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Introduction

The Old World pigs and their New World analogues, the peccaries, are important to people. Hippos are also important but, being (spectacularly) more specialized, much less so. Nonetheless, the arrival of human settlers on Madagascar is implicated in the extinction of up to three species of endemic hippopotamuses in the last one and a half millennia (Grubb, this vol., section 4.1). Elsewhere human exploitation of the suiformes dates back for tens of thousands of years. In many parts of the world, wild pigs have long constituted the most commonly eaten large animal. The earliest human remains (c. 40,000 yrs. BP) in the Niah Caves of Sarawak (Borneo) are associated with large numbers of bearded pig (S. barbatus) bones (Cranbrook, 1979), and recent studies of the economy of hunted species in this country have demonstrated that this species is still by far the most important game animal (Caldecott and Nyanoi, 1985).

Pigs were also amongst the first species to be domesticated, and it is now certain that this happened in several different places and times with different (local) progenitors. Most of these progenitors were regional variants of the Eurasian wild pig (Sus scrofa) but, as Groves (1981) revealed, the Sulawesi warty pig (S. celebensis) has also been domesticated, and its purebred, hybrid and feral derivatives are still hunted and husbanded in various parts of South-east Asia and the Papuan Realm. In these regions, in particular, the economic importance of wild and domestic pigs led inevitably to their

being interwoven with the cultures of the people who depended upon them. Surviving examples of these 'pig cultures' are still to be found amongst some tribal groups in these areas, and it is apparent that pigs are as fundamental to the integrity and economy of these societies as cattle are to other, comparable societies in the drier regions of the Indian Subcontinent and Africa.

Being highly adaptable, more prolific and more suited to backyard and small-scale commercial husbandry, pigs are also more abundant and more widely distributed than other hoofstock and they are still amongst the most important of all domestic animals. In Asia alone, the annual consumption of pork had exceeded 20 million tons per year by the mid-1980's, an amount greater than the total consumption of all other domesticated species put together (FAO, 1985).

The importance of these animals as a basic food resource was also reflected in their widespread carriage and dispersal during the early transmigrations of settling peoples, who either released them to be hunted whenever required for eating or who maintained them in varying states of domestication.

Their dispersal was continued by the later European explorers, sealers, whalers, immigrant settlers and colonialists, and most recently (and irresponsibly) by commercial and recreational hunters and game meat producers; all of whom have transported and (whether accidentally or deliberately) released founder stocks to form naturalized populations. As a result, pigs are now one of the most widely distributed of all species, and the diversity of wild and domestic, feral, hybrid, native and introduced forms, has produced patterns of distribution and interrelationships of almost unparalleled confusion.

This complexity of forms is most apparent in South-east Asia, where an inordinate number of taxa have been described in the scientific literature. The challenge of unraveling their relationships was taken up by Colin Groves, whose major reviews of *Babyrousa* (1980) and, especially, *Sus* (1981) are the basis for our present understanding of the diversity and regional genetic variation in these genera. In clarifying the affinities and distribution of innumerable naturalized populations, many of which were erroneously recognized as valid taxa, Groves also helped to clear the dross and provide a contextual framework for the interpretation and weighting of other, conservation-related data.

The current and equally important review of the subgeneric taxonomy of the Afrotropical suids by Peter Grubb (section 4.1, this vol.) has also provided an indispensable rationale for weighting future research and conservation priorities amongst these animals. In this instance, however, the prioritization process was greatly facilitated by the simultaneous collection of questionnaire data on the present distribution and conservation status of all suiform species from most (sub-Saharan) African countries. In 1988/89, following a format similar to that devised by the Antelope Specialist Group (East, 1988), approximately 600 questionnaires (one questionnaire for each species of wild pig and hippo known or believed likely to occur in each country) were sent to a total of 115 wildlife officials and biologists in 42 countries. A total of 236 (39%) completed questionnaires and/or copies of relevant reports, reprints and maps, were returned by 93

(81%) correspondents, with information from 34 (81%) countries. Analyses of these data, together with information gleaned from a variety of other sources, including Grubb's review, provide the basis for the 'action plan' chapters for each species/genus in this volume. A similar questionnaire survey is now being undertaken for the peccaries in Central and South America and, in 1990, in collaboration with the Deer Specialist Group, a questionnaire survey was initiated for all Eurasian and South-east Asian suids. Unfortunately, however, only a very small number of completed questionnaires have been returned to date, though the few data obtained from these have also been incorporated in the relevant species' chapters.

The obvious importance of utilizing both latest taxonomic and recent field status data sets in the formulation of conservation plans is exemplified by Grubb's (section 4.1, this vol.) revelations about the warthogs of Somalia and northern Kenya. These animals are diagnostically distinguished from all other living warthogs (*P. africanus*) by a variety of dental and cranio-morphometric characters. However, these characters are shared by another recent warthog, the so-called 'Cape' warthog (*P. aethiopicus*), which was known only from the vicinity of Cape Province, where it is now extinct. Clearly, the recognition of the survival of *P. aethiopicus* elsewhere, and the apparent isolation of the Somali population, can only profoundly influence our perceptions about the relative importance of these animals, in both scientific and conservation terms.

Unfortunately, the import of Grubb's review may be bedeviled by bickering between the traditionalists and the revisionists or, as with Phacochoerus, between neontologists and paleontologists, as to the validity of the two species approach. This also applies to the separation of the bushpig and the red river hog as two, distinct species, *Potamochoerus larvatus* and *P. porcus*, respectively. Neither of these divisions is new, since both have been proposed by various earlier authors, though never in the light of so comprehensive a re-examination of available museum specimens as that undertaken by Grubb. Despite this, the recognition of two species in each of these genera has already ruffled a few traditionalist feathers, and it seems likely the debate will rumble on as a futile distraction from the more pressing business of addressing the future research and management requirements of these animals.

This is not to suggest that Grubb's review, or those of Groves (1980, 1981) before him, are the last word on the subgeneric taxonomy of these animals. Taxonomy is at best an inexact science, and the present subdivisions are no more than a logical reflection of current understanding of the variation within these genera. By the same token, the relative extent of variation within these or other genera, will not only determine where the lines are drawn, but influence the taxonomic ranking accorded to the various subgroupings. Thus, the distinction between species and subspecies is frequently blurred and, in the absence of any precise knowledge of the degree of genetic variation within the genus as a whole, and an objective overview of that variation, it may become nonsensical to dismiss 'subspecies' as intrinsically less important than 'species'.

These sentiments can be illustrated by the recent 'elevation' of two 'new' species of *Sus*, both endemic to the Philippines. These are the Visayan warty pig (*S. cebifrons*) from the

West-Central Visayas Islands and the East Philippines' warty pig (*S. philippensis*) from Luzon, Mindanao and associated islands. Following Sanborn (1970), both of these taxa were assigned to *S. celebensis* until Groves (1981) reassigned them as endemic subspecies of S. barbatus. However, following the acquisition of additional skulls and mandibles in 1990, Groves (1991) suggested these were actually sufficiently distinct to merit full species status; a view which has recently (too recently for the full results to have been incorporated in this volume) been strongly endorsed by de Haan *et al.* (in press) on account of their lower chromosome number (i.e. 36, as opposed to the 38 typical of other members of the genus) and other cytological characters.

The addition of these two species, together with at least one endemic and one endemic subspecies *of S. barbatus* (i.e. *ahoenobarbus* from Palawan and associated islands, and *barbatu*s from Tawi-tawi and Sibutu, respectively), makes the Philippines the second most important country in the world (after Indonesia) for its diversity of wild pigs. There may even be still more taxa awaiting description in the archipelago. *S. philippensis*, for instance, is currently regarded as monotypic, though the few adult individuals which have been examined from the two, principal populations on Luzon and Mindanao, appear morphologically distinct in some respects (e.g. color and shape of the crest and mandibular warts, color of pelage on cheeks, etc.), and these may be new subspecies. Theoretically, the wild pigs of Mindoro should be closely related to those of neighbouring Luzon, though the only specimen examined to date shares the same chromosome number (38) as those from Palawan (de Haan *et al.*, in press), which it also resembles more closely in appearance. Wild pigs have already been extirpated on two (Tablas and Romblon) of the three islands in the isolated Romblon Group, and although they are reported to survive on Sibuyan, no museum specimens exist. This situation also applies to Masbate and a number of other, relatively isolated islands where pigs are reported to survive, as well as to Siquijor where they are now extinct (Cox, 1987; Oliver, 1992; Oliver et al., this vol., Fig. 14).

In any event, it is clear that much more work is needed in countries like the Philippines, where we have only very recently begun to obtain an understanding of the genetic diversity and future management requirements of these animals. Moreover, some of this work is undoubtedly urgent. Whatever was on Siquijor has been lost, and whatever the identity of the wild pigs on Sibuyan, Masbate, Bohol and many other smaller, or more isolated, islands, these populations are seriously threatened or likely to become so in the near future. The recently recognized Visayan warty pig is already extinct on two islands (Cebu and Guimaras) and endangered on the only other islands (Negros and Panay) on which it is known to occur. As a result, this species is now rated as one of the most endangered of all wild suids.

In a very real sense, this situation also reflects a much wider, and in many ways quite astonishing, upheaval in our understanding and appreciation of the genetic diversity and conservation status of the suiformes which has occurred over the past twenty years or so. The key events include the recognition, in 1969, of an isolated population of pygmy hippo from the Niger Delta, as a separate subspecies (*Hexaprotodon liberiensis heslopi*). The present status of this animal is not known, though it is rumored to survive (Corbett,

1969; Grubb, this vol. a; Eltringham, this vol.). In 1971, the (somewhat dramatized) 'reappearance' of the pigmy hog (S. salvanius) was announced by tea planters in N. W. Assam, following the burning of grasslands in one of only two small areas still known to support remnant populations of this critically endangered species. The continuing tenuous existence of this species, arguably one of the most important indicator species for the enhanced management of the crucially important tall grasslands, and certainly one of the world's potentially most valuable genetic resources, is still the *cas celebre* of the Pigs and Peccaries Group, but by no means its only concern. One of the most amazing large mammal discoveries of this century, that of the giant peccary (*Catagonus wagneri*), has also emerged as one of this Group's major preoccupations (Taber, this vol.). *C. wagneri* was originally described in the 1930's from late Pleistocene material, and its survival was unknown until some fresh skulls were collected from local hunters during mammal inventory project in the Chaco of Paraguay in 1972 (Wetzel et al., 1975).

In the process of unraveling the genus *Sus*, Groves (1981) also unearthed a 'mystery pig' (*S. bucculentus*), which is still known from only two skulls collected in Cochin China (southern Vietnam) before the turn of the century, and described a new subspecies of warty pig (*S. v. blouchi*) from skulls recently collected from the tiny island of Bawean, off N. E. Java. Despite its minuscule range, the Bawean warty is thought to be relatively secure at present, though the animal's external appearance remains virtually unknown. Thanks to the observations of Hoogerwerf (1970) in Udjong Kulon National Park, and various earlier authors, much more information was available on the closely related Javan warty pig (*S. v. verrucosus*). However, these animals inexplicably disappeared from Udjong Kulon sometime during the 1970's and, in the absence of contemporary reports of their occurrence elsewhere, they were feared extinct in the wild by the end of the decade (J. MacKinnon, pers. comm.). Fortunately, this proved not to be the case, though the implementation of recommendations arising from an island-wide status survey conducted the following year at the Group's behest, have proved problematic (Blouch *et al.*, 1983; Blouch, this vol.).

A rather similar situation obtained at about this time with another, equally extraordinary suid, the 'golden' or 'hairy' babirusa (*B. b. babyrussa*), from Buru and the Sula Islands. However, it was not until the late 1980's, after an interval of about thirty years, that the first confirmed reports of the continuing existence of these animals were finally obtained (Macdonald, this vol.). As in this instance, relevant field data may be very difficult to acquire simply because of the remoteness or inaccessibility of the areas. Buru, for example, being a penal colony until quite recently, was closed to visitors. In countries like Indonesia and the Philippines, the sheer logistics of trying to obtain recent population status data, let alone research specimens, over all or most of a species' known or presumed range, is at best daunting and at worst either effectively impossible or cost prohibitive. Despite a high probability of new taxa awaiting discovery, or becoming extinct before discovery, many islands have never been surveyed or even visited by biologists. Permits for obtaining specimens for captive breeding programs or scientific study, and/or accessing those specimens for examination by specialists, is also becoming increasingly difficult. This is particularly true in the case of wild pigs, where concern (sometimes amounting to paranoia) in the pork industry about the possibility of disease

transmission, has resulted in total bans or excessively stringent veterinary regulations being imposed on the movement of wild pig specimens across (in some cases even within) national boundaries.

Nonetheless, this work continues as opportunities are presented or created, and a good deal of progress has been made in some areas. Even so, the exercise is often difficult, frequently more frustrating than rewarding, and almost always salutary. Even as initial priorities are identified and (where practical) addressed, old problems are seldom vanquished and new questions, problems and priorities multiply. The recent upheaval in our understanding of these animals is far more a reflection of our ignorance than of our knowledge. A great deal of basic data on the distribution, population status, ecology and behavior of most species of wild suiformes are still required, and these needs must be tackled if we hope to develop the most appropriate management strategies for these species.

In the broadest terms, these are the reasons and the justification for this Action Plan - or, more precisely, these 'action plans', since the modest number of extant species (currently 18, excluding the enigmatic *Sus bucculentus*) within the purview of the Pigs and Peccaries and the Hippo Specialist Groups, has enabled us to produce an 'action plan' for each species, and even a few related topics. The format adopted (which has been unashamedly lifted from the now, sadly defunct, Red Data Books) has also allowed us the luxury of including summaries of much of what is already known about the taxonomy, distribution, ecology and behavior of each species. This was done both as a deliberate attempt to pull these data together, and as a means of identifying some of the starkest gaps in our knowledge; thereby providing perspectives and justifications for most of the emergent recommendations. By the same token, we have endeavored to produce priority recommendations for useful future research and conservation management of each of these species and topics, both as an exercise for people with specialist interests and as the source of reference for the various, highest priority recommendations which are brought together in the regional reviews at the end of each section.

William L. R. Oliver

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Chapter 1

THE SUBORDER SUIFORMES

Colin P. Groves and Peter Grubb

Pigs and babirusa, peccaries and hippopotamuses belong to the mammalian Order Artiodactyla, the even-toed ungulates, of which there are three major lineages or clades - the Suiformes, Tylopoda and Pecora - each ranked as a suborder. Of these, the Suiformes are the only non-ruminants. The Tylopoda are the camels and llamas, and the Pecora are the deer, giraffes, cattle, goats, antelopes and their relatives. In many ways, the Suiformes are the most primitive of the three. The stomach is less complex than in ruminants, many teeth are present and they are low-crowned and bunodont, the unguligrade condition of the limbs is less advanced and, in one family, the females make nests! These are

generalizations, which indicate the primitive nature of some suiform artiodactyls, but they do not apply to all of them.

Within the Suiformes there are three living Families: Hippopotamidae (hippopotamuses), Dicotylidae (peccaries) and Suidae (pigs). The first is separated into a Superfamily Anthracotheroidea together with fossil relatives, while the others are assigned to the Suoidea (Simpson, 1945), a classification that may need modification in future.

Hippopotamidae

Holocene or Recent hippos belong to two genera, *Hexaprotodon* (including *Choeropsis* according to Coryndon, 1977) and *Hippopotamus*, each with one surviving and one and two (respectively) recently extinct species (Steunes, 1989; Faure & Guerin, 1990; Harris 1991). The two genera can be traced back to the late Miocene as separate entities, while the family itself separated from its ancestors (anthracotheres?) about 11 million years ago. Hippos are distinguished among the Suiformes by several features: the lack of the snout disc, the arrangement of limb muscles, the weak development of hooves with the lateral digits reaching the ground, the naked glandular skin, the specialized stomach morphology and the amphibious habit.

Dicotylidae

Pigs and peccaries agree in having a remarkable organ adapted to rooting in the soil - the snout disc or rhinarium. The tip of the snout is flattened and supported by cartilage, a tough pad for pushing into even quite hard ground. The upper edge of the disc is at right angles, or even at an acute angle to the top of the snout, so that loosened soil is most easily pushed aside by an upward motion of the head. The lower edge runs without a break into the mucous membrane of the mouth. The nostrils are centered in the disc where they are well placed to detect potentially edible items but can be closed so that soil does not enter the nasal passages. The snout is moved by special muscles located just in front of the eyes, so that fine rooting movements are possible.

The three species of living peccaries are assigned to the genera *Tayassu* and *Catagonus*. *C. wagneri* was only recognized as an extant species in 1975 (Wetzel, 1977) - an amazing discovery - but was first described from late Pleistocene sub-fossil deposits in the 1930's. Peccaries are now confined to the New World, but the family has not always been so restricted in distribution. Their earliest representatives occur in the Oligocene of Europe, and up until the Middle Miocene (Chinji Formation of India) they still inhabited Eurasia. Peccaries survived into the late Pleistocene in areas of North America and South America where they are now absent (mainly the genera *Platygonus*, *Catagonus* and *Mylohyus*). Recently a peccary was thought to have turned up in the Pliocene of South Africa (Hendey, 1976), but it has now been shown to be a new species of dwarf pig (Pickford, 1988). Nevertheless, true peccaries occurred in the Miocene of Africa (Pickford, 1986).

Pickford's research has also revealed closer links between hippopotamuses and peccaries than have previously been acknowledged. Both groups have specialized digestive tracts and adaptations for a very wide gape (Herring, 1975). In both, the upper canine points

down while the lower one points up and, when the mouth is closed, fits into a notch formed by the bony sheath of the upper canine root. Pickford also noted that in both groups, the upper canine is round in section with a deep posterior open groove (rather than rounded-triangular without indentation as in true pigs), that there is little or no sexual dimorphism in canine development and that there are close similarities in the cuspidation of the cheek teeth in primitive hippos and peccaries.

Peccaries differ from pigs in other and more advanced features, including the very short tail, which has no more than seven vertebrae; the presence of a scent gland on the back just in front of the sacral region; and the cursorial specializations of the hind foot. Metatarsals 3 and 4 are fused together into a single cannon bone except for their distal extremities; digit 5 has completely disappeared though there is a remnant of metatarsal 5, and in *Catagonus*, but not in *Tayassu*, there is no external trace of digit 2 on the hind foot.

Suidae

The babirusa (*Babyrousa babyrussa*) of Sulawesi (formerly Celebes) and some neighboring islands in Indonesia may have no common ancestors with the true pigs more recent than the late Oligocene, c. 40 million years BP. Indeed, this animal is peculiar in several respects, including its somewhat more complex stomach (Langer, 1988), the remarkable canines of the male (Groves, 1981), and the style of combat between males, which is quite different from that of true pigs (A. Macdonald pers. comm.). For the moment, it is retained in its own subfamily, Babyrousinae, but its eventual assignment to a family of its own seems possible.

The true pigs of the subfamilies Suinae and Phacochoerinae, include four living genera - *Sus* in Eurasia and North Africa, and *Potamochoerus*, *Hylochoerus* and *Phacochoerus* (only living genus assigned to Phacochoerinae) in the Afrotropical Region. Among these, *Sus* and to some extent *Potamochoerus* are the most generalized of surviving suiforms in their bunodont dentition, retention of many teeth and less specialized digestive tract and limbs. Yet all Suinae share unique features of the canines and some have other highly specialized adaptations. The upper canines are rounded-triangular in cross-section, larger in males than in females, and their alveoli are directed outward and even somewhat upward. The upper canines are abraded across their tips through honing by the lower canines, as in peccaries or hippos (the more primitive condition, *Sus* and *Potamochoerus*), or along their anterior surfaces only, so that they are not kept short but grow unchecked, curving outwards, backwards and upwards (*Hylochoerus*, *Phacochoerus* and many extinct genera). The canines in the genera just mentioned have evolved to be among the largest of any mammals, relative to body size. In some of the same genera, but particularly *Phacochoerus*, modification of the molars for the grinding of abrasive vegetable material has become extremely specialized. Knobs, warts or fender-like excrescences on the skull have evolved repeatedly among true pigs (and also in the Pleistocene American peccary *Platygonus vetus*) partly in association with patterns of combat between males.

