic animals, as well as improper removal of animal waste were identified as important epidemiological factors which significantly affect the epidemiology of *Salmonella* in wild boars from lowlands.

Genetic Diversity of Porcine Circovirus 2 in Wild Boar and Domestic Pigs in Ukraine
Rudova, N., Buttler, J., Kovalenko, G., Sushko, M., Bolotin, V., Muzykina, L., Zinenko, O., Stegniy, B., Dunaiev, Y., Sytiuk, M., Gerilovych, A., Drown, D.M., Bortz, E. and O. Solodiankin 2022
Viruses-Basel 14(5): 924, doi: 10.3390/v14050924
Porcine circovirus type 2 (PCV2) is responsible for a number of porcine circovirus-associated diseases (PCVAD) that can severely impact domestic pig herds. For a non-enveloped virus with a small genome (1.7 kb ssDNA), PCV2 is remarkably diverse, with eight genotypes (a-h). New genotypes of PCV2 can spread through the migration of wild boar, which are thought to infect domestic pigs and spread further through the domestic pig trade. Despite a large swine population, the diversity of PCV2 genotypes in Ukraine has been under-sampled, with few PCV2 genome sequences reported in the past decade. To gain a deeper understanding of PCV2 genotype diversity in Ukraine, samples of blood serum were collected from wild boars (n = 107) that were hunted in Ukraine during the November-December 2012 hunting season. We found 34/107 (31.8%) prevalence of PCV2 by diagnostic PCR. For domestic pigs, liver samples (n = 16) were collected from a commercial market near Kharkiv in 2019, of which 6 out of 16 (37%) samples were positive for PCV2. We sequenced the genotyping locus ORF2, a gene encoding the PCV2 viral capsid (Cap), for 11 wild boar and six domestic pig samples in Ukraine using an Oxford Nanopore MinION device. Of 17 samples with resolved genotypes, the PCV2 genotype b was the most common in wild boar samples (10 out of 11, 91%), while the domestic pigs were infected with genotypes b and d. We also detected genotype b/d and b/a co-infections in wild boars and domestic pigs, respectively, and for the first time in Ukraine we detected genotype f in a wild boar from Poltava. Building a maximum-likelihood phylogeny, we identified a sublineage of PCV2 genotype b infections in both wild and domestic swine, suggesting a possible epizootic cluster and an ecological interaction between wild boar and domestic pig populations in northeastern Ukraine.

Gut Bacterial Composition and Functional Potential of Tibetan Pigs Under Semi-Grazing
Niu, H., Feng, X.Z., Shi, C.W., Zhang, D., Chen, H.L., Huang, H.B., Jiang, Y.L., Wang, J.Z., Cao, X., Wang, N., Zeng, Y., Yang, G.L., Yang, W.T. and C.F Wang 2022
Frontiers In Microbiology 13: 850687, doi: 10.3389/fmicb.2022.850687
Gut bacterial community plays a key role in maintaining host health. The Tibetan pig (*Sus scrofa*), an ancient breed in China, has been known for its high adaptability to harsh environments and for its meat quality. To understand the underlying mechanisms facilitating to shape these unique features, in this study, 16S rRNA sequencing using pig feces and subsequent bacterial functional

prediction were performed. Also, the gut bacteria of two other breeds of pigs, Barkshire and Landrace, were examined for comparison. It was revealed that the structure of bacterial community in Tibetan pigs appeared to be more complex; the relative abundances of dominant bacterial families varied inversely with those of the other pigs, and the proportion of Firmicutes in Tibetan pigs was lower, but Bacteroides, Fibrobacterota, Lachnospiraceae, Oscillospiraceae, and Ruminococcaceae were higher. Bacterial functional prediction revealed that the dominant flora in the Tibetan pigs was more correlated with functions regulating the hosts' immune and inflammatory responses, such as NOD-like receptor signaling pathway and vitamin metabolism. In addition, in Tibetan pigs, the taxonomic relationships in the gut bacteria on day 350 were closer than those on earlier stages. Furthermore, gender played a role in the composition and function of bacterial inhabitants in the gut; for boars, they were more correlated to drug resistance and xenobiotics metabolism of the host compared to the sows. In sum, our preliminary study on the gut bacterial composition of the Tibetan pigs provided an insight into the underlying host-microorganism interactions, emphasizing the role of intestinal bacteria in the context of modulating the host's immune system and host development.

Elements and antioxidants in wild boar from northwestern Russia

Kalinina, S., Panchenko, D., Ilyukha, V., Canfield, A., Baishnikova, I., Antonova, E. and K. Nikerova 2022

European Journal of Wildlife Research 68(2): 22, doi: 10.1007/s10344-022-01570-1

To evaluate the nutritional status and the environmental exposure to toxic elements of the wild boar *Sus scrofa* L. (n = 20) from northwestern (NW) Russia, we determined the contents of the essential (Co, Cu, Fe, Mg, Mn, Ni, and Zn) and toxic (Cd and Pb) elements in the muscle, kidney, and liver. A second aim was to study the interactions between these elements and several antioxidants, namely, the activity of superoxide dismutase (SOD) and catalase, and the contents of glutathione (GSH), retinol, and alpha-tocopherol. A third aim was to assess whether the meat and offal of the wild boar are suitable for consumption or unsuitable due to the level of toxic elements. According to reference values of elements reported for domestic pigs, the wild boar from NW Russia was deficient in most of the essential elements (Co, Cu, Mn, Ni, and Zn) but had optimal values of Fe and Mg. The concentrations of Cd and Pb were lower than the values reported for pigs and wild boars living in heavily polluted areas. The correlations between antioxidants and elements could indicate that mineral balance in the body is regulated by antioxidants, among which the SOD activity, GSH, and retinol levels are the most sensitive parameters. Our assessment indicates that consumption of wild boar meat and liver, either rarely (4 times a year) or regularly (monthly), does not pose a health risk to adults and children, although wild boar kidney is not suitable for consumption.

Predicting the risk of *Alaria alata* infestation in wild boar on the basis of environmental factors

Klich, D., Nowicki, M., Didkowska, A., Belkot, Z., Popczyk, B., Wisniewski, J. and K. Anusz 2022

International Journal for Parasitology-Parasites and Wildlife 17: 257-262, doi: 10.1016/j.ijppaw.2022.03.004

Alaria alata is an emerging parasite that poses a potential risk for those consuming game, pork, snails and frogs. One paratenic host of *A. alata* that is known to play an important role in its spread through its feeding habitats is the wild boar. However, no statistical analysis of the

influence of aquatic environments and carnivores on the occurrence of *A. alata* in wild boars has yet been performed. The present study combines a small-scale analysis based on hunting districts in the Mazowieckie province with a large-scale analysis based on data for all provinces in Poland. We applied various modeling approaches, including logistic regression and a generalized linear model in order to determine the presence, intensity and prevalence of *A. alata*. We used the Alaria mesocercariae migration technique (AMT) to estimate the risk of *A. alata* among wild boar in a given hunting district or province. The small-scale analysis found that mesopredators (red fox (*Vulpes vulpes*)) and racoon dog (*Nyctereutes procyinoides*) were likely to influence *A. alata* infestation of wild boar; however, the effect was weak, probably as a result of the large home range size of these animals. The large-scale analysis found that wetlands influence the prevalence of *A. alata* in wild boar, with the estimated risk increasing in the north of the country; this finding is consistent with other studies. Our findings indicate that the occurrence of *A. alata* in wild boar requires analysis on many levels, and environmental factors play a key role in risk assessment.