The greatest radiation of pigs and the development of the most extreme specializations occurred in Africa, so it is of some interest to unravel the phylogeny of the group. Thenius (1970) traced the Suidae back to the Oligocene, *Palaeochoerus* being the earliest genus. Ancestors of *Potamochoerus* and *Sus* (*Propotamochoerus* and *Dicoryphochoerus*, respectively) were present in the Middle Siwaliks. *Sus* appeared in the lower Pliocene of Europe (*S. minor*) and Indonesia (*S. stremmi*). *Potamochoerus* is now known (White & Harris, 1977) from the mid-Pliocene, while the *Nyanzachoerus-Notochoerus* line, an offshoot of the *Propotamochoerus* stem according to Thenius (1970), is known from the latest Miocene in East Africa. Another offshoot, *Kolpochoerus* (= *Mesochoerus* according to Cooke & Wilkinson, 1978), first appeared in the Upper Pliocene and can be regarded as the direct ancestor of *Hylochoerus*. From quite a different stock, whose earlier representatives are as yet unknown, comes *Metridiochoerus* (= *Stylochoerus*), known first in the Upper Pliocene and plausibly the ancestor of *Phacochoerus* (White & Harris, 1977). In summary, it seems possible that the African suid radiation was monophyletic but this has not been fully established (though see Bender, 1992). *Hylochoerus* proves to be less closely related to *Phacochoerus* than one might conclude from similarities in the dentition. Thenius (1970) broke the Suinae into two subfamilies, one containing only *Phacochoerus*. Until the cladistic relationships of the whole group are finalized, it may be premature to make these divisions.

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Table 1. Taxonomy of living and recent Suiformes

Order: **Artiodactyla** (comprising three suborders: Suiformes, Tylopoda and Pecora)

Suborder: **Suiformes** (comprising two superfamilies and three families, as follows):

Superfamily: **Anthracotheroidea**

Family: **Hippopotamidae** (no separate subfamilies, but two genera and two living and three

  recently extinct species, as follows):

  Genus: *Hippopotamus*

  Species: *H. amphibius* (5? ssp) - Common Hippo
          H. laloumena - Madagascan Hippo (extinct)
          H. lemerlei - Madagascan Dwarf Hippo (extinct)

Genus: *Hexaprotodon* (= *Choeropsis*)

Species: *H. liberiensis* (2 + ? ssp) - Pygmy Hippo
H. madagascariensis - Madagascan Pygmy Hippo (extinct)

Superfamily: **Suoidea** (comprising two families, seven genera and at least fifteen species, as follows):

Family: **Dicotylidae** (no separate subfamilies, but two genera and three species, as follows):

Genus: *Tayassu*

Species: *T. tajacu* (? 14 ssp) - Collared Peccary
T. pecari (c. 5 ssp) - White-lipped Peccary

Genus: *Catagonus*

Species: *C. wagneri* (0 ssp) - Giant or Chacoan Peccary

Family: **Suidae** (comprising three subfamilies, five genera and <fourteen species, as follows):

Subfamily: **Suinae** - the 'true' pigs

Genus: *Sus*

Species: *S. scrofa* (c. 16 ssp) - Eurasian Wild Pig
S. salvanius (0 ssp) - Pigmy Hog
S. bucculentus - Vietnam Warty Pig (extinct ?)
S. verrucosus (2 ssp) - Javan Warty Pig
S. barbatus (3 ssp) - Bearded Pig
S. cebifrons (0 ? ssp) - Visayan Warty Pig
S. philippensis (0 ? ssp) - Philippine Warty Pig
S. celebensis (0 ? ssp) - Sulawesi Warty Pig

Genus: *Potamochoerus*

Species: *P. larvatus* (5 ? ssp) - Bushpig
P. porcus (0 ssp) - Red River Hog

Genus: *Hylochoerus*

Species: *H. meinertzhageni* (3 + ? ssp) - Forest Hog

Subfamily: **Phacochoerinae** - the warthogs

Genus: *Phacochoerus*

Species: *P. aethiopicus* (2 ssp, 1 extinct) - Desert Warthog

Chapter 2

THE NEOTROPICAL PECCARIES - DICOTYLIDAE

Tayassu and *Catagonus*

2.1 Taxonomy and Description

Peter Grubb and Colin P. Groves

Introduction

There are two genera and three extant species of peccaries. These are the collared peccary, *Tayassu tajacu*, the white-lipped peccary, *Tayassu pecari (= albirostris)*, and the giant or Chacoan peccary, *Catagonus wagneri*. The peccaries, both living and extinct, are assigned to a separate family within the Suiformes, the Dicotylidae. The name Tayassuidae has also been widely used to denote this Family, but this is not correct as it dates from Palmer, 1897, while Dicotylidae dates from Turner, 1849. Being an older name, the latter takes precedence according to the International Code of Zoological Nomenclature (International Commission of Zoological Nomenclature, 1985), as clearly shown by Husson (1978).

There are also some problems with the generic name *Tayassu*, particularly if the two living species should no longer be regarded as congeneric, as Woodburne (1968) has suggested. Unfortunately, both of these species have at one time or another been assigned to a separate genus *Dicotyles*. In fact, *Dicotyles* and *Tayassu* were coined independently for the two species, and neither is unequivocally associated with one species or the other by the authors of the names. However, whilst such problems are relevant to our

understanding of peccary phylogeny, they are of limited significance to conservation and, for the purposes of this Action Plan, the single genus *Tayassu* is retained for both species.

The three extant species, and some other problems with their existing subspecific nomenclature, may be described as follows:

The Collared Peccary
(*Tayassu tajacu*)

This species, the smallest and most widely distributed of the living peccaries, occurs from southern Texas, New Mexico and Arizona in the United States, south through northwestern Sonora in Mexico to Tubes and Piura in Peru, west of the Andes, and Santiago del Estero in Argentina, east of the Andes. The species is extremely eurytopic, inhabiting deserts, arid woodlands, oak woodlands and tropical rain forests. It is a comparatively small animal, perhaps reaching as much as 30 kg but averaging 22 kg for males from the Chaco, with females a little less. In proportions it is large-headed with relatively slight, slender limbs. Body measurements (total length and lengths of tail, hind-foot and ear, in mm) have been given as 870-940, 19-55, 180-200, 84-100 (Hall & Kelson, 1959), source not stated but presumably applying to North American populations. Mayer & Brandt (1983) gave rather higher figures for Chaco specimens: males 840-1,040, 10-106, 163-253, 27-98; females 788-1,060, 10-60, 170-235, 27-93. The general color of the pelage is a strongly speckled dark blackish gray, blacker on the limbs and along the dorsal crest, with a whitish band passing across the chest from shoulder to shoulder. The juvenile coat is grizzled reddish-tan with a distinct dark brown mid-dorsal stripe and light shoulder collar. Change to the adult coloration occurs at two to three months of age. The diploid chromosome number is 30.

There has been no modern revision of the species. Two species or subspecies-groups have been differentiated in the past, the '*angulatus*' group in Central America and the nominate '*tajacu*' group in South America. This situation could parallel the biogeography of other Neotropical mammals, such as tapirs, tamanduas or coatis, but it is not currently recognized and needs further investigation. Woodburne (1968) concluded that geographic variation in this species was relatively gradual, that characters distinguishing the *angulatus* group were not confined to Central America and that only one species should be recognized. The fourteen described subspecies may be divided informally into three groups, as follows:

1) South American gray to buff subspecies with clearly marked pale collar and black dorsal stripe: *tajacu* Linnaeus, 1758, Brazil.

2) Blackish forms with very poorly expressed collar and dorsal stripe: *patira* Kerr, 1792, French Guiana (synonym: *macrocephalus* Anthony, 1921, Guyana); *torvus* Bangs, 1898, Colombia; *crusnigrum* Bangs, 1902, Panama; *niger* Allen, 1913, Ecuador; *bangsi* Goldman, 1917, Panama (synonym: *modestus* Cabrera, 1917, Colombia). Hershkovitz (1963) doubts whether most of these can be distinguished from *patira*.

3) Grey Central American forms: *angulatus* Cope, 1889, Texas; *sonoriensis* Mearns, Sonora, Mexico; *nanus*, *humeralis*, *yucatanensis* and *crassus*, all of Merriam, 1901, from Cozumel I., Colima, Yucatan and Puebla respectively, all in Mexico; *nelsoni* and *nigrescens* of Goldman, 1926, from Chiapas, Mexico, and Honduras, respectively (*nigrescens* perhaps representing intergradation with *patira - sensu lato*).

The White-Lipped Peccary
(*Tayassu pecari*)

This species has a less extensive distribution than the collared peccary, occurring from Veracruz and Oaxaca in southern Mexico, south to Esmeraldas and Pichincha in Ecuador west of the Andes, and Entre Rios in Argentina east of the Andes. Most of its range is within tropical rain forest, but it also occurs in drier habitats such as the savannas of Venezuela and the Gran Chaco of Paraguay. It is larger that *T. tajacu*. Recorded body weights range from 25 to 40 kg, averaging 28kg, and a pregnant female from the Chaco weighed 38kg (Mayer & Brandt, 1982; Mayer & Wetzel, 1987). Body measurements in mm, again from Chaco specimens, for males are: 961-1,390, 10-55, 165-233 and 73-85; and for females: 905-1,250, 20-65, 181-250, 68-80 (Mayer & Brandt, 1982). In color the white-lipped peccary is blackish brown becoming grizzled or light-colored in the pectoral and inguinal regions. The face and mid-dorsum are often grizzled black and tan, as are the legs, with white adjacent to the hooves and on the lateral and hind surfaces of the forelimbs. In contrast to the body color, the chin, cheeks and sides of the muzzle are white or yellowish-white. The ears are black with white insides. The juvenile pelage is mixed red-brown, black and cream with a black mid-dorsal stripe and white undersides, legs and rostrum. The coat darkens during the first year and changes to the adult coloration in the second, so that maturation of the pelage takes much longer than in the other peccaries. Specimens without the white cheeks are known (W. Oliver pers. comm.) and they may represent an undescribed subspecies if they are not merely subadults that have yet to acquire the full adult pelage. The diploid chromosome number is 26.

There has been no modern revision of the species. However, since the type locality of *Tayassu pecari* (Link, 1795), is Cayenne, French Guiana (Hershkovitz, 1963, followed by Mayer & Wetzel, 1987), and not Paraguay as widely stated, the nominate subspecies *T. p. pecari* cannot have a distribution excluding the Guianas (Mayer & Wetzel, loc. cit.). The prior name for the animals in Brazil and further south is *T. p. albirostris* (Illiger, 1815) (type locality, Paraguay). The prior name for animals north of Brazil is *T. p. pecari* of which *beebei* (Anthony, 1921) must surely be a synonym. The five generally recognized subspecies should therefore be named as follows:

1) *T. p. pecari* Link, 1795, French Guiana (synonym: *beebei* Anthony, 1981, Guyana), Guianas.

2) *T. p. albirostris* Illiger, 1815, Paraguay.

3) *T. p. ringens* Merriam, 1901, Campeche, Mexico.

4) *T. p. spiradens* Goldman, 1912, Costa Rica.

5) *T. p. equatoris* Lönnberg, 1921, Ecuador.

In line with Hershkovitz (1963), who treats the species as monotypic, the status of all these subspecies should be regarded as doubtful and requiring review, though it is possible that the Central and South American populations should be distinguished subspecifically.

The Chacoan Peccary
(*Catagonus wagneri*)

Not recognized as an extant form until 1974, this species is known only from the dry thorn forest in the Gran Chaco of northern Argentina, southeastern Bolivia and western Paraguay (Wetzel, 1977a,b). It is the largest and most distinct of the living species. It may be distinguished from the other peccaries by its much larger head, longer ears with long whitish hairs, and paler hair on the legs and feet rather than dark hair. The skull length is nearly one third (28%) of total length, compared with one quarter for the white-lipped peccary. The Chacoan peccary is a brownish-gray animal with a collar of whitish bristles around the shoulders, similar to the collar of the considerably smaller collared peccary. The bristles are much paler on the basal half than the vivid black and white banded hairs of the latter, and differ in detailed structure from those of both *Tayassu* species. Newborn juveniles have a mixture of mostly tan and black bristles in the coat, with a black mid-dorsal stripe and a tan collar across the shoulder, the pattern less distinct than in collared peccaries of similar age. The end of the snout, the digits and the anterior edges of the forelimbs are brown to black. Unlike those of adults, the bristles are entirely black, brown, tan or white, and they are longer than those of juvenile *Tayassu* species. Change to adult coloration occurs at three to four months of age. Body measurements in mm from Mayer & Brandt (1982) for males are 957-1,161; 24-102; 206-250; 100-122; and for females 1,030-1,170, 170; 45-100; 222-257; 100-120. Body weight is 29.5-40 kg in males, 30.5-38.5 kg in females, but up to 43.5 if pregnant.

The Chacoan peccary is the most specialized of the living peccaries in that it lacks dewclaws on the hind feet, present (second digit) in the other peccaries. It also has cranial and dental specializations suggesting adaptation to dry, relatively open environments. The teeth are high-crowned, there is a distinct basicranial flexure, the orbits are set well back and the nasal cavity and cranial sinuses are enlarged. These features are adaptations associated with browsing and scanning the surroundings during mainly diurnal activities, in a situation where the air may be charged with dust.

The diploid number of chromosomes in the species is 20. A full reconstruction of karyotypic evolution among peccaries cannot yet be made, but *C. wagneri* seems to be the most distinct of the three living species in the number and structure of its chromosomes (Benirschke et al., 1985).

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Chapter 2.2

The Collared Peccary
(*Tayassu tajacu*)

Richard E. Bodmer and Lyle K. Sowls

Status and Action Plan Summary

Status category 1-2 (widespread and locally abundant or relatively secure).

The collared peccary is the most abundant, most widely distributed and least threatened of the three extant species. It occurs in a variety of habitats, including woodlands, tropical dry and rain forests, savannas, chaco and deserts, from the southern U.S.A. through to northern Argentina. Owing to its large geographical range, evident adaptability, relatively high reproductive rate and proportionally high population densities, it does not merit high conservation priority at the present time. Nonetheless, these peccaries are still hunted extensively for their meat and hides, and much of their natural habitat is being destroyed. As a result, the species has already been extirpated in parts of its former range and it is locally threatened in other areas.

Given the continuing rates of habitat destruction and potential for over-hunting of this species, the status of all populations requires monitoring. This and related recommendations, including the species' continued inclusion on Appendix II of CITES, are outlined in the Action Plans for these animals, though those recommendations relating to the management of hunted populations, control of pelt and meat markets and other aspects relating to human exploitation are detailed elsewhere (see Bodmer *et al.*, 1993). The most important non-human oriented priorities for applied research and possible future conservation action for this species are the continued collection of regional data on population distribution and status, and a thorough review of its subspecific taxonomy. This review, which should be undertaken at the genetic as well as gross morphological level, should enable a better understanding of the genetic diversity of this species and facilitate the identification of future conservation priorities at the population and subspecies level. Further longer-term studies of the species' ecology and social behaviour in habitats other than the south-western U.S.A. are also of importance.

Introduction

The collared peccary, *Tayassu tajacu*, is the smallest, most abundant and most widely distributed of the three extant species of peccaries. It occurs in a wide range of habitat types from tropical rain forest to semi desert, from the southern U.S.A. in the north to northern Argentina in the south; one of the widest distributions of any American terrestrial mammal.

The collared peccary is the smallest of the living Dicotylidae. Total body weights of adults usually range from 15-28 kg; males generally being larger than females (Sowls, 1984). The species is characterized by its relatively large head, fine and slender legs, a dark brown pelt with white-tipped hairs, and a white collar circumscribing the neck that extends obliquely upward and backwards from the jaw. For a full description see Grubb & Groves (1993). Variation in size and pelage color has lead to various subspecies categorizations, the latest recognizing ten separate subspecies of *T. tajacu* (Hall, 1981). However, as Grubb and Groves (1993) have stated, this is almost certainly too many and the subspecific taxonomy of *T. tajacu* requires revision if a proper understanding of its genetic and geographic variation is to be attained. For this reason, we follow the latter authors' informal recognition of three 'subspecies' groups' (Fig. 1). Sowls (1984) and Emmons (1990) also noted that savannah and desert populations in xeric habitats in the northern parts of their range tend to be lighter gray and heavier than those in similar

habitats in the south, whereas tropical forest forms are darker and larger than animals inhabiting open environments.

Distribution

The collared peccary occurs in Arizona, New Mexico and Texas in the U.S.A., a large part of Mexico and Central America, the entire Amazon basin, the Pacific coastal forest of Colombia, Ecuador and Peru, the llanos and the forest of Venezuela, the Guianas and Suriname, the Pantanal and Mato Grosso of Brazil and the Chaco of Paraguay, Bolivia and northern Argentina (Fig. 1). The upper limit of its range along the Andean foothills is between 1,000-1,500 m (Grimwood, 1969). Some of the larger islands near the mainland in the Caribbean, such as Cozumel and Trinidad and Tobago, also have populations of T. tajacu. However, islands further away from the mainland do not have peccaries except where they have been introduced, such as in Cuba (Varona, 1973; see later text).

Link to Fig. 1: Approximate known range of the collared peccary, *Tayassu tajacu* ssp.

Habitat, Ecology and Behavior

T. tajacu is not only the most widely distributed of the three peccary species, it is also by far the most adaptable. It inhabits tropical forests where average midday temperatures are around 27oC, relative humidity is high (c. 80%), and annual rainfall often exceeds 2,000 mm per year. At the other extreme, the species is also found in desert areas where midday temperatures reach 45oC, relative humidity is below 6%, and annual rainfall is less than 250 mm. At the northern fringe of its range collared peccary maintain viable populations in areas where the winter night temperature falls below 0oC and light coverings of snow are occasionally present. The species' evident tolerance of low seasonal temperatures is exceptional for an animal also living in the tropics.

The species' diet varies in accordance with this range of habitats. Foods of *T. tajacu* can generally be classified as roots, tubers, fruits, nuts and edible parts of green growing plants. In tropical forests, diets are dominated by palm fruits and supplemented with invertebrate animal material (Kiltie, 1981b; Bodmer, 1989), whereas in deserts environments their diet is dominated by the cladophylls of prickly pear cactus (*Opuntia* spp.) (Corn and Warren, 1985).

Densities of collared peccary differ between habitats and rainfall patterns. In the south-eastern U.S.A. densities range from 10.9 ind./km2 in the Tucson mountains (Schweinsburg, 1969), 7.3 ind./km2 at the King Ranch, Texas (rainfall: 660 mm/year) and 3.5 ind./km2 at the Welder Wildlife Refuge, Texas (rainfall: 762 mm/year), to only 1.1 ind./km2 in a Texas desert with 279 mm of rainfall/year (Low, 1970). In the llanos of Venezuela collared peccary density is 8 ind./km2, whereas, in gallery forests in Venezuela it is 2 ind./km2 (Eisenberg, 1980) and in the Pantanal of Brazil it is less than 1 ind./km2 (Schaller, 1983). Densities of T. tajacu in tropical forest range from 9 ind./km2 on Barro Colorado Island, Panama (Glanz, 1982), to 5 ind./km2 in Manu National Park, Peru (Terborgh et al., 1986).

Collared peccary densities decrease in hunted areas (Emmons, 1984), but are less susceptible to human hunting pressure than cebid primates and other large-bodied mammals (Bodmer et al., 1990).

Like all peccaries, *T. tajacu* is a highly social animal, living in herds, which vary from fewer than six to over 30 individuals. Home ranges of groups average approximately 150 ha, but can range from 24 to 800 ha (Sowls 1984). Social herds are kept together by vocalizations and a strong musk released from the dorsal gland, scent from the latter being deposited on tree trunks, rocks and other individuals (Byers 1980).