Seroprevalence of Enzootic Teschen Disease in the Wild Boar Population in Ukraine
Sytiuk, M.P., Bezymennyy, M.V., Halka, I.V., Uhovskyy, V.V., Muzykina, L.M., Lavalley, M., Nychyk, S.A., Nedosekov, V.V., Howard, M.W. and E. Bortz 2022
Vector-Borne and Zoonotic Diseases 22(2):138-147, doi: 10.1089/vbz.2021.0063
Teschen disease is an acute fatal enterovirus encephalomyelitis of pigs, characterized by a range of central nervous system disorders. The cause of porcine enterovirus encephalomyelitis is the picornavirus porcine teschovirus-1 (PTV-1). There are at least 12 distinct serotypes of PTVs, where PTV-2 to PTV-12 serogroups are associated with other forms of disease (Talfan disease or poliomyelitis sum) or benign enzootic paresis. Combined, PTVs have been found to have a high seroprevalence, up to 65%, in healthy pig populations in Europe. PTVs have also been detected in wild boar, including the divergent PTV-13 serogroup; wild suids may represent a sylvatic reservoir capable of carrying the virus long distances. In Ukraine, Teschen disease is widespread and causes lethal disease in domestic pigs. To understand temporal and geographical distribution of Teschen disease virus (PTV-1) in wild boar in Ukraine (2001-2013), we analyzed seroprevalence of 6840 blood serum samples from hunted suids using a virus microneutralization assay. A total of 1364 samples (19.9%) were seropositive, with average antibody titer ratios 5.89 +/- 0.03 log(2) (range 5-12 log(2)). Teschen seroprevalence was temporally and geographically concentrated in the northern and western regions of Ukraine, corresponding to forested regions (polissya) and overlapping with wild boar populations and habitats, suggesting endemicity in wild boar. The virus sporadically emerged in central, southern, and eastern forested regions, suggesting long-distance movement of infected wild suids. Thus, wild boar should be monitored for potential transboundary spread in forested and mountain regions and spillover of PTVs to domestic swine populations.

Genetic Diversity, Admixture and Analysis of Homozygous-by-Descent (HBD) Segments of Russian Wild Boar
Kostyunina, O., Traspov, A., Economov, A., Seryodkin, I., Senchik, A., Bakoev, N., Prytkov, Y., Bardukov, N., Domsky, I. and T. Karpushkina 2022
Biology-Basel 11(2): 203, doi: 10.3390/biology11020203
Simple Summary The wild boar is one of the most common wild animals. On the territory of

Russia, there are two subspecies of the wild boar-European and Asian. At the beginning of the 20th century, the wild boar in the European part of Russia was practically exterminated. Later the population was restored by importing animals from other regions and by self-repopulation. The aim of our research was to assess the population structure of the Russian wild boar in comparison with the wild boar from other regions of the world and to determine the level of autozygosity, which allows us to determine the state of the population. We found traces of introgression of the Asian wild boar into the European one due to, migration of the wild boar in the population recovery process. Further analysis for genetic influx into Russian wild boar population identified four samples in which more than 10% of the genome belonged to domestic pigs. The Homozygous-by-Descent (HBD) Segments evaluation showed a low level of autozygosity in comparison with the aggregate sample of the European wild boar. Based on our genetic evaluation, we concluded that the population of the Russian wild boar of the European and Asian subspecies are characterized by a sufficient level of genetic diversity. The wild boar is the wild ancestor of the domestic pig and one of the most common species of ungulates. At the beginning of the 20th century, the wild boar was practically exterminated in the European part of Russia. In the period 1935-1988, 7705 boars were caught in various regions of the European part of Russia, the Far East, Ukraine, Belarus, Kyrgyzstan, Kazakhstan, Latvia, Lithuania, Estonia, Tajikistan and resettled in the territory of Russia. Asian and European wild boars dwell the territory of Russia. The aim of our research was to study the genetic diversity and structure of wild boar populations in different regions of Russia using genome-wide genotyping. We have determined the genetic distances, population structure, parameters of genetic diversity and significantly expanded our understanding of the genetic state of the Russian wild boar. For the first time, we calculated autozygosity of the wild boar of the European and Asian subspecies using Homozygous-by-Descent (HBD) Segments analysis, which is important in terms of population recovery. We also found evidence of hybridization between Russian wild boar and domestic pigs. A group of European wild boars showed introgression of the Asian boar into population. The mean level of the inbreeding coefficient in European wild boar was higher than in Asian wild boar, and combined groups of the European boar had higher inbreeding coefficient than Russian wild boars. These results obtained can be used in population management.

Dental formula variations in wild and domestic *Sus scrofa*: is the first premolar agenesis an evolutionary trend?

Azorit, C., Oya, A., Hohl, L.S.L., Carrasco, R., Rocha-Barbosa, O. and A. Casinos 2022
Mammalia 86(3): 287-297, doi: 10.1515/mammalia-2021-0001

We investigated the occurrence of congenital dental abnormalities in 94 wild boars *Sus scrofa scrofa*, and 20 Iberian pigs *Sus scrofa domesticus* from Donana (DNP) and Sierra de Andujar Natural Park (ANP) southern Spain. The only dental variation found was agenesis of the lower first premolar, either deciduous (Dp(1)) or permanent (P-1). We analyzed prevalence variations using: odds ratios, Fisher's exact test and logistic-regression models. The lower first premolar has often been reported to be absent in modern domestic breeds of pigs, but it is usually reported as present in wild boar. However, we found a similar occurrence of agenesis in wild boar as in Iberian pigs. A common genotypic background between wild boar and Iberian pig populations of ANP sharing the same ecosystems may explain this result. When considering only wild boar, unexpected differences between populations were detected. The wild boar from ANP showed higher estimated probabilities of agenesis than those from DNP. Environmental conditions can

also represent influencing factors for changes within subspecies. Our findings reinforce the idea that in suids the congenital absence of premolars probably has an evolutionary relevance, which could represent a generalized trend towards the reduction of the dental formula from the plesiomorphic placental dentition.

Seroepidemiological surveys of tick-borne encephalitis virus and novel tick-borne viruses in wild boar in Nagasaki, Japan

Luvai, E.A.C., Uchida, L., Tun, M.M.N., Inoue, S., Hu, W.Y., Shimoda, H., Morita, K. and D. Hayasaka 2022

Ticks and Tick-Borne Diseases 13(1): 101860, doi: 10.1016/j.ttbdis.2021.101860

In Japan, tick-borne viruses such as tick-borne encephalitis virus (TBEV) and severe fever with thrombocytopenia syndrome virus have been identified in humans, animals, and ticks. In addition, novel tick-borne viruses have been isolated from ticks in Japan. This study aimed to determine the seroprevalence of TBEV and novel viruses, particularly Tofla virus (TFLV), Kabuto Mountain virus (KAMV), and Muko virus (MUV) in wild boar in Nagasaki, Japan. Enzyme-linked immunosorbent assays and neutralization tests were performed to detect antibodies against each virus. Wild boar serum tested positive for antibodies against KAMV, TFLV, and TBEV, but not MUV. This study revealed the seroprevalence of newly identified tick-borne viruses and TBEV in animals residing in the Nagasaki area. The seroprevalence of these viruses in sentinel animals may inform policies aimed at preventing tick-borne virus disease outbreaks.

Detection of *Mycobacterium tuberculosis* complex antibodies in free-ranged wild boar and wild macaques in selected districts in Selangor and reevaluation of tuberculosis serodetection in captive Asian elephants in Pahang, Peninsular Malaysia

Lekko, Y.M., Che-Amat, A., Ooi, P.T., Omar, S., Mohd-Hamdan, D.T., Linazah, L.S., Zakaria, Z., Ramanoon, S.Z., Mazlan, M., Jesse, F.F.A., Abdul-Razak, M.F.A., Jasni, S. and N. Abdul-Hamid 2021

Journal Of Veterinary Medical Science 83(11): 1702-1707, doi: 10.1292/jvms.21-0144

Tuberculosis (TB) is a chronic inflammatory and zoonotic disease caused by *Mycobacterium tuberculosis* complex (MTBC) members, affecting several domestic animals, wildlife species and humans. The preliminary investigation was aimed to detect antibody against MTBC among indigenous wildlife which are free-ranged wild boar, free-ranged wild macaques and captive Asian elephants in selected areas of Selangor and elephant conservation centre in Pahang, respectively. The results indicate that MTBC serodetection rate in wild boar was 16.7% (7.3- 33.5 at 95% confidence interval (CI)) using an in-house ELISA bPPD IgG and 10% (3.5-25.6 at 95% CI) by DPP (R) VetTB assay, while the wild macaques and Asian elephant were seronegative. The univariate analysis indicates no statistically significant difference in risk factors for sex and age of wild boar but there was a significant positive correlation ($P<0.05$) between bovine TB in dairy cattle and wild boar seropositivity in the Sepang district.