The collared peccary has a diurnal/crepuscular activity pattern, feeding in early hours of the night. They commonly rest in small groups of three to four individuals and often seek shelter in burrows, caves and under logs. Collared peccaries frequently wallow in mud or dust and rarely spend time auto-grooming (Sowls 1984).

Births have been recorded at all times of the year, though in the southern U. S. A. there is a birth peak during the summer rainy season. The gestation period is 142 to 145 days and the usual litter size is two. The young are highly precocial at birth, following their mothers within an hour of parturition and stopping to suckle at frequent intervals. In one case infants were observed to spend up to 24% of their time suckling (Sowls 1966). Weaning occurs at approximately 6 weeks (Sowls 1984).

Threats To Survival

The two major threats to the survival of collared peccary are over-hunting and excessive destruction of its natural habitats. These factors have already resulted in the extensive fragmentation of peccary populations and its extirpation over large parts of its former range. Where these processes have been most severe, these and other larger-bodied animals have also disappeared from many of the smaller/least-protected reserves (e.g. in most of the smaller reserves in the Atlantic Forest region of south-eastern Brazil; W. Oliver, pers. comm.) and they are already extinct in two countries, Uruguay (Mones and Ximenez, 1980) and El Salvador (R. Mittermeier, pers. comm.)

Indigenous tribes in the Americas have hunted collared peccary for countless generations as an important source of animal protein and have maintained a sustained balance between human needs and peccary populations. Indeed, Indians have altered forests for agriculture in a manner that often increases peccary densities (Steward, 1946, 1948), and in parts of Mexico and Central America these animals are reported to cause considerable damage to subsistence crops. However, where modern market forces and updated hunting and agricultural techniques have been introduced and human population expansion has been uncontrolled or encouraged, ecological balances are undermined and animal populations have become threatened.

These broad socio-economic circumstances are by no means specific to peccaries, but threaten whole ecosystems and their dependent animal and plant species. The more

specific threats to *T. tajacu* are the hide and meat trade which are detailed in the section on 'Economic Importance and Human Utilization of the Peccaries' (see later text).

Conservation Measures Taken

Collared peccaries occur in a large number of national parks and other reserves throughout their extensive range in the Americas. In many of these areas populations are relatively secure, although poaching and inefficient protection are common and may nullify the nominal protection afforded by the designation of protected sites.

Conservation measures specific to collared peccaries include national wildlife protection legislatures, which vary from country to country, and the recent (1986) inclusion of this and other peccary species on the Appendices of CITES; the latter to enhance regulation of the international trade in hides of these animals. Specific management regulations appertaining to hunting and movement of peccary products exist for all countries within the geographical range of *T. tajacu*. In the U.S.A., for example, the species is managed as a game animal outside national parks and reserves, and may be hunted with permits under a quota system operated by the state authorities. In Brazil there is a total ban on all hunting of peccaries by non-indigenous people, though this is largely unenforced in many states. Subsistence hunting is permitted in Colombia and Venezuela, but these countries prohibit the movement of peccary products, whilst in other countries, such as Peru, subsistence hunters are allowed to trade peccary products under management laws. However, in these and many Central and South American countries, rural people are often unaware of wildlife management regulations or these are flouted, sometimes quite openly, owing to the common lack of resources and trained personnel for the enforcement of protective legislation.

The collared peccary was originally placed on Appendix III of CITES and in 1986 it was moved to Appendix II. Animals listed on Appendix II can be legally traded across international borders, but monitoring of this trade between signatory nations is greatly enhanced. Details concerning the current levels of trade in the hides of this species, and other conservation - related issues appertaining to it, are discussed in Section 2.5.

Table 2
Differences in collared peccary density with habitat and rainfall pattern

Geographcal Area Reference	Density (ind./km2)	Habitat		Rainfall (mm/year)	
Tuscon Mountains 1969	10.9	Sonoran desert			Shweinsburg
King Ranch, Texas	7.3	Chapparal	660		Low 1970
Welder Wildlife Refuge, Texas	3.5	and deciduous woodland	726		Low 1970
Texas desert	1.1	desert	279		Low 1970

Llanos, Venezuela	8.0	Llanos	Eisenberg 1980
Gallery forest, Venezuela	2.0	Gallery forest	Eisenberg 1980
Pantanal, Brazil	<1.0	Pantanal	Schaller 1983
Barro Colorado I., Panama	9.0	Tropical forest	Glanz 1982
Manu N.P., Peru	5.0	Tropical forest	Terborgh et al. 1986

Conservation Measures Proposed:
An Action Plan

Since this species is not considered to be seriously threatened over most of its still extensive range at present, such actions as are required in the short term are essentially directed towards an improved understanding of its regional genetic diversity, and its distribution, population biology and status in areas and habitats, which have not yet been studied. The continued monitoring of known threats to the peccary populations in some countries, particularly habitat destruction and hunting pressure are also identified as priorities for this and other peccary species, but these and other factors relating to human over-exploitation are detailed and summarized elsewhere (see sections 2.5 and 2.6 of this Plan). Given these provisos, the objectives and priorities for research and conservation action for the collared peccary may be described as follows:

Objectives

1. To promote a better understanding of distribution, current population status, and the nature and levels of human utilisation and other potential threats to this species in all countries in which it occurs.

2. To encourage a thorough reappraisal of its systematics in order to identify and implement management strategies directed towards the most threatened forms.

3. To promote further research on this species, particularly field studies and surveys in habitats and areas which have not yet been investigated, on topics relevant to its continued management on a sustainable basis and the enhanced protection of potentially threatened forms.

Priority Projects

1. Collect data on the distribution and population status of this and other peccary species in all South and Central American countries.

A survey, incorporating questions about the species' legal status, its occurrence in protected areas, levels of utilisation and its potential socio-economic importance, etc., has

already been initiated by the PPSG, but is not yet complete and additional data is required for most countries.

2. Thoroughly reassess the subspecific taxonomy of the species.

This should include a genetic analysis of variability within and between populations as well as gross morphological features, osteological characters and pelage form/color. Such a review will facilitate identification of any potentially threatened nominate forms so that appropriate conservation measures can be initiated to ensure their survival. The systematic relationships of this species with *T. pecari*, also needs to be resolved (see Grubb and Groves 1993).

3. Study the behaviour and ecology of collared peccaries in tropical and sub-tropical habitats.

This information can be compared to the extensive data already available from the south-western U.S.A. Such comparative data on the ecology and population dynamics of major herbivores are not only of considerable scientific interest, but are also crucial to the determination of appropriate management strategies. Specific behavioral questions, which also require further study, include the 'incest taboos', which are also of great scientific interest and are potentially important to the successful management of small isolated populations, either in the wild or captivity.

4. Establishment a properly structured captive breeding program.

Although this species is relatively well represented in captivity at present, the overwhelming majority of captive animals are of unknown or mixed origin. Very few collections have made any attempt to ascertain, let alone ensure, the genetic integrity of recognized subspecies and regional populations. This is hardly surprising given the present confused state of the species' subspecific taxonomy, and the highly restrictive regulations appertaining to the movement of these animals across international borders; but every attempt should be made to rationalize existing interests and resources devoted to the captive management of these animals, which serve little useful conservation purpose at the present time.

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Chapter 2.3

The White-lipped Peccary (*Tayassu pecari*)

Ignacio J. March

Status And Action Plan Summary

Status categories 2 - 4 and 'indeterminate', depending on subspecies/population.

The White-lipped peccary is not considered seriously threatened over much of its extensive range. However, the available data suggest that most of the remaining populations of two subspecies, *T. p. ringens* and *T. p. spiradens*, of southern Mexico and Central America are threatened to varying degrees, whilst the former population of *T. p. ringens* in El Salvador is already extinct. Recent data is lacking on the current distribution and status of *T. p. equatorius*, which has much the smallest range of the five currently recognised forms, being apparently confined to the remaining lower altitude forests west of the Cordillera Real in south-western Colombia and north-western Ecuador. Recent information is lacking on the distribution and status of white-lipped peccaries in many other continental South American countries, the main stronghold for this species. However, some reports indicate significant, recent population declines in parts of the Amazon Basin and in the dry Chaco of south-eastern Bolivia, western Paraguay and north-western Argentina. Peccary populations in these areas may now be discontinuously distributed even in virgin forest. The species is also reported to have become extinct in Uruguay about 100 years ago, though it is probably not seriously threatened throughout much of its range elsewhere in central and northern South America at the present time.

The destruction and fragmentation of habitat is undoubtedly the most important threat to this species, though overexploitation by subsistence and commercial hunters has also

contributed to its decline in many areas. Priority actions for the white-lipped peccary include: a) assessments of its current distribution and status in each country, with a view to the development of management plans for the most threatened populations and subspecies and the strengthening of those protected areas which maintain important habitat and populations; b) promotion of field studies on its habitat requirements, its ranging behaviour and its role as a seed predator/dispersal agent; c) development of projects to encourage self-regulation by subsistence hunters and to control or curtail large scale commercial hunting and trade; d) the development of training courses and workshops on research and management of peccaries; and e) a thorough review of its generic and subspecific taxonomy at the genetic, as well as the phenotypic, levels.

Introduction

The white-lipped peccary has played an important role in the economic and cultural development of many indigenous peoples in the neotropics and still constitutes an important resource for various tribal and rural groups, both as a source of food and income (Olsen, 1982; Donkin, 1985). Ecologically, it is also important, since it is the only large, terrestrial mammal in the neotropics to form large herds, often of more than 100 individuals. In addition, it has a large range, which includes or extends into 19 Latin American countries.

There have been relatively few studies conducted on this species, and many aspects of its behaviour, ecology, habitat requirements, population biology and status remain poorly known. However, Sowls (1984) has provided a useful summary of most of the available information, much of which originates from the studies of Kiltie (1980, 1981, 1982, 1983) and Kiltie & Terborgh (1983) of the species' ecology in the rainforests of the Peruvian Amazon. Barreto & Hern ndez (1988) have also undertaken a study of its feeding habits and behaviour in tropical rainforest in Venezuela, and an evaluation of the species' status and habitat in southern Mexico was conducted recently (March, 1990).

The social behaviour of white-lipped peccaries is similar to that of *T. tajacu* in most respects, except for its tendency to form large herds. In common with *T. tajacu*, they have a rich repertoire of vocalizations which have a role in agonistic and reproductive behaviour, and also possibly in the cohesion of herds in dense vegetation. They use smell to communicate and engage in reciprocal rubbing of the dorsal scent gland, as does the collared peccary. Unlike the latter species, however, white-lipped peccaries have not been observed marking their territories with their scent glands, at least in captivity.

Captive animals reach sexual maturity between one and two years of age. Although distinct reproductive seasons have been suggested, it is probable that these peccaries breed throughout the year, with a peak in the most favourable months. In Peru, Kiltie and Terborgh (1976) observed mating during July and August, whilst in Chiapas, Mexico, mating has been recorded from April to November (March & Cuar¢n, 1987). Roots (1966) recorded a gestation period of 156 to 162 days in captive animals. As in the collared peccary (Byers & Beckoff, 1981), the modal litter size is two, and it is probable that the dominant males are responsible for most litters.

Little work has been done on the genetics and geographical variation of *T. pecari*, and a thorough review of its systematics is required to enable a proper re-assessment of its generic and subspecific taxonomy (see Grubb and Groves, 1993). Five subspecies are recognised at present, but the validity of some of these are in question. The ranges of these subspecies (Fig. 2) are as follows:

Link to Fig. 2: Approximate former distribution of the white-lipped peccary, *Tayassu pecari* ssp.

Former and Present Distribution

White-lipped peccaries are confined to the Neotropical Region, from south-eastern Mexico in the north, through Central America and northern and central South America, as far south as Entre Rios in northern Argentina and Rio Grande do Sul in southern Brazil (Sowls, 1986). Over this range it inhabits lowland forests at sea level to lower montane forests at maximum recorded altitude of 1,900 m on the eastern slopes of the Andes in Peru (Osgood, 1914). The species has also been reported at altitudes of 1,500 m in Venezuela (Röhl, 1959), Panamá (Anthony, 1916), and in Atitlan, Guatemala (Alston, 1879), although there have been no recent, verified records at altitudes of <800 m.

Its distribution is somewhat more restricted than that of the more adaptable collared peccary, *T. tajacu*, with which it is almost everywhere sympatric, but it has a much larger range than the Chacoan peccary, *Catagonus wagneri*, with which it is also sympatric over the latter species' restricted distribution in the Gran Chaco.

Recent data on the distribution and status of *T. pecari* are lacking, or inadequate for many of the 19 countries in which the species has been recorded. Nonetheless, it is clear that its former range has been severely reduced and fragmented during recent decades. Available data on its present range in each country/region, and the status of the five currently recognised subspecies may be summarised as follows:

1 *T. p. ringens*: southern Mexico (Oaxaca, Chiapas and Yucatan Peninsulas), Guatemala, Belize, El Salvador (extinct), Honduras and northern Nicaragua.

In Mexico this subspecies has probably been extirpated from the more northerly states of Veracruz and Tabasco, though its continued presence has been confirmed in a total of over 1.5 million ha of protected forest in the states of Oaxaca, Chiapas, Campeche and Quintana Roo. Within this combined area, the most important populations are in the proposed biosphere reserve of Los Chimalapas (>400,000 ha) in Oaxaca, the Lacandona Rainforest (which includes the Montes Azules Biosphere Reserve, >300,000 ha) in Chiapas, and in the recently established Calakmul Biosphere Reserve (>700,000 ha) in Campeche State. A few herds may also persist in the El Ocote Reserve (35,000 ha) and in the region of La Sepultura, Chiapas, and in the Sian Ka'an Reserve in north Quintana Roo State, though the future of these populations is uncertain. The neighbouring Mayan Reserve in the Department of El Peten in Guatemala is, perhaps, now the single most

important area for this subspecies. It is also thought to occur in one or more reserves elsewhere in Guatamala, and in some reserves in Belize, Honduras and northern Nicaragua, but recent data from these areas are lacking at present. White-lipped peccaries, formerly of this subspecies, are now extinct in El Salvador.

2) *T. p. spiradens*: southern Nicaragua, Costa Rica, Panama and north-western Colombia (areas west of the Cordillera Central and Cordillera Oriental).

Both *T. p. ringens* (north only) and *T. p. spiradens* occur in Nicaragua, where a total area of 1,451 km2 of largely undisturbed rainforest are currently protected (FAO/PNUMA, 1989). Nicaragua is therefore a potentially important stronghold for this species in Central America, though their present status, and the consequences of this country's years of strife and guerilla warfare on their populations, are not known. In Costa Rica, the subspecies has been recorded in the Corcovado National Park (43,735 ha ; pers. obs.) in the Osa Peninsula, and in the Oros¡ Reserve Forest (10,147 ha), Ca¤o Negro Wildlife Refuge (9,969 ha) and the Tortuguero National Park (18,947 ha) (A. Carr, pers. comm.). It probably also occurs in La Amistad Biosphere Reserve, which extends across the southern border into Panama. However, its status in the latter area, and in other reserves in Panama is unknown, though the subspecies is now extinct on Barro Colorado Island. Information on the present distribution and status of these animals in Colombia is also lacking.

3) *T. p. equatorius*: south-western Colombia and north-western Ecuador (west of the Cordillera Real) only.

This subspecies is reported to occur only in the south-west corner of Colombia, in Cauca and Narino Provinces, and in the neighbouring provinces of Esmareldas, Manabi and Pinchicha in north-western Equador. It therefore has by far the smallest range of any of the currently recognised forms of *T. pecari*, but its present status in these areas is not known.

4/5) *T. p. pecari*: eastern Colombia, Venezuela, British Guiana, Suriname, French Guina and areas north of the Amazon River in Brazil.

T. p. albirostris: eastern Peru, eastern Bolivia, Paraguay, northern Argentina (south to Santiago del Estero and Entre Rios) and (formerly) Uruguay, to central and south-eastern Brazil.

The Amazon Basin remains by far the most important stronghold for this species, though the increasing destruction and fragmentation of this region are the focus of international attention and concern; not least because only 4.28% of this region had been declared as protected areas. Nonetheless, large populations of this species still exist in this region, and it occurs in most of the larger and many of the smaller parks and reserves on both sides of the Amazon River. The latter also represents the approximate southern and northern limits of the respective distributions of these two subspecies, neither of which can be regarded as seriously threatened over all of their extensive ranges at present, though the southern subspecies, *T. p. albirostris*, is extinct is Uruguay where it was last recorded in 1890 (C. Gastelmundi, pers. comm. to W. Oliver).

The approximate distribution and current status of the five subspecies are summarized in Fig. 2 and Table 3.

Table 3 Status of _T. pecari_ populations according to the categories adopted by the IUCN/SSC Pigs and Peccaries Specialist Group.

Subspecies Category	Country/(Region)	Status
T. p. ringens	Mexico (El Ocote Reserve, north of Quintana Roo, & Sian Ka'an Reserve)	5
T. p. ringens	Mexico (Lacandona Rainforest, Chiapas; Oaxaca and Campeche)	3 - 4
T. p. ringens	Guatemala (Peten)	2 - 3
T. p. ringens	Belize, Honduras, Nicaragua (north)	Indeterminate
T. p. ringens	El Salvador	Extinct
T. p. spiraden	Nicaragua	Indeterminate
T. p. spiradens	Costa Rica (north)	5
T. p. spiradens	Costa Rica (south)	4
T. p. spiradens	Panama	Indeterminate
T. p. spiradens	Colombia (north-west)	Indeterminate
T. p. equatorius	Colombia (south-west), Ecuador (north-west)	Indeterminate
T. p. pecari	Colombia (east), Venezuela, Guianas, Surinam, Brazil (north)	1 - 2 ?
T. p. albirostris	Brazil, Peru (east), Bolivia, Paraguay, Argentina (north)	1 - 2 ?
	Uruguay (north only ?)	Extinct

? = Insufficient information.

Habitat, Ecology and Behavior

There have been erlatively few studies conducted on this species, and many aspects of its behavior, ecology, habitat requirements, population biology and status remain poorly known. HOwever, Sowls (1984) has provided a useful summary of most of the available information, much of which originates from the studies of Kiltie (1980, 1981 a, b, c, 1982) and Kilte and Terborgh (1983) on the ecology of the speciesin the rainforests of the Peruvian Amazon. Baretto and Hernández (1988) have also undertake a study of its feeding habits and behavior in tropicalrainforest in Venezuela, and an evaluation of the species' status and habitat in southern Mexico was conducted recently (March 1990).

The majority of habitat records for the species are from humid tropical forests, though it is also occurs in various drier habitats; the latter including dry savannas in Venezuela, the

xerophitic areas of the Chaco and in the tropical dry forest of Costa Rica (Wetzel & Lovett, 1974; Mayer & Brandt, 1982; Vaughan, 1983; Sowls, 1984; D. Janzen and S. Cornelius, pers. comm.). According to Sowls (1984) *T. pecari* is restricted to a narrower climatic range than *T. tajacu*. The optimal habitat for this species appears to be lowland rainforests, especially in well conserved areas (>30,000 ha) where it reaches its greatest abundancy. Conversely, its tolerance to deforested areas appears to be minimal, as it is easily hunted out where it no longer has sufficient cover.

White-lipped peccaries usually frequent areas close to water, and will even visit coastal beaches to forage. They are omnivorous, but have a strong tendency towards frugivory (Husson, 1978; Kiltie, 1981b, 1981c). Their diet is comprised mostly of fruits, seeds and roots, but they will also take invertebrates, small vertebrates, fungi and carrion. More than 40 plant species have been recorded in their diet (March, in press), and the species may play an important role in the ecology of Neotropical forests as a major dispersor and predator of seeds - this role being reminiscent of, and perhaps analogous to, that of bearded pigs, Sus barbatus, in the tropical forests of South-east Asia (Caldecott *et al.*, 1993). Its tendency to form large herds may also have an important consequences on the composition of ground plant communities and the drainage of surface water merely as a result of their intense rooting activity and the compaction of soil caused by the passage of large herds.