Survey of severe fever with thrombocytopenia syndrome virus in wild boar in the Republic of Korea

Rim, J.M., Han, S.W., Cho, Y.K., Kang, J.G., Choi, K.S., Jeong, H., Son, K., Kim, J., Choi, Y., Kim, W.M., Cho, N.H. and J.S. Chae 2021

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Severe fever with thmmbocytopenia syndrome (SFTS) is caused by Dabie bandavirus that belongs to the genus Bandavirus in the family Phenuiviridae and order Bunyavirales and is transmitted by hard ticks. It has been detected in several tick species, various animals, and humans. The purpose of this study was to detect SFTS virus (SFTSV) antigen and antibody in wild boar in the Republic of Korea (ROK). A total of 768 sera samples were collected from wild boar in the ROK between January and December 2019. Viral RNA was extracted from sera using viral RNA extraction kit, and one-step RT-nested polymerase chain reaction (PCR) was performed to amplify the S segment of the SFTSV. The sequencing data were analyzed using Chromas and aligned using Clustal X. The phylogenetic tree was constructed using the maximum-likelihood method using MEGA7. In addition, wild boar sera were tested for IgG antibodies against SFTSV by enzyme-linked immunosorbent assay (ELISA) and immunofluorescence assay (IFA). Of a total of 768 sera samples, 40 (5.2%) were positive for SFTSV by RT-PCR targeting the S segment. Two hundred twenty-one (28.8%) and 159 (20.7%) of 768 sera samples were sempositive by ELISA and IFA, respectively. Based on both ELISA and IFA tests of the same samples, 110 (14.3%) wild boar sera samples were positive for SFTSV antibodies. Of a total of 40 positive serum samples by RT-PCR, 33 (82.5%) and 7 (17.5%) sera were classified as the genotype B-3 and D, respectively, by sequence analysis. These results provide useful information that demonstrates the detection of antigen and antibody in wild boar sera samples for every month of a certain year throughout the ROK.

A closer look on the variety and abundance of the faecal resistome of wild boar
Dias, D., Fonseca, C., Mendo, S. and T. Caetano 2022
Environmental Pollution 292(B): 118406, doi: 10.1016/j.envpol.2021.118406
Antimicrobial resistance (AMR) is a serious problem for public and animal health, and also for the environment. Monitoring and reporting the occurrence of AMR determinants and bacteria with the potential to disseminate is a priority for health surveillance programs around the world and critical to the One Health concept. Wildlife is a reservoir of AMR, and human activities can strongly influence their resistome. The main goal of this work was to study the resistome of wild boar faecal microbiome, one of the most important game species in Europe using metagenomic and culturing approaches. The most abundant genes identified by the high-throughput qPCR array encode mobile genetic elements, including integrons, which can promote the dissemination of AMR determinants. A diverse set of genes (n = 62) conferring resistance to several classes of antibiotics (ARGs), some of them included in the WHO list of critically important antimicrobials were also detected. The most abundant ARGs confer resistance to tetracyclines and aminoglycosides. The phenotypic resistance of E. coli and Enterococcus spp. were also investigated, and together supported the metagenomic results. As the wild boar is an omnivorous animal, it can be a disseminator of AMR bacteria and ARGs to livestock, humans, and the environment. This study supports that wild boar can be a key sentinel species in ecosystems surveillance and should be included in National Action Plans to fight AMR, adopting a One Health approach.

African swine fever vaccine development: current status and challenges ahead
Monoldorova, S., Koltsova, G., Titov, I., Yoo, I., Gogin, A., Jeong, J., Byeon, H. S., Yun, S., Chang, Y. and S. S. Kang 2022.
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African swine fever (ASF) is a contagious, hemorrhagic and highly lethal viral disease in swine. Following the initial report of ASF in Kenya in 1921 it spread to East Asia through Western Europe and Russia (including Eastern Europe). Many efforts have been dedicated to controlling ASF but the struggle to eradicate this disease continues. Thus far, the efforts to develop an effective vaccine to control ASF have been unsuccessful. A previous inactivated ASF vaccine, developed by traditional methods, failed to protect pigs from ASF virus (ASFV) infection. Neutralizing antibodies were not effective in inducing protective immunity and it appears that cellular immunity is required. To develop an effective ASF vaccine the identification of protective antigens of ASFV has been explored and subunit vaccines that target these potential protective antigens have induced partial protection. DNA vaccines that induce cellular immunity have been effective in inducing protection against ASFV infection. ASFV live attenuated vaccines (LAVs) can be rationally designed and engineered via comparative and functional genomics. LAVs have a major safety concern despite their high protective efficacy. ASF vaccines are urgently needed to control ASF; however, many obstacles remain to be overcome to develop an effective ASF vaccine.

Typical intracranial myiasis in Nigerian red river hogs (*Potamochoerus porcus*) caused by an unknown bot fly (Diptera: Oestridae)

Friant, S., Young, D. K. and T. L. Goldberg 2022.
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We report an unknown taxon of bot fly (Diptera: Oestridae: Oestrinae) in red river hogs (*Potamochoerus porcus* Linnaeus, 1758) in Cross River State, Nigeria. From direct observation and interviews with local hunters, we document that, remarkably, the parasite typically occurs within the intracranial supra-meningeal space – i.e., between the inner wall of the skull and the brain – but without causing visible inflammation or clinical signs. The parasite is most similar (up to 87.9%) to *Rhinoestrus usbekistanicus* based on cytochrome oxidase subunit 1 DNA sequencing but is sufficiently divergent phylogenetically to represent a new or previously un-sequenced taxon. Morphologically, the parasite shares some, but not all, features with *R. nivarleti*. Local cultural belief systems attribute aspects of red river hog behavior (e.g. intelligence, elusiveness) to the parasite, suggesting a prolonged presence in the red river hog population. The parasite's unusual anatomic location may be aberrant, or it may be a protective adaptation to life in red river hogs, which forage vigorously with their snouts.

Diagnosis of *Mycobacterium bovis* infection in free-ranging common hippopotamus (*Hippopotamus amphibius*)

Kerr, T. J., Goosen, W. J., Gumbo, R., de Klerk-Lorist, L. M., Pretorius, O., Buss, P. E., Kleynhans, L., Lyashchenko, K.P., Warren, R. M., van Helden, P. D. and M. A. Miller 2022.
Transboundary and Emerging Diseases 69: 378– 384, doi:https://doi.org/10.1111/tbed.13989.

Bovine tuberculosis (bTB), caused by *Mycobacterium bovis* (*M. bovis*) infection, is a multi-host disease which negatively affects the wildlife industry, with adverse consequences for conservation, ecotourism, and game/wildlife sales. Although interspecies transmission has been reported between some wildlife hosts, the risk of spread in complex ecosystems is largely unknown. As a controlled disease, tools for accurate detection of *M. bovis* infection are crucial for effective surveillance and management, especially in wildlife populations. There are, however, limited species-specific diagnostic tests available for wildlife. Hippopotamuses are rarely tested

for *M. bovis* infection, and infection has not previously been confirmed in these species. In this study, blood and tissue samples collected from common hippopotamus (*Hippopotamus amphibius*) residing in a bTB-endemic area, the Greater Kruger Protected area (GKPA), were retrospectively screened to determine whether there was evidence for interspecies transmission of M. bovis, and identify tools for *M. bovis* detection in this species. Using the multi-species DPP® VetTB serological assay, a bTB seroprevalence of 8% was found in hippopotamus from GKPA. In addition, the first confirmed case of *M. bovis* infection in a free-ranging common hippopotamus is reported, based on the isolation in mycobacterial culture, genetic speciation and detection of DNA in tissue samples. Importantly, the *M. bovis* spoligotype (SB0121) isolated from this common hippopotamus is shared with other *M. bovis*-infected hosts in GKPA, suggesting interspecies transmission. These results support the hypothesis that M. bovis infection may be under recognized in hippopotamus. Further investigation is needed to determine the risk of interspecies transmission of *M. bovis* to common hippopotamus in bTB-endemic ecosystems and evaluate serological and other diagnostic tools in this species.

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Pigs, peccaries and hippopotamuses are nonruminant ungulates belonging to the Suborder Suiformes of the Order Artiodactyla (the eventoed ungulates). Within the Suborder Suiformes, pigs belong to the Family Suidae, peccaries to the Family Dicotylidae and hippopotamuses to the Family Hippopotamidae.