White-lipped peccary herds often exceed 100 individuals, though groups of as few as 5 to more than 200 individuals have also been observed (Mayer & Brandt, 1982; March, pers. obs.). It is possible that in certain seasons, large herds divide into smaller groups according to the distribution and abundance of food, though the more frequent reporting of smaller groups in some areas is probably correlated with increased hunting pressure.

The adaptive significance of forming large herds in this species is not clearly understood, though Kiltie & Terborgh (1983) have suggested it is primarily a predator defence strategy. In any event, the formation of these large herds also presupposes the need to preserve relatively extensive and continous tracts of habitat, particularly as the movements of these herds are likely to be strongly influenced by the pattern of food dispersion (Sowls, 1984). Kiltie & Terborgh (1983) estimated that in the Amazon region of Peru, these herds travelled up to 10 km per day, were able to cross wide rivers without difficulty, and had a home range of 60 to 200 sq. km. From calculations based on hunting data in this region, Bodmer et al. (1988) obtained a local density for the species of 1.3 individuals per sq. km, representing a biomass of 43.2 kg/sq. km. In the Matto Grosso of Brazil, Schaller (1983) estimated a density of 1.6 animals per sq. km.

The social behavior of the white-lipped peccaries is similar to that of *T. tajacu* in most respects, except for its tendency to form large herds. In common with *T. tajacu*, they have a rich repertoire of vocalizations which have a role in agonistic and reproductive behavior, and also possibly in the cohesion of herds in dense vegetation. They use small to communicate and engage in reciprocal rubbing of the dorsal scent gland, as does the collared peccary. Unlike the latter species, white-lipped peccaries have not been observed marking their territories with their scent glands, at least in captivity.

Captive animals reach sexual maturity between one and two years of age. Although distinct reproductive seasons have been suggested, it is probable that these peccaries breed throughout the year, with a peak in the most favourable months. In Peru, Kiltie and Terborgh (1976) observed mating during July and August, while in Chiapas, Mexico, mating has been recorded from April to November (March and Cuarón 1987). Roots (1966) recorded a gestation period of 156 to 162 days in captive animals. As in the collared peccary (Byers and Bekoff 1981), the modal litter size is two, and it is probable that the dominant males are responsible for most litters.

Threats to Survival

Widespread and increasing deforestation and intense hunting pressure are the main reasons for the increasing diminution and extinction of many populations of this species. In most Latin America countries, the progressive destruction of habitat for agriculture and cattle ranching, as well as timber extraction, has already accounted for much of the species' former habitat. It has been calculated that by the end of this century, Latin American forests will be reduced to roughly 366 million ha, approximately half of the estimated original forest cover of 693 million ha (Wolf, 1987). Owing to their habit of forming large herds, white-lipped peccaries require relatively extensive and continuous areas of habitat in order to obtain sufficient resources throughout the year. The loss and fragmentation of their habitat also exposes them to increased hunting pressure by facilitating their location by hunters, who can kill many individuals in a large herd during a single encounter.

White-lipped peccaries are hunted for sport, as well as by subsistence and commercial hunters, and they are killed for their hides as well as for meat. They have been identified as the single most important source of meat for the Mundurucu tribe in Brazil (Murphy, 1960), the Guayakí in Paraguay (Cadogan, 1973) and the Mayan Lacandones of Chiapas (March, 1987), as well as for many other indigenous groups who hunt them for purely subsistence purposes (Hames, 1980). In many countries (e.g. Mexico and Guatamala) subsistence hunters operate in most reserves and national parks, and there is no doubt that hunting pressure is increasing over the species' range as a whole as a result of the continuing immigration of people to forested areas. The species has also been affected by militarization and war in several Central and South American countries, where army personnel and guerilla groups are often heavily dependent on wild game and can kill large numbers of peccaries, often with automatic weapons.

Despite the lack of knowledge about the species, several countries permit sport hunting of white-lipped peccaries. In Mexico, for example, sport hunting was permitted until at least 1990 in Campeche State; whilst in Costa Rica it was possible to get a permit for up to 5 animals per season until 1986. In Argentina and Paraguay, sport hunting is quite commonplace, and is controlled to only a very limited extent (A. Taber, pers. comm.). However, sport hunting is of relatively minor significance in comparison to the large scale commercial exploitation of the species for meat and, especially, for hides (see Bodmer *et al.*, 1993).

Conservation Measures Taken

This species occurs in numerous protected areas throughout its extensive range, though it is far from certain that the existing network of protected areas is adequate to ensure the survival of representative populations of all currently recognised subspecies or of sufficient size to maintain viable populations of these animals in many of the smaller nation states, especially in Central America. It is also doubtful if many of these reserves are large enough to allow the formation of large herds of this species.

Concerns about the large number of peccary hides of both species of *Tayassu* in international trade (Broad, 1984) led to their recent (1986) inclusion on Appendix II of CITES (Oliver, 1987; Bodmer *et al*., 1988b, 1993). This measure is of considerable significance for future regulation and control of this trade, which is potentially more damaging to *T. pecari* than to *T. tajacu* in terms of the species' susceptibility to commercial hunting pressures.

Captive Breeding

White-lipped peccaries are widely maintained in captivity in their countries of origin, but very rarely elsewhere, mainly because of the stringent veterinary restrictions placed on the movement of live animals into countries with a significant domestic pork industry. The species has been bred infrequently in captivity (Roots, 1966; McDonald and Lasley, 1978; Frädrich, 1986), and little attempt has been made to develop cooperative breeding programmes for this species in zoos in their countries of origin, where replacement stock may be obtained relatively easily.

The most notable exceptions to this are the captive breeding of *T. p. albirostris* at the School of Agriculture, University of Sao Paulo in Piracicaba City (Brazil), the Santa Cruz Zoo (Bolivia), and the West Berlin Zoo (Germany), and the pioneering programme for the locally threatened subspecies, *T. p. ringens* in the Regional Zoo of Chiapas (Mexico). The Sao Paulo University project was started in 1986 and currently (August 1991) comprises 34 individuals, all of which (including the founder stock) are captive-bred (S. Nogueira-Filho, pers. comm. to W. Oliver). The West Berlin stock, which comprised 18 animals in February 1991, is derived from 5 wild-caught (in Paraguay) founders, obtained at intervals between 1979 and 1985 (H. Frädrich, pers. comm.). By comparison, the breeding programme for *T. p. ringens* in Chiapas was started in 1985 with 5 wild-caught pairs and comprised a total stock of 26 individuals by the end of January 1991.

On at least two occasions, captive *T. pecari* and *T. tajacu* have produced F1 hybrids which were reared to maturity (Zuckerman, 1953; Sowls, 1984), though it is not known whether these hybrids were fertile.

Additional Remarks

Given that this species is a relatively large-bodied mammal of some ecological importance (as a major seed predator/dispersal agent), as well as being of considerable socio-economic importance to local people, it is a potentially ideal 'flagship' species for tropical forest conservation projects. The fact that it is also the only large terrestrial mammal to form large herds in neotropical forests, and that it inhabits a broad spectrum of forest types, is also of significance, since it presupposes the need to conserve substantial tracts of forest, with all that that implies in terms of the maintenance of representative diversity in these areas. Thus, the development of conservation plans targetted on this species should not only help to ensure the enhanced future management of an important local resource, but also help to ensure the survival of diverse other, more immediately threatened species.

Conservation Measures Proposed:
An Action Plan

Although this species is not yet seriously threatened throughout it extensive range, there is concern about its continuing decline in some regions. However, the rate, severity and magnitude of this decline, or what actions may be needed to reverse this trend, are not always apparent owing to the paucity of accurate information on its present status and future management needs in most countries. Any actions intended to clarify this situation must therefore assume a high priority. By the same token, there are many aspects of its biology which are poorly known at present, but which are highly relevant to its future conservation, as well as the wider issues surrounding these animals; the latter including subsistence and commercial hunting, and national and international trade, which are discussed in more detail elsewhere (see later text, Sections 2.5 & 2.6).

Objectives:

1. To promote the effective conservation of representative populations/subspecies of these animals and their habitats in each country/region/biome, with particular reference to the currently most threatened populations and subspecies.

2. To obtain more basic and applied information on the species with a view to the development of practical management strategies on a sound conservation basis.

3. To initiate and improve routine monitoring of peccary population status, trends and levels of human utilisation for subsistence and trade purposes.

4. To enable the rational and sustainable utilization of peccary by subsistence hunters wherever appropriate (i.e. where this is not in conflict with ultimate survival prospects of that population).

Priority Projects:

1. Assess and monitor the status and habitats of the most threatened populations (e.g. in Mexico, Costa Rica and Panama).

2. Elaborate, supplement and disseminate existing data on the distribution, status and habitat of the species throughout its range.

Literature and questionaire surveys need to be conducted to assess the current distribution, status and priority management needs of this species on a country-by-country basis, in order to the promote field surveys in selected areas and to develop management recommendations relating to particular populations, protected areas or other conservation issues.

3. Strengthen existing protected areas which maintain important populations and habitats of this species.

This must include the enforcing of protective legislation, improving the infrastructure of these areas, and promoting the training of personnel and wildlife managers (see below). Particular problems which need to be addressed include regulation or prevention of subsistence hunting within designated protected areas, and coordination between neighbouring nations for better protection of this species. For example, subsistence hunting still occurs in most parks and reserves in Mexico and Guatamala, including the recently gazetted Mayan Reserve (c. >800,000 ha) in the Department of El Peten in Guatemala (perhaps the single most important protected area for the threatened subspecies, *T. p. ringens*).

4. Continue existing studies, and promote further comparative studies of the population dynamics, home range and ecology of selected populations/herds.

Priority should be given to the promotion of applied research on this and other peccary species in Latin American universities, research and breeding centres; thereby also facilitating the generation of information relevant to local/national needs and issues.

5. Develop studies and projects focused on the regulation (rather than prohibition) of subsistence hunting.

White-lipped peccaries are an important socio-economic resource for many ethnic groups and rural settlers and that the desired regulation of this activity requires the active participation of those people, and in some situations could be integrated with forestry management plans. A model programme has already been implemented in Peru (Bodmer, 1988b), which is intended to ensure its optimal utilisation through the active monitoring and management of peccary populations and establishing hunting quotas.

6. Implement and enforce of measures aimed at reducing or eliminating large scale commercial hunting for trade (see recommendations in Section 2.5).

7. Develop conservation-education programmes in rural areas, and training courses and workshops for wildlife managers and reserve staff.

Education programmes are important in rural areas to disseminate information on conservation of peccaries (their ecological and socio-economic importance, existing utilisation levels, legal and conservation status and future management needs, etc.), and other wildlife species. These programmes should be specifically targeted at subsistence hunters and reserve staff, as well as the wider rural communities.

8. Research on captive breeding and reintroduction.

The lack of sufficient data on the biology of *T. pecari* greatly hinders the development of projects for its management, conservation and sustained use. Research in captive animals could provide much valuable information on the life-history, reproduction and other aspects of the biology of these animals. This research should also address the possibility of reintroducing or translocating animals as a means of restoring populations of this species where necessary.

9. Conduct a thorough review of the generic and subspecific taxonomy of this species, assess its regional variation and enhance protection of any threatened forms.

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Chapter 2.4

The Chacoan Peccary (*Catagonus wagneri*)

Andrew B. Taber

Status and Action Plan Summary

Status category 5 (endangered).

Although still widely distributed through its limited geographical range, the Chacoan peccary is now seriously threatened. Its numbers are declining and populations are becoming increasingly fragmented. Destruction of its habitat is accelerating, and hunting for human consumption continues uncontrolled. The evident scarcity of Chacoan peccaries in the few national parks within its range is particularly worrying. Under existing conditions there is little hope for recovery and the trend is downwards. The total population size is unknown, but probably several thousand persist in the dry Chaco of Argentina and Bolivia and an estimated 5,000 individuals survive in Paraguay.

Priority conservation actions recommended for this species are: (1) investigate the feasibility of establishing a new national park where a substantial peccary population still exists; (2) establish private reserves on land where significant numbers of peccaries survive; (3) enforce regulations against hunting both inside and outside national parks and reserves; (4) establish and enhance existing environmental education programmes to increase local awareness of conservation problems and the value of native wildlife, using the Chacoan peccary as a flagship species; (5) strengthen wildlife services in Argentina, Bolivia and Paraguay so that populations can be monitored and hunting controlled; (6) continue efforts to breed Chacoan peccaries in captivity; (7) investigate the feasibility of translocating wild caught animals from areas being deforested, to the parks; and (8) continue research on the status of wild populations, aspects of the ecology and behaviour of the species relevant to its conservation, and human hunting patterns in the Chaco, so that effective management recommendations can be made.

Introduction

The existence of the Chacoan peccary or 'tagua' was first reported in 1975 making it one of the most recently discovered large mammals (Wetzel *et al.*, 1975). The species is endemic to the dry Chaco of western Paraguay, south-eastern Bolivia and northern Argentina; one of the hottest and driest regions of South America. The Gran Chaco, of which the dry Chaco forms a part, is an enormous flat plain with a mosaic of vegetation types including thorn forest, savannah, parkland, marsh and gallery forest. Chacoan peccaries are a scientifically interesting and important endemic form with many morphological, behavioral and ecological adaptations to their hostile environment. They also have potential as a source of bush meat for rural inhabitants and, if properly conserved and managed, they could prove an invaluable economic incentive to preserve habitat in a wild or semi-wild state. Being large and conspicuous, *C. wagneri* is also an ideal flagship species for the Chaco, a region with a surprisingly rich and still little known fauna (see Redford *et al.*, 1990).

The Chacoan peccary is distinguished from the other living peccaries, *Tayassu tajacu* and *T. pecari*, by its larger size, greater mass, proportionally bigger head with an elongated and convex rostrum, long ears and fur, whitish ruff on the jowls, and relatively long legs (Wetzel *et al.*, 1975; Wetzel, 1977b; Grubb & Groves 1993). Mean body weight of non-pregnant adults is 34.7kg (range: 29.5 - 40), total length averages 1,091mm, and height at shoulder 575mm (Mayer and Brandt, 1982). Its long legs and hooves suggest that it is more cursorial than either *Tayassu* species. The structure of its mandible and dentition

also seem to be more adapted for browsing than the other living peccaries (Wetzel, 1977b). They have four pairs of mammae, and a dorsal scent gland about 20cm above the tail; the latter is a typical feature of the Dicotylidae. In common with the other peccaries, they have 4 toes on their fore feet, but most individuals have only two toes on the hind feet instead of three as in the other species. There is no significant sexual dimorphism; nor have any subspecies been described (Mayer and Brandt, 1982).

Former and Present Distribution

The Chacoan peccary is endemic to the semi-arid thorn forest of the Gran Chaco. It has a total geographical range of approximately 140,000 km2 (Fig. 3; Sowls, 1984).

In Paraguay, the species formerly occurred in all departments of the Chaco. At the time of its discovery in the mid 1970's this species was still remarkably abundant, though its numbers have since plummeted. In 1976, Sowls (1984) sighted 72 individuals during a 19 day period along one section of the Trans-Chaco highway. However, far fewer animals were sighted during field trips in the same area in 1977 and 1979 and, in 1981, only 6 individuals were seen. In 1987, during a 10 day survey in the same region, no Chacoan peccaries were sighted by the present author, who was told by local people that the species had virtually disappeared. Today the Chacoan peccary has an extremely fragmented distribution in Paraguay and the only area where a significant population survives (c. 4,000 individuals; Taber, in press), albeit at low density, is in the southwestern department of Boquerón.

During 1989, the presence of Chacoan peccaries was verified in both Argentina and Bolivia (Taber, 1991). In Argentina, Chacoan peccaries occurred in Chaco, Formosa, Salta and Santiago del Estero Provinces, and although it remains widely distributed through this region it is now found only at very low density (Ojeda and Cajal, 1976; Olrog et al., 1976; Wetzel et al., 1975; Wetzel and Crespo, 1976; R. Ojeda, pers. comm.). The Bolivian Chaco is on the periphery of its range but C. wagneri persists in the departments of Chuquisaca, Santa Cruz, and Tarija (Eisentraut, 1986; Taber, unpubl.; Tello, 1986).

Link to Fig. 3: Approximate former and present known range of the giant or Chacoan peccary, *Catagonus wagneri*.

Habitat, Ecology and Behavior

The Chacoan peccary occurs in areas of low rainfall and high temperature and is restricted to the driest parts of the Gran Chaco biome (Sowls, 1984). Mean annual temperatures in its range exceed 24oC (Gorham, 1973) and annual rainfall may be as little as 200 mm in the western part of its range. Precipitation increases to the east to about 900 mm where the dry Chaco is replaced by the palm savannah of the moist Chaco.

Most of the precipitation in its geographical range occurs between December and March, and no rain may fall during five (June to October) or more months of the year.

The prime habitat for the species is thorn forest characterized by emergent tress, such as *Schinopsis lorentzii* and *Aspidosperma quebracho-blanco*; a dense shrub layer including *Ruprechtia triflora*, *Caparis* sp. and *Acacia* sp.; and a ground cover of bromeliads and cactii, such as *Opuntia* sp., *Cleistocactus baumannii* and *Eriocereus guelichii* (Mayer and Brandt, 1982). Chacoan peccaries are also found at lower density in open woodland, characterized by trees such as *Tabebuia caraiba* and *Schinopsis balansae* (Taber, unpubl.).

Cactii, including *Cleistocactus*, *Eriocereus* and at least two species of *Opuntia*, constitute the principal food of Chacoan peccaries. They also forage on the roots of bromeliads, fruit from various species of *Acacia* and *Prosopis*, and occasionally browse on forbs (Mayer and Brandt, 1982; Taber, unpubl.). Chacoan peccaries lick and eat mineral rich soil from naturally occurring salt licks and leaf-cutter ant mounds. They also consume carrion on occasion and may even prey on small mammals (Benirschke *et al.*, 1990). Although captive animals drink daily (D. Meritt, pers. comm.), there is circumstantial evidence that the species seldom drinks water in the wild, and radio-tagged individuals did not leave their territories to obtain water even during the five months long dry season when no surface water was available in their ranges.

Like the collared peccary, they are territorial and maintain scat stations and marking posts; the latter being marked with their dorsal scent gland. Their home range size, based on convex polygons, measure about 1,100 ha and contain a core area of about 600 ha (Taber, unpubl.).

Chacoan peccaries are diurnal and become active about sunrise, are active throughout the day and become inactive at dusk (Taber, unpubl.). The species seems to have a similar behavioral repertoire and social system to that of Collared peccary, *T. tajacu* (Mayer & Wetzel, 1989). Chacoan peccaries live in small stable groups of 2 to 10 individuals, with most groups consisting of 4 to 5 adults and accompanying juveniles. A slightly biased sex ratio in favor of males has been reported by Mayer and Brandt (1982) and Sowls (1984). Circumstantial and captive evidence suggests that females produce their first litters at a minimum age of two years and have only one litter a year (Benirschke *et al.*, 1990; Taber, unpubl.). The mean litter size is 2.72, with a range of 1 to 4. The farrowing season extends from September through January. Maximum longevity is unknown but Sowls (1984) estimated the age of some individuals, based on tooth cementum layers, as at least nine years.

Threats to Survival

The recent decline in the range and numbers of Chacoan peccaries is probably due to a combination of factors. These factors include hunting by humans, predation by larger felids, habitat destruction and disease (Taber, 1989, 1991).

Of these, hunting pressure undoubtedly has a major negative impact on these animals. All peccary species in the Chaco are vigorously hunted wherever they occur, even in the national parks and reserve areas. Sowls (1984) has stated the Chacoan peccary constituted one of the most important sources of bush meat in the areas where they were previously abundant. The species is particularly susceptible as they frequently emerge onto roads to dust bathe during the day, and they often react to danger by standing their ground rather than fleeing. Both of these behaviors enable hunters to eliminate whole groups during a single encounter. Unlike the collared and white-lipped peccaries, however, Chacoan peccaries are rarely exploited commercially for their hides, which are thinner and much less valuable than those of the other species. Fur buyers in Paraguay in 1988, for example, purchased Catagonus skins from settlers for about US$ 0.5 each compared to about US$8.0 for those of *T. tajacu* and US$ 5.0 for *T. pecari* (Taber, 1991).

Jaguar (*Panthera onca*) and puma (*Felis concolor*) are the main natural predators of Chacoan peccaries though ocelot (*F. pardalis*) may also prey on the young (Mayer & Brandt, 1982; Taber, in press). During the early 1970's local settlers attributed an apparent increase in Chacoan peccary numbers in Paraguay to the over-hunting of jaguar (Wetzel, 1977a). By the same token, some Paraguayans now ascribe the current scarcity of the species to predation by the apparently recovered large felid population. However, whilst these predators may exert some control on Chacoan peccary numbers, it is unlikely that they could cause the present population crash.

Habitat destruction, however, is the major threat to this species and may, ultimately, cause its demise in the wild state. Although large tracts of intact bush survive, the rate of clearance for agriculture and cattle pasture in the Paraguayan Chaco has been estimated by some authorities as being as much as 1,500 sq. km annually (M. Sanjuro, pers. comm). Moreover, the pace of land clearance is accelerating and in as little as a decade this species may not have enough contiguous habitat left to support viable populations. The pattern of development in Argentina and in Bolivia where Chacoan peccaries are found, differs in that much of the land is degraded by fire and overgrazed by livestock (Morello and Hortt, 1985; Taber, unpubl.). These peccaries seem to adapt to this degraded dry Chaco bush, and survive in altered, but not cleared, habitat as long as enough food and cover is available and they are not over-hunted (Taber and Ojeda, unpubl.).

Several, apparently reliable reports have been received that individuals and groups of Chacoan peccaries were found dead or dying from disease in the northern and western Paraguayan Chaco between 1979 and 1981. The nature of this disease is unknown, but both foot-and-mouth disease and bovine rabies were common in the region in the late 1970's (W. Regehr, pers. comm.). It is noteworthy that large numbers of cattle first reached this area during the 1970's, though Chacoan peccaries have persisted in parts of the Argentine Chaco, which have had livestock, and their associated diseases, for 100 years or more. Thus, a possible explanation for the population crash in the largely virgin bush of northwestern Paraguay may be that the peccaries previously had little exposure and, hence, little immunity to livestock diseases (Taber, 1989, 1991).

Conservation Measures Taken

The Chacoan peccary is classed as 'Vulnerable' in the IUCN Red List of Threatened Animals (1988), and it is included on Appendix I of CITES, to which all three Chaco countries are signatories. Hunting of all wildlife in Paraguay is officially prohibited. The species is also protected in Argentina, where its exportation, interprovincial traffic and commercial exploitation is illegal. However, there is little commercial traffic in the hides of this species and it is not thought to be threatened by the skin trade at the present time. Even so, the Chacoan peccary is heavily hunted for its meat everywhere it occurs and existing regulations prohibiting its hunting are ignored and unenforced.

Field status surveys on the species have been completed in all three Chaco countries, as well as an ecological field study in Paraguay. A conservation action plan for the species in Paraguay was submitted to the Paraguayan Government in 1990 (Taber, 1990) and similar plans are being prepared for submission to the relevant authorities in Bolivia and Argentina in 1991.

At present, there are only two national parks within this species' range in Paraguay, the Defensores del Chaco (7,800 sq. km) and Teniente Enciso (400 sq. km). As yet, there are no reserves of any kind in the Bolivian Chaco. In Argentina, the only protected area containing Chacoan peccaries is the El Copo Provincial Reserve (1,140 sq. km), in Santiago del Estero province. However, there are only small numbers of Chacoan peccaries in this reserve, and in each of the two Paraguayan parks, and it is doubtful if any of these areas support viable populations. In addition, these reserves all require major investments in personnel, training, equipment, and infrastructure if the staff is to control hunting effectively.

Captive Breeding

The species has proved difficult to establish in captivity. Two of the three hand-reared animals exported to Zoo Berlin died in quarantine and the third succumbed shortly afterwards (Frädrich, 1986). Two animals also died after capture in Argentina (J. Cajal, pers. comm.), and two of three animals kept at various times at the Asuncion zoo died within a year of their arrivals, one of them probably from erysipelas (J. A. Rivas, pers. comm). The zoo in Santa Cruz de la Sierra, Bolivia has also acquired at least three animals in recent years, though the first two of these have died (O. Jordan, pers. comm).

In 1985, following PPSG representation, the Chacoan peccary was adopted for a Species Survival Plan (SSP) under the aegis of the Conservation Management Committee of the American Association of Zoological Parks and Aquariums (AAZPA). The following year, a captive breeding station was established at Estancia Toledo, near Filadelfia, in the central Paraguayan Chaco, with funding from the Foundation for Endangered Animals, the Zoological Society of San Diego, and the Lincoln Park Zoo. During the first few years of this project, serious problems were experienced obtaining animals and many of those acquired from hunters were in a seriously debilitated condition. Of the total of 44

wild caught adult and juvenile animals obtained (mostly by purchase) for 'Proyecto Tagua' 31 died in captivity (Byrd *et al.*, 1988; Benirschke *et al.*, 1990; Unger, i992; D. Brooks, pers. comm.). However, as of 10th May 1992 (Unger, 1992), the colony comprised a total of 43 (22 males, 14 females + 7 unsexed) individuals of which 32 (15 males, 10 females + 7 unsexed) individuals were captive born (Unger, 1992).

Conservation Measures Proposed:
An Action Plan

With the wide range of problems confronting this species in the wild, a variety of actions will be necessary to conserve it. The principal objectives and priorities of the conservation action plan for the tagua in the Paraguayan Chaco (Taber, 1990), and the similar plans being prepared for the populations of this species in Bolivia and Argentina, are incorporated in the following recommendations, with the additional proviso that the priority projects should be implemented as soon as possible.

Objectives

1. To ensure the survival of the Chacoan peccary in perpetuity by the promotion and implementation of those activities and projects specified in the Action Plan or such others as may be identified in future.

2. To promote the development and implementation of an effective conservation strategy for the whole dry Chaco as a means of preserving not only the Chacoan peccary but representative parts of this ecosystem in its entirety.

3. As part of this strategy to promote research into, and implementation of, ecologically sustainable development practices in the Chaco.

Priority Projects

1. Upgrade and expand the existing protected areas system within the dry Chaco of Paraguay, Argentina and Bolivia.

At present, there are only two national parks within this species' range in Paraguay (Defensores del Chaco, 7,800 sq. km, and Teniente Enciso, 400 sq. km), one provincial reserve in Argentina (El Copo, 1,140 sq. km), and no reserves at all in the Bolivian Chaco. Moreover, none of the three reserves in which it occurs is thought to support a viable population, and major investments in personnel, training, equipment, and infrastructure are needed in each of these areas if hunting is to be controlled effectively. Efforts must therefore be directed towards the establishment of additional protected areas

in each of these countries, but especially in the Paraguayan department of Boquerón, where substantial numbers of these animals still occur. The problems with the existing parks systems in these countries also need to be addressed by local, national and international organizations. Investments will need to be made by international aid organizations; though the solutions to the problems will depend as much on promoting regional patrimony and interest in the parks as in providing financial assistance.

2. Create a private reserve system in the Chaco.

Given that significant numbers of Chacoan peccaries now survive in only a few locations outside the existing protected areas system, and that these may be the only viable populations, the creation of additional reserves is critical. Current efforts in Paraguay to set up a system of reserves on private land in areas with high densities of Chacoan peccaries are, therefore, a matter of the highest priority. Parallel private reserve programmes also need to be developed in the Argentinean and Bolivian Chaco by appropriate NGO's. These areas may be of the utmost importance in the event that the populations in the parks do not recover with more effective protection, and could provide a source of animals for re-stocking those parks in the future.

3. Establish an effective hunting ban on the species.

The capability of the wildlife services of the Paraguayan, Argentinean and Bolivian governments to monitor Chacoan peccary populations and enforce existing regulations should be developed by all possible means (also see below). In Paraguay, for example, it might be better to permit hunting of less vulnerable species, than perpetuate the existing total, but totally unenforceable, ban on all hunting. This would provide better protection for the most vulnerable species, whilst also enabling subsistence hunters to obtain meat legally. By the same token, this would also encourage the government to establish an effective wildlife management system rather than avoid confronting the problem by making hunting of all species illegal.

4. Develop an environmental education program.

The Chacoan peccary has tremendous potential as a flagship species around which to stimulate conservation interest and action in the Chaco. New and existing programmes established by governmental organizations and NGO's should focus attention on this species by the production of posters, booklets and other materials for distribution amongst Chaco inhabitants to inform them of the species' status and the potential benefits of protecting it and its habitat. Such education programmes should also inform local people which species may and may not be hunted, in order to protect the most threatened species.

5. Develop effective wildlife services in all three Chaco countries.

There is a need to establish an integrated approach to wildlife management in these countries, which incorporates both conservation and game management policies, in order to protect the most threatened species. The economic importance of some non-threatened species, such as the collared peccary, should be recognized within a management system designed to ensure the sustainable exploitation of those species, as well as the enhanced future protection of the most threatened forms, such as the Chacoan peccary. However, there is a lack of trained personnel in this region and the training of local biologists to study and monitor wildlife populations should be a high priority. Conservation biology workshops would be held each year in each Chaco country to provide biologists, rangers and wildlife administrators with the opportunity to obtain field experience and exchange ideas and expertise. Grants should be provided for biology students from each country to obtain advanced degrees in wildlife management or a related field.

6. Improve and extend captive breeding initiatives.

The existing captive breeding program at Estancio Toledo in the Paraguayan Chaco should be continued and developed with a view to: (a) provide a safeguard against the extinction of this species in the wild; (b) serve as a source of animals for the establishment of similar projects in the other Chaco countries and/or for reintroduction projects; (c) provide the means of obtaining biological data on the species which cannot be obtained from the wild; and (d) serve as a public education and training facility for wildlife biologists and veterinarians from Paraguay and the other Chaco countries.

7. Assess the feasibility of translocating wild caught peccaries into the national parks or other reserves from areas where the natural habitat is being destroyed.

Problems which need to be addressed include: (a) how can animals be captured and transported safely; (b) how can translocated animals be effectively protected in these areas; and (c) what behavioral and ecological problems must be solved to make translocation successful?

8. Conduct further research on various aspects of the Chacoan peccary's reproductive biology, behavior, ecology and future management needs both in the wild and in captivity.

In particular, the status of the various wild populations needs to be monitored, the effects of human hunting and predation on these populations needs to be determined, and studies should be conducted on the susceptibility of this species to various livestock borne diseases so that appropriate management responses can be devised if necessary. A study of human hunting patterns in the Chaco and estimates of the annual harvest of all species taken by both sports and subsistence hunters in the various parts of the Chaco are also required. These data are likely to prove essential for the enhanced future management of this species, and they may provide strong incentive reasons for national governments to

initiate serious efforts to control human hunting activities and conserve wildlife populations.

Acknowledgements

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Chapter 2.5

Economic Importance and Human Utilization of Peccaries

Richard E. Bodmer, Lyle K. Sowls and Andrew B. Taber

Action Plan Summary

Human exploitation of peccaries for meat and for hides occurs throughout the ranges of the three living species. The most widely hunted species is the collared peccary, *Tayassu tajacu*, which also has by far the largest range, yields the most valuable hides and appears to be least susceptible to this pressure. The white-lipped peccary, *T. pecari*, is also exploited heavily for meat and hides, but is apparently more vulnerable to this pressure because it has a much smaller range and because it forms much larger social groups. By comparison, the Chacoan peccary, *Catagonus wagneri*, is hunted mostly for its meat, but this species is already seriously threatened throughout its very small range and is unlikely to withstand continued intense hunting pressure. The large volume of international trade in peccary hides, coupled with need to protect *C. wagneri* by all possible means, have

resulted in the recent (1986) inclusion of the latter species on Appendix I of C.I.T.E.S and both species of Tayassu on Appendix II.

For all of these reasons, this section deals only with the socio-economic issues relating to the continued use of the *Tayassu* peccaries for food by subsistence and recreational hunters and the commercial sale of their meat and hides. These peccaries constitute a major source of meat for many rural and indigenous people in Central and South America, though they are hunted mainly for sport by people from the higher socio-economic classes in these regions and in the USA. Hunters from rural areas also commonly sell peccary meat and hides in urban markets, and these may constitute a principal source of revenue for those hunters and a major proportion of the total volume of game meat sold. In the 1950's, 60's and 70's large numbers of commercial hide hunters were also operating throughout South America, and although this practice has become less prevalent since that time peccary hides are still an important export in those South American countries - notably, Argentina, Bolivia and Peru - which have maintained a legal skin trade. Action plan recommendations are primarily directed towards the improved regulation of peccary hunting to ensure the sustainable utilisation of these animals for subsistence purposes, the prohibition of hunting for purely commercial purposes, and the utilisation of profits from the marketing of peccary products for the benefit of rural communities and the enhanced future management of peccary populations.

Introduction

Human utilization of the peccaries is widespread throughout the New World. Collared peccaries, *Tayassu tajacu*, are the most frequently exploited species and are hunted throughout their range from southern North America through to northern Argentina. White-lipped peccaries, *Tayassu pecari*, are also hunted widely, but have a smaller geographical range and are apparently more vulnerable to hunting pressure than collared peccaries; perhaps because they form much larger social groups. One or both species of *Tayassu* are legally hunted in many Central and South American countries and in the U.S.A., and are listed on Appendix II of CITES, which permits international trade in their products so long as harvests do not overexploit natural populations.

The Chacoan peccary, *Catagonus wagneri*, has a much smaller geographical range and population size than either *Tayassu* spp. These factors, together with the former's strictly diurnal habits and defensive strategy of standing its ground rather than fleeing, makes it much more susceptible to hunting than the other peccaries (see earlier text, Section 2.4). The Chacoan peccary is categorized as 'Vulnerable' in the IUCN Red List of Threatened Animals (1990) and (since 1986) is included on Appendix I of CITES. However, this species is now endangered and should not be used by people for meat or hides and efforts should be made to curtail any hunting, which is presently occurring. Therefore, the following discussion will deal only with the socio-economic issues appertaining to the two *Tayassu* species and not the Chacoan peccary.

These issues relate to the use of these peccaries for food by subsistence hunters and for commercial sale, the pelt trade for national and international markets, and sport hunting. Data on sport hunting is available only from the U.S.A., though recreational hunting is also practiced widely amongst higher socio-economic groups in most Central and South American countries. Various management options for the possible enhanced future regulation of the peccary harvest are also discussed with a view to the need to avoid the overexploitation of these animals. An 'action plan' to manage peccary populations is outlined below.

The Hunters

Depending on locality, peccaries are hunted for their meat and/or hides and for sport. In the U.S.A. they are hunted predominantly for sport, whilst in Latin America they are hunted mostly for meat. In the 1950's, 60's and early 70's large numbers of hide hunters were operating throughout South America, but this practice became less prevalent in the late 70's and 80's. However, peccaries are still being hunted at least partly for their hides in Argentina, Paraguay and Bolivia.

Sport hunting of collared peccaries in the U.S.A. is permitted in Arizona, New Mexico and Texas. Arizona has adopted a permit lottery system and a division of the State into hunting units. Winter surveys by wildlife managers determine population trends and estimates, and set permit quotas. Annual peccary harvests from 1950 to 1980 range between a low of 1,344 in 1950 to a high in 1970 of 6,602 animals. During the 1970's, Arizona sold an average of 24,991 hunting permits per year, recorded an annual mean of 21,903 hunters afield and an average harvest of 4,795 animals. The hunting season in Arizona is usually in late February or early March and lasts for one to two weeks (Sowls, 1984). New Mexico has a similar system to Arizona, but the peccary population in this State is confined to only a few, isolated areas.

In both Arizona and New Mexico peccaries are found mostly on land owned by the government and where there is free access by hunters. In Texas, where there are far more peccaries, hunting regulations vary in different counties and most land is privately owned. Until a few years ago the collared peccary was listed as vermin in this State, but it now has game animal status. Ranchers sell permits for hunting peccaries on their land. This has become a thriving business, particularly popular amongst archers. During 1989, 18,477 collared peccaries were harvested in Texas.

Subsistence hunters are common throughout Central and South America, but are often difficult to classify because some sell portions of game meat and hides for cash income. Local people commonly hunt peccaries whilst collecting other minor forest products. For example, rubber tappers in south-western Brazil, palm leaf (*Chamaedorea* spp.) cutters in Mexico, Guatemala and Belize, and palm fruit collectors throughout the Amazon basin often hunt peccaries along their trail systems.

Professional meat hunters are also prevalent in some countries and may cause considerable damage to peccary populations. However, it is the commercial enterprises,

such as lumber, oil and mining operations that often result in the most severe hunting pressure, since their employees frequently rely on game meat as a major source of food. For instance, in a 500 sq. km study site in the Peruvian Amazon, persons employed in small lumber operations were also responsible for more than 50% of the 148 peccaries harvested in 1985 (Bodmer *et al.*, 1988). In some countries, such as Guatemala, Nicaragua and Colombia, soldiers and guerrillas often hunt both species of *Tayassu* for meat.

Peccary Meat and the Meat Trade

Peccaries constitute a major source of meat for many rural and indigenous people in Central and South America, and they are often the most important animals hunted in both frequency and harvested biomass (Vickers, 1984; Redford & Robinson, 1987). Indeed, its importance to many of the Amerindian groups has resulted in their adopting the peccary as a ceremonial animal (Donkin, 1985). In Brazil, For example, headhunting by the Munduruc Indians revolved around the "mother of the peccary" and their warfare with neighboring tribes may have been a mechanism to increase peccary densities by eliminating hunting competitors (Durham, in press).

Peccaries also provide a substantial quantity of meat. Collared peccaries have a total body weight of 15-28kg and yield a dressed weight of 10-12kg of meat, and white-lipped peccaries a total body weight of 24-40kg and a dressed weight of 12-18kg (Sowls, 1984). Most subsistence hunters in Central and South America also consume the brain, tongue, lungs, heart, kidneys and liver, which, together with the flesh, represents about 60% of the total body weight.

Hunters throughout Central and South America commonly sell peccary meat in urban markets. In the public markets of Iquitos in Peru, 60.2% of the total volume of game meet sold between May 1986 and April 1987 was from ungulates, of which 64.8% were collared peccaries (1,211 individuals) and 19.5% were white-lipped peccaries (261 individuals) (Bendayán, 1990). In Iquitos, a single collared peccary can fetch between 20-30 US dollars, so this trade may constitute a major source of revenue to hunters supplying these markets. In Argentina and Paraguay, peccary meat is of far less value, because beef is readily available and inexpensive, but peccaries are still widely hunted for the hide trade.

The Peccary Hide Trade

Peccary hides constitute an important export in those South American countries, such as Argentina, Bolivia and Peru (Fig. 4), which have maintained a legal skin trade. Traditionally, the (former) Federal Republic of Germany was the primary importer of peccary hides, which are used mostly for equestrian leathers, especially gloves. The use of these hides for this purpose, as opposed to more popular but ephemeral fashion accessories, has produced a relatively stable market. Germany still dominates this market, but various other countries, such as the U.S.A. and Italy, have imported increased numbers of hides in recent years. Of the 362,745 hides exported from Argentina in 1988

and 1989, for example, 48% were exported to West Germany, 26% to the U.S.A., 16% to Italy, 3.2% to Japan, 2.4% to the Netherlands and 4% to other European countries (J. Cajal, pers. comm.).

In principle, the commercial hunting of peccaries for their hides is prohibited in these and other South American countries. In practice, however, until at least 1990 commercial hide hunting was still common in Argentina, Bolivia and Paraguay, where peccary hides fetched relatively high prices and the trade was still profitable. In 1989, raw white-lipped peccary hides fetched about $5 U.S. each, and collared peccary hides fetched as much as $8 U.S. each; the latter being exceeded in value only by caiman hides. Conversely, there are now far fewer commercial hunters in those countries where peccary hides attract much lower prices. In Peru, for example, peccary hides are currently (1990) fetching only c. US$1.5-2.5 per hide, which evidently deters purely commercial hunting.

The total number of peccary hides exported from South America has been relatively constant over the past 3 decades. However, the major exporting country has switched from Peru to Argentina in recent years. In Peru, hunters obtained a relatively good income from peccary hides in the 1950's, 60's and early 70's, when exports from the Peruvian Amazon alone exceeded 200,000 hides/year (Grimwood, 1969). During the 16-year period from 1970 to 1985 (incl.), a total of 1,164,781 collared peccary hides and 577,880 white-lipped peccary hides were exported from Peru alone. However, even these figures were exceeded on occasions by Brazil, which exported as many as 479,941 collared peccary hides and 216,575 white-lipped peccary hides in 1969, though this large number may be partly accounted for by the ban on further exports from this country which came into effect the following year. Since the early 1970's, the hide trade has become both less lucrative for hunters and more strictly controlled, and exports have declined to the current level of around 50,000 skins/year (Bodmer, *et al.*, 1988). In Argentina, an average of 32,251 peccary hides were exported annually between 1976 and 1984 (R. Ojeda, pers. comm.), but this increased to an annual export of 181,373 during 1988 and 1989 (J. Cajal, pers. comm.); thereby compensating for the decrease in the Peruvian export. In 1988, the number of peccary hides exported from Argentina constituted 64.3% of the market, whilst Peru and Bolivia exported 29.6% and 6.0%, respectively (CITES, Data Base; Fig. 4). However, although large numbers of hides were exported from Argentina it is that likely that more than half of these actually originated from Bolivia and Paraguay.

Link to Fig. 4: Recorded numbers of T. tajacu and T. pecari hides exported from South America during the period 1946 to 1990 (incl.).

The Economics of the Peccary Harvest

The peccary hide trade is a profitable market to the major exporting countries in South America, as well as the major importing nations of Germany, U.S.A. and Italy. During 1988, for example, (West) Germany alone imported 5,071 white-lipped peccary hides from Peru and Bolivia, and 160,391 collared peccary hides from Argentina, Bolivia and Peru (CITES Data Base). The total value of this trade was approximately US$30 million of which about US$ 1 million was received by rural hunters, US$1.5 million was

garnered by intermediaries in South America, and the rest remained in the German economy (calculated from data in Bodmer *et al*., 1990). Little if any of these profits is recycled back into peccary management in South America. As a result, the peccary hide market lacks necessary management information on its primary resource and is thus susceptible to unpredictable collapse. This contrasts with sport hunting of collared peccaries in the USA where hunting permits generate substantial income for management. In Arizona, for instance, the price for a collared peccary hunting permit in 1990 ranged between US$14.50 to US$92.50, with a total of 13,400 permits being available for sale.

Nonetheless, the peccary harvest in Peru is an example of how an animal, if well managed, can bring economic benefits to local people, urban markets, and the national and international trade. The economics of peccary hunting in Peru is unique in the sense that it is operating on two levels - hunters and meat, and exports and hides. The number of peccaries hunted is determined by the value of meat either as a source of income or food, and not by the hides. Indeed, many rural hunters treat hides as a minor by-product. However, hides are of much greater economic value for the national economy and international trade, because they bring foreign currency to this developing country. This economic situation is intriguing because its stability depends on a food resource, while its profits are made from the hides.

The peccary harvest in Paraguay and Argentina, unlike that of Peru, has become less stable in recent years, because of increases in the numbers of peccaries hunted. This was undoubtedly a consequence of higher prices being paid for pelts, which encouraged commercial hunting, as the value of the meat appears to have little influence on the size of the peccary harvest in these countries. However, in 1990 the market for peccary skins in Argentina, the main transit point for hides exported from Bolivia and Paraguay, was closed. Since then the commercial hide harvest in these three countries seems to have declined, though it is not clear how long this control will remain effective.

The Management of Peccary Hunting

At present, the majority of Central and South American countries attempt to manage peccary populations by only permitting subsistence hunting (Broad, 1984). In principle, this is a good strategy, but it makes it difficult to determine the impact of subsistence hunting in each of these countries since it means that there is also little or no monitoring of the peccary harvests. Moreover, game meat hunting is known to be damaging many mammalian populations throughout Central and South America. The best examples are the recent declines of the woolly monkey (*Lagothrix lagothricha*) and manatee (*Trichechus inunguis*) populations in Brazil and Peru (Peres, 1990). By the same token, peccary populations that are exploited by meat or hide hunters must be managed to avoid overexploitation. In this respect, priority should also be given to the interests of subsistence hunters, by the placing of restrictions on commercial hunters.

Certain countries, such as Peru, have estimated peccary harvests by closely monitoring the movement of hides, because the number of hides is assumed to reflect the number of

peccaries hunted. Restrictions placed on specific types of hunters in Peru have significantly decreased the number of hides exported. For example, before the prohibition of professional pelt hunters in Peru the average annual harvest was 173,543 peccaries, whereas after the prohibition the average annual harvest dropped to 64,034 (Bodmer *et al.*, 1988). Thus it appears that some countries in South America might best manage the peccary harvest by regulating specific types of hunters. In contrast, in countries such as Argentina and Paraguay, where no attempts have been made to control the peccary harvest, there has been a decline in the populations of all three species of peccaries, which may ultimately lead to the collapse of the peccary harvest as well threatening the survival of more abundant *Tayassu* spp., as it is already threatening the Chacoan peccary, *C. wagneri* (Taber, 1990, 1993).

Conservation Measures Proposed:
An Action Plan

An action plan for the human utilization of *Tayassu* is in fact a management plan to ensure the sustained use of peccaries and avert over-hunting. This action plan outlines the procedures necessary to monitor and analyze the present status of peccary populations, hunters, meat and pelt markets, and past and existing management programmes. The implementation and monitoring of alternative management techniques is also discussed. In order to ensure the sustained use of *Tayassu* peccary populations, hunters, markets and management programmes must be analyzed in representative habitats within different countries. Each country has its own set of management legislations that effect peccaries, hunters, and markets. Management programmes must work with legislatory authorities in order to keep within legal boundaries, initiate appropriate amendments to existing laws and promote new legislation.

Objectives

1. To promote the sustainable utilisation of healthy populations of both *Tayassu* spp. by subsistence hunters, based on sound management principles.

2. To develop and improve local legislations and enforcement procedures appertaining to the management of peccary populations in the various Latin American countries.

3. To promote the improved monitoring and control of trade in peccary meat and hide products and the prohibition of hunting for purely commercial purposes.

4. To encourage the return of profits from peccary hides sold as by-products of subsistence hunting to rural communities and utilized to improve peccary management and conservation, as well as the wider issues of habitat protection and sustainable rural development.

Priority Projects and Recommendations

1. Carry out comparative studies of peccary population dynamics in hunted and non-hunted areas.

Studies of selected peccary populations are required to determine the relationship between hunting pressure and the age structure and density of those populations in representative areas. Comparative data should be obtained from studies in fully protected areas, so as to provide control data, if hunting is truly absent. Particular aspects of such studies should include: a) estimates of the densities of peccary populations (e.g. by using Fourier series expansion of line transects; Burnham *et al.*, 1980); b) the determination of age structure of peccary populations (e.g. by examining teeth wear from a representative sample of individuals; though a standard correlation measure for age/teeth wear also needs to be determined for both *Tayassu* spp. in tropical forest, savanna, and desert/chaco habitats); and c) estimation of hunting pressure in representative areas (by monitoring harvests at check points and/or by oral and written surveys). The correlation of hunting pressure to age structure and density will enable managers to determine which peccary populations are sustainably harvested and which are over-hunted. For example, peccary populations with an age structure tending towards younger animals coupled with low densities signifies a healthy population. However, density, age structure and hunting pressure must be collected using standardized measurements to permit quantitative comparisons.

2. Conduct hunter surveys and analysis of the peccary harvest.

Types of hunters and methods of harvest should be studied in each representative area and hunters categorized according to their intended use of the peccaries. These categories include: sport hunters and recreational benefits, commercial meat hunters and the meat trade, commercial hide hunters and the hide trade, subsistence hunters and levels of dependency on game meat resources, agricultural hunters and elimination of pests, and timber/oil hunters and company operations. Data required includes: a) the proportion of the harvest taken by each type of hunter; b) determination of products (pelts, meat or both) used by each type of hunter; and c) determination of hunting methods and their relative efficiency and proportion of animals taken by each of the different hunting techniques. This information will enable managers to determine who is harvesting the peccaries and why, with a view to the development of management strategies geared to the needs of specific socio-economic groups and the improved regulation of this harvest.

3. Study and improve the monitoring of the peccary meat and hide trade.

Markets that sell peccary meat should be monitored in large cities and a representative sample of smaller towns. The quantities of peccary meat and hides sold, and prices paid to producers and retailers, should be registered in order to calculate the size and value of

these products in these markets. The socio-economics of meat consumers should be studied to determine who buys peccary meat in different regions and countries. The peccary hide market should be monitored at local and national levels, as well as the international level. On a local scale the price paid to hunters per hide, the movement of hides into cities and the proportion of hides sold per animal hunted, should be studied in representative areas. Monitoring on a national level should include the number of peccary hides processed, the price paid to intermediaries per hide and the proportion of hides exported versus those used nationally. On an international scale, CITES-listing must be maintained and trade data collection improved by the enhanced monitoring of the movement of peccary products between producer countries in South America. Wholesale and retail prices paid for peccary hides and products, and the demand for these products also require monitoring.

4. Analyze, develop and implement management programs.

Existing peccary populations management programmes should be investigated to determine criteria and operational procedures most likely to be successful in different countries and regions. Effectiveness of management programmes will vary between different habitats, types of hunters and market forces. Wildlife personnel must be appropriately trained before peccary management initiatives can be implemented. However, generalized procedure for the management of peccary populations might be as follows:

- Study past and existing management programmes with regard to peccary populations, hunters and markets to determine the relative success of current management strategies and options for their improved effectiveness.

- Studies should then be conducted to determine at what level management procedures can be most effective by testing alternative programmes.

- The most effective management techniques should then be implemented.

- Peccary populations, hunters and markets should be continually monitored and management programmes adjusted to changing conditions. Potential options for the improved management of peccary populations, which can be implemented at the animal, hunter, and market levels, are outlined as follows:

  a) Animal population level - encourage increased size of peccary populations by slowing destruction of natural habitats (e.g. rainforests and the Chaco); introduce ranching or captive propagation of peccaries, with appropriate genetic and demographic management.

  b) Hunter level - prohibit or strictly regulate certain categories of hunting (e.g. commercial hunting for meat or hides, hunting by lumber and fuel company employees); implement male only hunts; implement comprehensive hunting quotas or quotas for commercial hunting categories; introduce education programmes to

teach hunters about overexploitation and the need to avoid harvesting certain age/sex classes; and regulate distribution of arms and ammunition.

c) Meat market level - establish inspection posts where peccary meat must be authorized prior to being sold in market stalls or restaurants; allow sale of only male peccary meat; set quotas or prohibit the sale of peccary meat in food markets; initiate education programmes directed towards urban consumers to decrease the demand for peccary meat; implement tax controls to maintain artificially low wholesale prices in order to reduce producer profits and lessen incentives for commercial meat hunting, whilst also maintaining high retail prices high to deter consumers; and permit profits from this trade to be used to support these management programmes.

d) Pelt market level - support efforts of CITES to monitor the hide trade and improve monitoring of the international trade between producer nations in South America; encourage the development of peccary management programmes, especially in producer countries; initiate education programmes in the major importing countries in order to decrease consumer demand (thereby also reducing retail prices and incentives for commercial hide hunters); impose wholesale price controls and/or control wholesale outlets, whilst also implementing sales taxes to maintain high retail prices to deter commercial interests at the producer and consumer level; permit profits to be recycled into peccary management program.

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Chapter 2.6

Review of priorities for Conservation Action and Future Research on Neotropical peccaries.

Andrew B. Taber and William L. R. Oliver

Introduction

The research and conservation action priorities for peccaries in Mexico, Central and South America, based on the preceding chapters 2.1 to 2.5 are reviewed and summarized below. This review does not include the collared peccary in the United States of America since management and conservation programmes have already been established for populations there.

In many respects, the most pressing problem confronting peccary conservation is the lack of information. Few field studies have been made on any of the peccaries outside the United States, where a substantial body of information already exists. As it is, very little information is available about the distribution, status and ecology of peccary populations in most of the habitats and countries in which they occur. Clearly, research on peccaries outside the United States is an overriding priority.

In addition to these problems, there is also a need to confront a range of related issues appertaining to wildlife in the neotropics. Efforts to conserve threatened peccary taxa will inevitably fail in the long run, and now stable populations may become seriously threatened, if the larger problems are not confronted. These issues include lack of reserves, lack of trained wildlife personnel, lack of awareness or interest in wildlife by the public at large, over-hunting, and habitat destruction on a colossal scale.

These problems and issues, whether specific to the peccaries or of much wider import and significance, underlie the objectives and priority recommendations for conservation action and future research, which may be summarized as follows:

Objectives

1. Maintain core wild populations of not less than 2,000 animals of each taxon in individual reserves with at least two reserves per species or subspecies.

2. Promote actions intended to increase the size of peccary populations in key areas and the number and size of protected areas in which they occur.

3. Respond to specific threats to viable populations of taxa at risk.

4. Permit a managed harvest of healthy peccary populations on a sustained yield basis by subsistence hunters outside reserves as a means of encouraging rational use of wildlife and to provide local people with an incentive to preserve habitat.

5. Encourage the implementation of sustainable development programmes, which maintain peccary habitat.

6. Promote the enhanced future monitoring and regulation of the peccary hide and meat markets and international trade in peccary hides.

7. Increase and promote public awareness of the need for peccary conservation in particular and nature conservation in general.

Conservation Action Priorities

A. Conserve Taxa at Risk

Highest priority must be given to developing conservation strategies for protecting those species and subspecies included in status categories 4 ('vulnerable') and 5 ('endangered'), or whose status is unknown ('indeterminate') but which have a restricted distribution. A taxonomic revision of *Tayassu pecari* (see below) may result in changes, but the following taxa are currently considered threatened: *Catagonus wagneri* - status category 5; *Tayassu pecari ringens* - status categories 2 to 5, depending on population; *T. p. spiradens* - status categories 4, 5 or indeterminate, depending on population/country; and *T. p. equatorius* - indeterminate, with very restricted distribution.

Actions needed to develop conservation strategies for taxa most at risk are:

1. Implement the recently agreed conservation action plan for *C. wagneri* in Paraguay and develop and implement similar action plans for this species in Argentina and Bolivia (for details, see Taber, 1993 [also on this website]).

2. Continue existing ecological field studies of *T. p. ringens* in southern Mexico, and conduct status and distribution surveys on this subspecies in Guatamala, Belize and Honduras, with a view to the development of management plans in these countries.

3. Conduct status surveys and ecological field studies to develop a conservation action plan for *T. p. spiradens* in southern Central America (i.e. Nicaragua, Costa Rica and Panama).

4. Conduct status surveys for *T. p. equatorius* in south-west Colombia and north-west Ecuador and, if necessary, develop a conservation action plans in these areas.

5. In those countries and regions mentioned above, where status surveys reveal that important populations of threatened taxa survive, the following actions are recommended:

   - Conduct field studies to determine factors negatively influencing these taxa/populations.

   - Work with relevant governmental authorities to establish and enforce regulations against hunting.

   - Assess the adequacy (size, habitat, and effectiveness of management) of existing parks with a view to the resolution of management problems and the enhanced future conservation of those populations.

   - Develop management plans to conserve peccary populations inside and outside existing reserves.

- Promote the establishment of new parks and reserves wherever necessary to ensure the protection of more than one population of each threatened taxon.

- Develop protected area systems on private land to conserve populations outside national parks and reserves (with particular priority to Paraguay, the main stronghold of *C. wagneri*).

- Promote the development and coordination of properly structured captive breeding programmes for these taxa.

- Assess the desirability and feasibility of translocating animals from threatened areas into reserves (e.g. in Paraguay, *C. wagneri* from the Boquerón to Teniente Enciso National Park) and develop programmes where necessary.

B. Encourage the Rational Management of Healthy Peccary Populations.

Peccaries are an important source of protein for subsistence hunters throughout their range, and models for the successful management of *T. tajacu* have already been developed in the United Sates of America and Peru. Where peccary populations are healthy, and their meat forms an important part of the diet of subsistence hunters, a managed harvest of those populations may be preferable to outlawing hunting, especially as the latter has proved ineffective in countries where such a policy has been implemented (e.g. Paraguay, Brazil). The opportunity to harvest non-threatened peccary populations on a sustainable basis may also provide an incentive for local people to preserve habitat. As a renewable resource, peccaries could form an integral part of sustainable development programmes.

By comparison, the commercial hunting of peccaries for meat and/or hides should be prohibited as effective means of control do not yet exist. However, the taking of hides as a by-product of subsistence hunting has proved to be sustainable in Peru and should be permitted in this and other countries under careful management and certain conditions. Sports hunting, using a seasonal and permit system, should also be permitted in areas where (i) recreational hunting interests are high, (ii) subsistence hunting is limited, (iii) the means exist to monitor and control a harvest, and (iv) it can result in other benefits such as habit preservation.

With these provisos, the actions needed to develop the management of (non-threatened) peccary populations - based on the recommendations detailed by Bodmer *et al*. (1993) - include:

1. Conduct surveys to establish status and size of peccary populations.

2. Conduct surveys of local human hunting patterns.

3. Monitor changes in the age structure, density and hunting pressure on peccary populations and set quotas where and when necessary.

4. Divide areas into management units and implement a rotational hunting system in which some populations are allowed to rest periodically.

5. Determine whether management of the hunt on a population is best done at the level of the animal, hunter, meat market, or pelt market (under CITES control).

However, since it would be impossible to implement such programmes on a continent-wide basis, particular emphasis should be put on the establishment and perpetuation of pilot studies in Peru, Brazil, Argentina and Paraguay, where peccary research projects are already underway.

C. Regulate the Peccary Hide Trade.

At present, available figures for peccary hide exports from some countries are unreliable since unmonitored, illegal trade occurs between neighboring countries and the origin of many legally exported hides is not known (e.g. it is certain that hides exported from Argentina include some from Paraguay and Bolivia). With the large volume of trade in peccary skins it is important to obtain more accurate date on the scale of harvest and to determine long-term trends throughout the neotropics.

Actions required to improve monitoring and facilitate the enhanced future regulation of the hide trade include:

1. Maintain inclusion of *C. wagneri* on Appendix I and both *Tayassu* species on Appendix II of C.I.T.E.S.

2. Initiate or improve monitoring of the peccary hide market at the local, national and regional (international) level, as well as intercontinental level; in each case by determination of the origin, quantity, price and destination of the hides.

3. Determine the size of the harvest and export figures for producing countries on an annual basis as well as the number of skins imported by individual countries.

4. Produce and distribute a peccary hide/leather identification key.

5. Work with CITES and other relevant (governmental and non-governmental) organizations to stop any trade in the hides of threatened taxa.

D. Development of Education and Training Programmes

The need for conservation-education programmes, especially in rural areas, and the training of local wildlife managers and biologists must merit high priority if conservation

management objectives and effective wildlife services are to be achieved and maintained over the long term. Particular priorities include:

1. Production of posters, education briefs, pamphlets and other materials featuring these animals and/or topics relevant to their conservation for distribution in areas of importance to peccary conservation

2. Development and implementation of conservation education programmes in rural areas in order to inform local people about peccaries and other wildlife species, legislation relating to these animals, and the importance and benefits of conserving them and their habitats.

3. The lack of trained personnel in many countries/regions should be addressed by the organization of conservation biology workshops to provide biologists, rangers and wildlife administrators with the opportunity to obtain field experience in the study and monitoring of wildlife populations and exchange ideas and expertise. The provision of grants for biology students from each country to obtain advanced degrees in wildlife management and related fields should be encouraged.

E. Coordinate Peccary Conservation and Management Programmes

Although a great deal more research is needed on many aspects of peccary biology and management, there is also a need to capitalize on the findings and conclusions of the few pioneering studies of these animals that have been conducted, or are currently in progress, in Bolivia, Brazil, Mexico, Paraguay, Peru, the U.S.A. and in Venezuela. Much of this information is currently inaccessible or effectively unavailable to wildlife administrators and other relevant people/agencies in many of the countries of origin of these animals. The dissemination of relevant information and coordination of future management and research efforts are therefore accorded a high priority. The following projects are identified as appropriate means of facilitating this endeavor:

1. Compile a database on the status, distribution and biology of the various taxa, and people and agencies working in the field of peccary conservation, management and research.

2. Organize an international workshop on peccaries for scientists working on peccary ecology and conservation, as well as for wildlife managers from all neotropical countries. The meeting will provide an opportunity for researchers to compare notes and develop research programmes, enable the development of regional/international conservation management initiatives, and facilitate the organization of smaller, regional workshops for wildlife managers to be trained in field study and population monitoring techniques.

3. Prepare a handbook on peccary management in Spanish and Portuguese on how to census populations, how to monitor peccary harvests, and how to control hunting.

This should be written in a simple form accessible to poorly trained wildlife managers who will carry out much of the work.

Future Research Priorities

Many questions remain unanswered about the biology and conservation of peccaries, and more information is needed on a wide variety of interrelated topics if future management and conservation efforts are to be implemented effectively. To this end it is imperative that ongoing ecological research projects in Bolivia, Brazil, Mexico, Paraguay and elsewhere are continued and that efforts are also made to address the following priority research topics:

1. Revise subspecific taxonomy of both white-lipped and collared peccaries.

This is essential if threatened forms are to be recognized and appropriate conservation measures taken. Certain problems with the existing scientific nomenclature at generic, specific and subspecific levels should also be resolved; if necessary by submission to the International Commission on Zoological Nomenclature.

2. Conduct a neotropic wide questionnaire survey of the status and distribution of the three peccary species.

These questionnaires should be sent to as many scientists, wildlife managers, government officials, conservationists and other knowledgeable people as possible, in order to develop a database of people working on peccaries and to compile unpublished information on the status and distribution of various taxa.

3. Determine habitat requirements, ranging behaviour, and dispersal patterns of all three peccary species as a means of assessing the adequacy of existing reserves for maintaining peccary populations, particularly in those areas where sympatry occurs.

4. Study population dynamics, habitat use patterns, foraging habits, spatial organization, social organization, predator/prey relations and other aspects of peccary ecology, as a means of improving their management.

5. Assess the importance of peccaries as seed predators and dispersers and their potential role as ecological keystone species in the neotropics.

6. Determine how to obtain estimates or indices of peccary population levels in different habitats. Assess the adequacy of various methodologies in different habitats in areas where good independent estimates of population sizes exist.

7. Determine how to age classify the different species of peccaries in different habitats based on teeth wear or other methods. Develop standard measures for all species in tropical forest, savannah, desert, and chaco.

8. Study the reproductive biology and genetics of all peccary taxa to provide data for peccary management and for developing strategies for conserving minimum viable populations.

Determine the susceptibility of peccaries to various livestock born diseases.

<div align="center">Chapter 3</div>

The Afro-tropical Hippopotamuses - Hippopotamidae
Hippopotamus and *Hexaprotodon*

3.1 Taxonomy and Description

Peter Grubb

Introduction

The hippos, Family Hippopotamidae, are separated from all other suiformes in the Superfamily Anthracotheroidea. All Holocene or Recent hippos belong to two genera, *Hexaprotodon* (= *Choeropsis*) and *Hippopotamus*. Only one species of each of these are usually recognized, but three more species became extinct within the Holocene on Madagascar (Stuenes, 1989; Faure & Guerin, 1990). The two living and three recently extinct forms may be described as follows:

The Pygmy Hippopotamus
(*Hexaprotodon liberiensis*)

The West African pygmy hippo has usually been referred to the genus *Choeropsis* but Coryndon (1977) has shown that it is essentially one of the hexaprotodonts - more generalized hippos, previously thought to be completely extinct. In spite of differences between this animal and the hexaprotodonts in the number of teeth, Coryndon believed they should no longer be placed in separate genera.

Although it is much smaller than the common hippo, the pygmy species has relatively longer limbs. It also has a proportionally smaller, narrower head with the orbits not raised above the skull roof. There are 38 teeth, as against 42-44 in the larger species, owing to differences in the numbers of incisors. Dorst & Dandelot (1970) give the weight as 270 kg and the shoulder height as 80cm.

There are two subspecies. The nominate race, *H. l. liberiensis* occurs in Guinea, Sierra Leone, Liberia and Ivory Coast. In the Ivory Coast it has been recorded as far east as between the Sasandra and Bandama Rivers (Dekeyser, 1954) but recently Bosman & Hall-Martin (1989) reported it from the Azagny National Park in the southeast corner of

the country. Whether it naturally occurs there or has been introduced is not clear. The second subspecies, *H. l. heslopi*, is known only from the Niger Delta east to the vicinity of the Cross River in Nigeria (Corbet, 1969). It differs from the nominate subspecies in skull proportions. It may be extinct, but Oates (in litt.) reports that residents in the Niger Delta still know of the species, and possibly it still survives.

The Common Hippopotamus (*Hippopotamus amphibius*)

The characteristic features of this species are well known: its great bulk and short limbs; its huge head with nostrils, eyes and ears placed on top; and its broad snout and enormous gape. Weight is 1,100-2,600 kg, shoulder height 140-160 cm (Dorst & Dandelot, 1970).

No serious attempt has been made in recent years to assess geographic variation in the species. The supposed subspecies have been listed below (from Lydekker, 1915) but unless more specimens are examined and from a wider area, it is impossible to say whether diagnostic skull characters are any more than peculiarities of particular specimens.

1. *H. a. amphibius*: skull with moderate preorbital constriction, convex upper surface, long mandibular symphysis and relatively large cheek teeth. Said to occur in Egypt (where it is now extinct) south to Sudan, northern Zaire and Ethiopia, and west to Gambia; also Tanzania and Mozambique. Populations in the Nile Delta and on the lower Nile were geographically isolated from other hippos (Kock, 1970) and may have represented distinguishable subspecies. If this is the case, the Delta population should bear the subspecific name *amphibius* and the naming of other populations will have to be re-appraised.

2. *H. a. tschadensis*: similar to nominate race but with orbits more prominent. Distinguished *from H. a. capensis* by much shorter and wider facial region and more forward direction of orbits. Range: Chad and Nigeria. Synonymised with *H. a. amphibius* by Haltenorth (1963).

3. *H. a. kiboko*: skull with very broad nasals, relatively small rostral constriction, and great elevation of orbits and occipital crest above deeply hollowed interorbital region. Orbits more nearly circular than in *H. a. capensis* and more prominent than in *H. a. constrictus* - which also differs by greater rostral constriction and shorter mandibular symphysis (see below). Also said to differ in color and hairiness of ears and tail! Range: Kenya and Somalia.

4. *H. a. constrictus*: skull lighter than in typical race with preorbital constriction deeper, upper surface more flattened, muzzle less expanded, mandibular symphysis shorter and cheek teeth smaller. Range: Angola, southern Zaire and Namibia. Synonymised with *H. a. capensis* by Ellerman *et al.* (1953).

5. *H. a. capensis* (syn. *australis*): skull still more flattened than in *H. a. tschadensis*, so that width of orbit is greater than height. Range: Zambia south to South Africa.

Extinct Malagasy Hippopotamuses

Stuenes (1989) showed that two kinds of dwarf hippopotamuses (*Hippopotamus lemerlei* and *H. madagascariensis*) survived late into the Quaternary on Madagascar, and Faure & Guerin (1990) have described another and larger species, *H. laloumena*. *H. lemerlei* occurred on the island at least until 980 + 200 yrs. B. P., but neither the *H. madagascariensis* or *H. laloumena* material has been dated, though both are believed to be Holocene in age. The latter species is known only from a lower jaw and limb bones obtained near Mananjary on the east coast. It was largest of the three species but was not as big as H. amphibius, which it otherwise appears to have resembled closely. *H. lemerlei* was somewhat larger than *H. madagascariensis* and differed from it in that the skulls of adults were markedly (presumably sexually) dimorphic in size. These two smaller hippos also appear to have differed in their ecology. Like *H. laloumena*, *H. lemerlei* (Plate ///) resembled a small *H. amphibius* and probably had similar habits. Its remains have been found mostly in the coastal lowlands. *H. madagascariensis* was a more terrestrial species, subfossils of which have been located in the central highlands. Recently, Harris (1991) has reassessed the systematics of the two smaller hippos and concluded that the more terrestrial species, *madagascariensis*, should be placed in the genus *Hexaprotodon*. Inferences to be drawn are firstly that each of the surviving species of hippos had close relatives on Madagascar, and secondly that Madagascar had been colonized three times by hippopotamuses! Early human colonization of Madagascar, which occurred c. 1,500 yrs BP, is implicated in their extinction, though climatic change may also have been a factor.

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Chapter 3.2

The Common Hippopotamus, *Hippopotamus amphibius.*

S. Keith Eltringham

Status and Action Plan Summary

Status category: 2 (widespread and relatively secure); though it is possible that future review of the subspecific taxonomy of this species will result in particular subspecies being accorded more threatened status categories.

The common hippopotamus spends the day in water but emerges at night in order to graze on land, often several kilometers from water. It still occurs widely throughout sub-Saharan Africa although its distribution is far from even. Information collected from questionnaires from 34 countries suggests that the total population in the whole of Africa is of the order of 157,000 animals. Few respondents gave actual numbers and the size of populations has largely been estimated by extrapolation from partial counts or based on qualitative observations. The species is not common in West Africa and the population is split into a number of small groups totalling about 7,000 spread over 19 countries. East Africa holds substantial numbers with 30,000 in eastern Democratic Republic of Congo and populations numbering tens of thousands in Ethiopia, Sudan and Tanzania. Several thousand also occur in Kenya and Uganda bringing the total for East Africa as a whole to about 70,000. Southern Africa also has flourishing populations, with Zambia containing the biggest population, 40,000, of any country in Africa. Others with large numbers

include Mozambique (16,000-20,500), Malawi (10,000), Zimbabwe (6,900) and South Africa (5,000). The total in the whole of the region may be around 80,000. Numbers are decreasing in 18 of the countries investigated and are stable in only six. Populations most at risk are those in West Africa, where the distribution is particularly fragmented.

The principal threat to survival is the loss of grazing lands to cultivation. There is little evidence as yet that the canine teeth are being used in trade as substitutes for elephant ivory, but if such a trade were to develop, the species would be at serious risk. Consequently, an investigation into the trade in hippopotamus teeth should be given high priority. Other sociological research projects recommended include the extent of the interaction between hippopotamus and agriculture and the possibility of exploiting the hippopotamus on a sustainable yield basis. Recommended biological research projects are mainly concerned with the population sizes of the hippopotamus in countries, which were not covered, or only partially covered, during the present survey. The identification of populations at particular risk or which are of special significance in conservation terms is another priority. Attention should also be paid to countries with large numbers of hippopotamus in order to ascertain population sizes more precisely and to ensure that populations are maintained at their optimal densities. Methods of improving census techniques should be investigated.

Introduction

The common hippopotamus still occurs widely throughout its range of sub-Saharan Africa, although its distribution is far from even. It is considered to be relatively secure within its range and, from information from a questionnaire survey, a conservative estimate of the whole population in Africa is in the order of 157,000 animals. Although the survey results confirmed the wide distribution of the species they also indicated that numbers have decreased in many areas.

There are said to be five subspecies but little recent research has been carried out and it is possible that this is no more than a classification of museum specimens (also see Grubb, 1993 [also this website]). Lydekker (1915) recognizes the following subspecies:

H. a. amphibius - East Africa and west to the Gambia.
H. a. tschadensis - Chad and Nigeria.
H. a. kiboko - Kenya and Somalia.
H. a. constrictis - Angola and Namibia.
H. a. capensis - Zambia and south to South Africa.

Even if valid, these subspecies cannot be distinguished in the field and none of the correspondents used subspecific names. The alleged ranges are also indistinct. Consequently, the hippo populations in this account are treated on a geographical rather than a taxonomic basis. However, it is quite possible that future reviews of the species' taxonomy will reveal regional genetic characteristics that merit subspecific attribution and that one or more subspecies/geographically distinct populations should be accorded a more threatened status category (see later text).

Former and Present Distribution

In order to obtain information about the current status of the common hippopotamus, correspondents in countries where the species was known or thought to occur were approached in 1989 and asked to complete a questionnaire, which was the same as that used by the Pigs and Peccaries Specialist Group. If information was not available from residents, it was obtained from persons with recent experience of the countries concerned. Replies were received from 55 correspondents covering 34 countries. The only country believed to contain sizeable numbers of hippopotamus but which was not included in the survey was Angola. The distributions and estimated numbers are based on the replies received and there may well be groups, which have not been recorded. The totals given, therefore, are conservative.

The common hippopotamus was previously found throughout Africa south of the Sahara in all suitable habitats. The species still occupied much of its former range in 1959 (Fig. 5), although it had disappeared from most of South Africa except for the Kruger National Park (Sidney, 1965). The results of the recent survey of the species for this account revealed that although the hippopotamus remains widely distributed, its numbers appear to have decreased in many areas. It is still abundant in East Africa where the majority of the population occurs. Because of the uneven distribution, this account will deal with each region in turn, beginning with the distribution and, where possible, the numerical status of the species.

Link to Fig. 5: Approximate current and former (c. 1959) distribution of the common hippopotamus (*Hippopotamus amphibius*).

Western Africa

Hippopotamus are absent from the rain forests except near large rivers. They are most abundant in estuarine habitats and on the lower reaches of rivers. Some are found in the sea in the Archipelago of Bijagos off Guinea Bissau. Few correspondents were prepared to assess the population size of hippopotamus and it is difficult to interpret their estimates in terms of varying levels of abundance, but it seems that the species is at least locally abundant in several of the countries.

Those in the west - Guinea, Guinea Bissau and Senegal - probably contain the bulk of the west African hippopotamus with total numbers likely to be in the region of a few thousand. Although small in area, Guinea Bissau supports a substantial population, which is particularly abundant on the islands of the Bijagos Archipelago and along the numerous inland rivers. The species is common on most of the rivers in Guinea and in the east and south of Senegal with an estimated country-wide population of between 500 and 700. The Gambia contains no more than about 40 animals. There are probably less than 200 in Sierra Leone or Mali and none at all in Liberia or Mauritania.

The group of contiguous countries, Ivory Coast, Ghana, Togo, Benin and Burkina Faso, contain a total of, at most, two thousand hippopotamus with the majority in Burkina Faso. There have been no recent counts except on the Comoe River on the border with the Ivory Coast, where 720 were recorded in 1989. A further group is found on the Pendjari River system bordering Benin. This numbered about 500 in 1979 but only some 280 remained in 1987. The Mono River between Benin and Togo supported a small but stable population of 53 in 1986. Only remnant populations remain in Ghana.

Nigeria and Niger between them contain at least 400. No recent information was obtained for Chad but according to Sidney (1965) the species was common in the vicinity of Lake Chad during the 1950s. Hippopotamus were also once numerous in Cameroon but the only information obtained during the present survey was from the Korup National Park, where signs of the species are common around the confluence of the Miri and Bake Rivers although sightings are few. It is likely that the species does not occur in the Bake River much further upstream than Bajo although some traces were found as far up as Bakut. At least 150 hippopotamus (possibly as many as 1,500) are known to exist in the Central African Republic in addition to an unknown number in Bamimgui-Bangoran National Park, where 136 were counted in 1973 although now there are probably only 20 to 30 present. Hippopotamus occur along most of the coastline of Gabon and for a considerable distance up the Ogooue River and although there are no recent estimates of numbers, they are said to be abundant in places. A few are found in neighboring Equatorial Guinea on the Campo River. No counts have been made in the Congo but the species is reported by one correspondent to be widely distributed and numerous on suitable rivers but another reports its presence on only one, the Niangua River. The entry for the Congo in the IUCN Directory (IUCN/UNEP, 1987) lists Odzala National Park, Lefini Reserve (Louna and Lesio Rivers), and Nyanga North Reserve as containing hippopotamus. Democratic Republic of Congo will be considered with East Africa as most of the hippopotamus are in the east of the country.

The total number of hippopotamus in the nineteen west African countries considered here cannot be assessed with any accuracy because of the absence of recent counts but the figure is likely to be in the region of 7,000.

Eastern Africa

Many of the hippopotamus in Africa are found in the east, especially in Ethiopia, Kenya, Sudan, Tanzania, Uganda and Democratic Republic of Congo. The hippopotamus occurs in the southern Sudan on the Rivers Nile, Sobat and Jur south of Malakal and in several national parks and reserves. Other localities include the Sudd and tributaries of the Nile. There is no information on population sizes but it is said to occur in good numbers in most places. The species is also abundant between altitudes of 200 and 2,000 m in neighboring Ethiopia, where its main strongholds appear to be the Omo, Awash and Great Abbi (Blue Nile) Rivers. It also occurs in most of the larger lakes and as isolated populations in smaller swamps and pools. The few that occur in the dry south-east are confined to the Webi, Shebeli and Ganale Rivers. The northern limit of the species is the Setit River. No precise counts have been made recently but the hippopotamus is said to

be numerous throughout its range. The total for the two countries combined is probably to be numbered in tens of thousands. Very few hippopotamus remain in neighboring Somalia although some small groups have been reported on the lower Scebeli River and along the Juba River, where they are rather more numerous. No hippopotamus have been reported from Djibouti.

The species occurs in most of the many suitable habitats throughout Kenya and some recent counts have been made in the Mara River area (2,132 in 1980), Lake Naivasha (220 in 1988) and along part of the Tana River between Osako and Adamson's Falls (220 in 1983) (Coe & Collins, 1986; Karstad et al, 1980; Smart, in litt.). The Mara figure includes some from over the border in Tanzania. Elsewhere in Tanzania hippopotamus are common in the Selous Game Reserve, where 1,894 were counted on 115 km of the River Rufigi in 1987 (Samuels, in litt.). An estimate for the total population of the Selous in 1986 was 16,900 (with a standard error 6,307) from an aerial sample count made by I. Douglas-Hamilton. Independent aerial counts in the Selous reported by Games (1990) returned figure of 15,483 in 1986, 24,169 in 1989 and 20,589 in 1990. The last total is a rather crude extrapolation from an observed figure of 6,866. A large population occurs on the Akagera River and associated lakes on the border between Tanzania and Rwanda but no recent count has been made. The total counted from the air in 1969 was 671 (Spinage *et al*., 1972). Hippopotamus are found in most other national parks and reserves of Tanzania and although not present anywhere in large numbers, the total probably amounts to several thousand more.

The principal concentrations of the species in Uganda are in the two large national parks, Murchison Falls and Queen Elizabeth. At one time the population in the latter park reached 21,000 but this was reduced to about 14,000 in the culling program of the 1950s. Counts in the early 1970s returned about 11,000 but heavy poaching during the Amin years had left only a couple of thousand by 1989 when 2,172 were estimated from an aerial sample count. Similar numbers were found in the Murchison Falls National Park in the past but there, too, heavy poaching has reduced the population to remnant numbers although a recent count has not been made. The latest appears to have been in 1980 when 1,202 were recorded on the Nile between the falls and Paraa Lodge. The total for the whole park is probably about the same as in Queen Elizabeth National Park i.e. a few thousand. Other regions in Uganda where substantial numbers of hippopotamus occurred include the Semliki River and lakes Victoria and Kyoga. An educated guess of about 7,000 for the present total population of hippopotamus in the whole country is probably not far wrong.

Hippopotamus have a wide distribution in the Democratic Republic of Congo including some in the north-west of the country although the bulk is in the east, where they occur around Epulu and Wamba and along some of the larger rivers in the Ituri Forest. Other populations occur on the Zaire River (Yangabi), Bomu River and elsewhere in several national parks including Garamba, Kundelungu, Salonga, Upemba and Virunga. The latter contains the greatest concentration with a total of 22,875 estimated from a 1988 aerial count made by C. Mackie, who with K. Hillman Smith also recorded 2,851 in Garamba National Park in 1988. In round figures, these counts suggest a total of some 26,000 hippopotamus for the two parks. Numbers elsewhere in the Democratic Republic

of Congo probably do not amount to more than a few thousand, perhaps bringing the country-wide total up to about 30,000.

There are not many hippopotamus in the remaining East African countries of Rwanda and Burundi. Numbers on the Akagera River have been mentioned above in the section on Tanzania and there are probably still a few in wallows within the Akagera National Park or Mutara Game Reserve but no recent information has been received. Hippopotamus occur in Burundi on the Malagarazi, Ruvubu and Rusizi Rivers but there are conflicting reports over numbers. P. Chardonnet reports good populations numbered in hundreds and P. C. Trenchard puts the total on these rivers as over 1,000 as a conservative estimate. K. M. Doyle, however, casts doubt on these figures, for along a 120 km stretch of the Ruvubu River where several hundred were reported by P. Chardonnet, he recorded only 39 hippopotamus, all but two within the Ruvubu National Park, although there may have been more in wallows etc. away from the river, which were not surveyed.

Although there are many gaps in the data, the above analysis suggests that there could be as many as 70,000 hippopotamus in the east African countries.

Southern Africa

No information has been received from Angola. According to Sidney (1965), the hippopotamus was widespread throughout Angola particularly in the east on the Cunene, Cubango, Cuando, Cuanza, Longa and Zambezi Rivers.

There are probably more hippopotamus in Zambia than in any other single country. F. E. C. Munyenyembe puts the country-wide total at 40,000 with 20-25,000 in the Luangwa Valley according to R. H. V. Bell. They are reported to be widespread on the Kafue Flats and in Lochinvar National Park. Neighbouring Malawi, although small, is also densely populated with hippopotamus, which occur on all rivers and lakes of sufficient size. The main concentrations are at Elephant Marsh (lower Shire River), the south-west arm of Lake Malawi, Upper Shire River and Lake Malombe in Liwonde National Park. R. H. V. Bell makes a guess that there are some 10,000 hippopotamus in the whole of Malawi. Further south in Zimbabwe, the species is still common. It is found on most of the large rivers particularly the Limpopo. Zambezi and the Sabi/Lundi systems. It is also found in smaller rivers and dams where there is permanent water. Some wander over long distances to provide isolated records. The only estimate for the country-wide total is that made by R. B. Martin on the basis of some limited counts, which have revealed some dense populations e.g. 2,000 on a 50 km section of the Zambezi. His estimate is 6,900, of which 5,530 occur in national parks or reserves, 1,020 on communal lands and 350 elsewhere.

A surprising number of hippopotamus appear to have survived in Mozambique, at least up to 1986, despite the recent civil strife. The species is still widely distributed throughout the country and is present on most river systems. Several national parks and reserves contain hippopotamus although only Gorongosa, with about 2,000, has a

sizeable population. L. Tello's estimate made in 1986 year puts the total at between 16,000 and 20,500 for the country as a whole with most (10,000 -12,000) in the Zambezi Wildlife Utilization Area, which includes Marromeu Reserve and four safari hunting blocks. It is also contiguous with the Gorongosa National Park. This is the only region where numbers have increased (by some 20% since 1974). Elsewhere there has been a decline, except in Tete Province, whose population of between 1,500 and 2,500 is said to be stable.

Namibia is too dry to support many hippopotamus except in the north, where the species is present in some numbers on the Cuando and Zambezi Rivers in the Caprivi Strip. Elsewhere it occurs along the boundary with Angola on the Okavango River. Botswana is also too dry for hippopotamus except in the north of the country, where some occur in the Okavango Delta and in the Chobe/Linyati River system. A few (18+) exist on the Limpopo in the east. Outside this area, a small population may still exist near Ghanzi although some observers think this is unlikely. C. A. Spinage puts the total in northern Botswana at 1,600 in the wet season and 500 in the dry.

Hippopotamus are confined to the north-east of the country in the Republic of South Africa, mainly in the Transvaal and the northern tip of Natal. Most of them are in the Kruger National Park in perennial rivers, dams and the larger pools of seasonal rivers. The total counted in the park in 1989 was 2,761 with 2,575 in rivers and 191 in dams and pools. R. H. Taylor gives a total (for 1986) of 1,264 for Natal and Kwazulu, with the largest concentration (595) on Lake St Lucia, but he suggests a better estimate of 1,423 averaged over the five years 1982-1986. Those in Natal outside the Kruger National Park are mainly confined to the large rivers in the eastern and northern regions of the province. These figures suggest that there are approaching 5,000 hippopotamus in the country as a whole.

It is not possible to provide a total for the whole of southern Africa because of the lack of data from Angola, which used to support large populations and may do so still, although the disturbed political situation in the country makes it more likely that most hippopotamus have been shot. Assuming the worst and that only a few hundred remain in Angola, a very rough estimate for the regional total would be 80,000.

Summary

A tentative total has been given for the number of hippopotamus in each of the three regions of Africa. These estimates included a high proportion of guesswork in each case and consequently, any figure for the total number of the species in the continent must be regarded with skepticism. Nevertheless, even a rough estimate is of interest and if the sectional totals are summed, the result is 157,000 hippopotamus in the whole of Africa. Although this is unlikely to be an accurate figure, it does suggest that the species is still abundant in many parts of Africa and the next step is to assess its conservation status in terms of population trends and legal status. This follows in Table 4, in which the situation in each country is briefly summarized.

TABLE 4. Population trends, legal status and occurrence of the common hippopotamus, *Hippopotamus amphibius*, in protected areas, based on returns from the 1989/90 African Suiform Questionnaire Survey.

Country	Popn Status	Popn Trend	Concern?	Legal Protection	Enforcement?	Protected Areas
Angola	No recent information					
Benin	RD-LA	D	N	U	P	Pendjari N.P.; "W" N.P. Pendjari H.Z.; Djona H.R; Wari Maro F.R; Mt. Koufee F.R
Botswana	RD-LD	D	N	G	F	Chobe N.P.; Makgadikgadi Pan G.R.; Moremi G.R.
Burkina Faso	RD-LD	D	Y	H	P	"W" N.P.; Arly F.R.; Deux Bales F.R.
Burundi	RD-LA	U	N	G	G	Ruvubu N.P.; Rusizi N.R.; Rwihinda N.R. Kigwena Forest N.R.; Lake
Cameroon	W -LD	U	Y	G	F	Benoue N.P.; Bouba Ndjida N.P; Faro NP; Kalamaloue N.P.; Korup N.P.; Pangar-Djerem H.R.
Central African Republic	RD-LA	D	Y	G	P	Andre Felix N.P.; Bamingui-Bangoran N.P; Manovo-Gounda-Saint Floris N.P; GribinguimF.R.; Koukourou F.R.; Yata- Ngaya F.R;
Chad	No recent information					
Congo	W-LA	I	N	G	U	Odzala N.P.; Nyanga Nord F.R. Lefini F.R; Tsoulou F.R.
Equatorial Guinea	RD-LD	U	N	G	P	None
Ethiopia	W-LA	S	N	G	F	No information
Gabon	W-LD	D?	N	G	P	Wonga-Wongue N.P; Lope F.R.; Moukalaba F.R.; Sette-Cama F.R.
The Gambia	RD-LD	D?	Y	G	F	Gambia River N.P
Ghana	RD-LD	D?	Y	G	G	Bui N.P.; Digya N.P.; Mole N.P.
Guinea	W-LA	D	Y	G	G	Badiar N.P.; Ziama B.R.
Guinea Bissau	RD-LA	D?	Y	G	U	None
Ivory Coast	RD-LD	D	Y	H	P	No information
Kenya	W-LA	S	N	G	G	Amboseli N.P.; Lake Nakuru N.P. Meru N.P.; Nairobi N.P.; Tsavo N.P.; Buffalo Springs N.R.; Kora N.R.; Lake Bogoria N.R; Masai Mara N.R. Mwea N.R; North Kitui N.R; Samburu N.R.
Liberia	Probably extinct					
Malawi	W-LD	S	N	H	G	Kasungu N.P.; Lake Malawi N.P.; Liwonde N.P.; Vwaza Marsh G.R.; Nkhotakota G.R.; Mwabvi G.R.
Mali	RD-LD	U	Y	U	U	Boucle du Baoule N.P.
Mauritania	Probably extinct					
Mozambique	W-LA	D	Y	H	U	Gorongosa N.P.; Gile G.R.; Maputo G.R.; Marromeu G.R.; Niassa G.R.
Namibia	RD-LA	U	Y	G	G	Mudumo N.P. (?); Nkasa N.P.; Western Caprivi G.R.
Niger	RD-LA	D	Y	G	F	"W" N.P.

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Nigeria	RD-LD	D	Y	H	F	Kainji Lake N.P.; Kwiambana G.R.; Sambisa G.R.; Yankari G.R.
Rwanda	No recent information					
Senegal	RD-LA	D	Y	G	P	Niokolo-Koba N.P
Sierra Leone	RD-LD	D	Y	G	P	Outamba-Kilimi N.P.; Tiwai G.S
Somalia	RD-LD	D	Y	U	P	None
South Africa	RD-LA	S	N	G	E	Kruger N.P.
Sudan	RD-LA	U	N	G	F	Boma N.P.; Southern N.P.; Nimule N.P.; Badingeru G.R.; Fanyikango G.R.; Juba G.R.; Mongala G.R.; Shambe G.R.; Zeraf G.R.
Swaziland	RD-LD	U	Y	U	U	Mlilwane G.S.
Tanzania	W-LA	S	N	G	F	Arusha N.P.; Lake Manyara N.P.; Mikumi N.P.; Ruaha N.P.; Rubondo N.P.; Serengeti N.P.; Taragire N.P.; Burigi G.R; Biharamulo G.R; Maswa G.R; Selous G.R. Moyowozi G.R.; Ngorongoro C.A.
Togo	RD-LD	U(S)	N	G	G	Keran N.P.; Togodo G.R.
Uganda	WLA	D	Y	G	P	Lake Mburu N.P.; Murchison Falls N.P.; Queen Elizabeth N.P.; Kyambura G.R.
Zaire (Democratic Rep. of Congo)	RD-HD	D	N	H	F	Garamba N.P.; Kundelungu N.P.; Salonga N.P.; Upemba N.P.; Virunga N.P.
Zambia	W-LA	I	N	H	F	Blue Lagoon N.P.; Kasanka N.P.; Kafue N.P.; Lochinvar N.P; Lukusuzi N.P.; Lower Zambezi N.P.; Mosi-Oa-Tunya N.P; Mweru-Wantipa N.P.; North Luangwa N.P; Nsumbu N.P.; South Luangwa N.P.; West Lunga N.P.
Zimbabwe	RD-LA	S	N	H	E	Gonarexhou N.P.; Hwange N.P. Mana Pools N.P.; Matusadona N.P.; Victoria Falls N.P.; Zambezi N.P.

KEY. Population Status: W = widespread; RD = restricted distribution; LD = low density; HD = high density; LA = locally abundant. Population Trend: U = unknown; S = stable; D = decreasing; I = increasing. Concern? (over population status): Y = yes; N = no. Legal Status: U = unknown; G = Total protection; H = partial protection. Enforcement: P = poor; F = fair; G = good; E = excellent; U = unknown. Protected Areas: B.R. = Biosphere Reserve; C.A. = Conservation Area; F.R. = Forest/Faunal Reserve; G.R = Game Reserve; G.S. = Game Sanctuary; H.R. = Hunting Reserve; H.Z. = Hunting Zone; N.P. = National Park.

Habitat, Ecology and Behaviour

As its name suggests, the hippopotamus is an amphibious creature, which spends the day in water and emerges at night to feed. The hippopotamus uses the water only as a retreat and it does not eat aquatic vegetation to any extent. Open water is not essential and the animal can survive in muddy wallows but it must have access to permanent water to which it can return in the dry season. The essential factor is that the skin must remain moist for it will crack if exposed to the air for long periods. The skin physiology is

complex and not fully understood but is clearly adapted for an amphibious existence. A curious feature is the red secretion from modified sweat glands, which is thought to have an antibiotic function.

The water body must be large enough to accommodate a number of animals for the hippopotamus is highly gregarious when resting by day. The social habits of the species have been studied by Klingel (1991), who found that the "schools" are unstable groups of females and bachelors. The social system is based on mating territoriality. Territorial males monopolies a length of the shoreline of the river or lake but tolerate bachelors within the territory provided they behave submissively. Non-breeding males also settle outside territorial areas, especially seasonal wallows. Fights for the possession of a territory can be fierce and the animals may inflict considerable damage on each other with their huge canines but minor conflicts are usually settled by threat displays, of which the "yawn" is the most conspicuous. Territorial males do not normally fight each other and severe fights usually occur only when a bachelor challenges a territorial male for control of its territory. There is little association between animals when they are feeding at night, except between females and their dependent young, and the males do not then behave in a territorial fashion.

The male hippopotamus, rarely the female, spreads its dung by wagging its tail vigorously while defecating, both in the water and on land, where it is thought to have a signalling rather than a territorial function. The dung piles may serve for orientation.

Vocalizations take the form of complex bellows and grunts, which presumably have a signalling function. Sounds may be made either on land or in the water and may be transmitted simultaneously through air and water. This is the only known case of amphibious calls in a mammal.

It is probable that the need to avoid the direct rays of the sun has determined the nocturnal feeding habits of the animal. It leaves its wallow soon after sunset and spends the night grazing on short grass swards for up to several kilometers from water. These swards, which are kept short by the activities of the hippopotamus, are known as hippo lawns. Although the hippopotamus grazes every night, except for mothers with very young calves, there are usually animals present in the water all night, as some return after a few hours and others leave later. The animal feeds by plucking the grass with its wide, muscular lips and passing it to the back of the mouth to be ground up by the molars. The front teeth (incisors and canines) play no part in feeding. The amount of food ingested is small relative to the size of the animal but its resting habits by day reduce its energetic demands. The stomach is a complex four-chambered structure with a ruminant type digestion although the animal does not chew the cud.

The ecological requirements for hippopotamus, therefore, include a supply of permanent water, large enough for the territorial males to spread out, and adequate grazing on open grassland within a few kilometers of the daytime resting sites.

Conservation Status

An examination of Table 1 shows that the hippopotamus is thought to be decreasing in 18 of the 34 countries considered although doubt is expressed over this point in four cases. The species is increasing in only two countries, Congo and Zambia. The former is probably unimportant to the conservation of the species but Zambia certainly is not. Populations are stable in another six countries with the trends unknown in a further eight. The number of countries is less important than their identities. Most of the declines are in west African countries with small populations but two East African countries, Uganda and the Democratic Republic of Congo, contain some of the largest populations. The decline does not appear to be serious or widespread in the Democratic Republic of Congo for not all correspondents reported one. The decline in Uganda occurred during the recent political troubles and now seems to have halted. Populations there are probably stable at present and may be expected to start increasing before long. Concern was expressed over the status of the species in just over half (18) of the 34 countries. In most states, the species is fully protected legally or can be exploited only under strict control. Whether or not the regulations are followed is another matter and in only two cases, South Africa and Zimbabwe, was enforcement of the law considered to be excellent. Enforcement was said to be good in seven other countries but for the rest, it was either fair (10) or poor (10); the latter including some cases in which it was non-existent. No information was available for five other countries.

The species appears to be most at risk in west Africa through low numbers in small, scattered populations, most of which are showing declines. It is also there that enforcement of legislation is least observed. Elsewhere, the species is holding its own despite some catastrophic declines in recent years. Countries with large populations include Ethiopia, Kenya, South Africa, Sudan, Tanzania, Uganda, Zambia and Zimbabwe.

The distribution of a species is as important as its numbers as far as its conservation is concerned and the risk to the many small populations in west Africa gives rise to concern. Only in a few regions in Africa are really large aggregations to be found and most of these are in the Great Rift Valley or its western branch. It is here that conservation efforts should be concentrated. The west African populations should not be neglected, however, in view of their importance to the genetic pool and the fact that there are subspecific differences. Two categories were used to describe the population status for each of the 34 countries so that a total of 68 assessments were made. In only eleven cases was the species considered to be widespread in a country and in only one (Democratic Republic of Congo) was it thought to be present at high density although it was classed as being locally abundant in 18 others. Most (23) of the assessments considered that the species was of restricted distribution and 15 that it was present at low densities. Too much significance should not be attached to these classifications as they depend on subjective judgments on the part of the respondents, who may well have had different interpretations of the categories used.

Given the estimated high numbers in several countries and the lack of evidence that numbers are declining seriously overall, there appears to be no justification for placing the hippopotamus on the list of threatened animals. Nevertheless, in parts of its range, identified above, the species has shown significant declines and could become locally endangered.

Threats to Survival

A number of factors threatening the survival of some populations became apparent from an analysis of the questionnaires although it is accepted that these may be biased by the attitudes and perceptions of the respondents. The most serious threat is likely to be loss of habitat. Except in times of serious drought, there is usually no shortage of water for daytime retreats but several reports have were received of loss of grazing habitat. Mention of this factor was made in accounts for Burundi, Guinea, Kenya, Mali, Nigeria and Democratic Republic of Congo. The reason for the loss in Mali is the general desertification of the country. The need for adequate space for grazing is not always appreciated because the animal is rarely seen on land by the average person and it is probable that the problem of reduction in grazing grounds exists in many more countries than those listed above.

The hippopotamus does not appear to suffer serious inroads from meat hunters although this factor was mentioned in the reports for the following sixteen countries: Benin, Burkina Faso, Central African Republic, Ethiopia, Gabon, Ghana, Guinea Bissau, Niger, Nigeria, Sierra Leone, Somalia, Sudan, Tanzania, Uganda, Democratic Republic of Congo and Zambia. The hippopotamus is hunted for use as fish bait upstream of Ifakara on the Rufuji River in Tanzania. The extent to which the animal is eaten in Ethiopia and Ghana is slight. Its taxonomic relationship to pigs seems to act in its favor in some countries with large Muslim communities, where the meat is not eaten for religious reasons. The meat is avoided in the Luangwa Valley in Zambia because it is believed to cause leprosy. This taboo may derive from experience with anthrax, which has caused widespread mortality in hippopotamus populations in the past.

Hunting for skins or for the trophy trade occurs but is probably not a serious threat. It is said to take place in Burundi, Central African Republic, Senegal, Sierra Leone, Somalia, the Democratic Republic of Congo, Zambia and Zimbabwe. The trade in Zimbabwe is legal and well controlled. The main trophy products are the tusks, which are used as ivory in carvings. According to a newspaper article (Barrett, 1991), there is a proposal in Tanzania to crop hippopotamus for ivory as well as for meat. Fears have been expressed that the trade in teeth may increase beyond control because of the restrictions on the trade in elephant ivory but so far this there is little evidence that it has.

Conflict between people and hippopotamus was reported from several countries. Crop damage was recorded in Botswana, The Gambia, Malawi, Niger, Sierra Leone and Somalia. Fishermen kill the animal in Gabon because of its attacks on them and it is likely that fishermen in other countries also treat the hippopotamus as a dangerous animal

and destroy it when possible. Such action is illegal but in some countries, particularly Malawi, the control is official and does not affect the species' survival. Expanding human populations pose a threat in some countries. Conflict with man is likely to escalate with the increase in human populations and some indications of this were apparent in the returns. Expansion of the human population was perceived as a threat in the Ivory Coast and disturbance from the timber and fishery industries were cited as threats in Equatorial Guinea. The hippopotamus is considered to be at risk in the south-eastern low veld in Zimbabwe because of conflict with a large-scale irrigation scheme. No doubt there are other threats from development elsewhere that were not recognized by correspondents.

Disease was rarely mentioned as a threat to the survival of hippopotamus although fears from anthrax in the Zambezi River system were expressed in Zimbabwe. Widespread mortality from disease has been suspected in the past, e.g. antibodies to rinderpest were found in the population of Queen Elizabeth Park, Uganda, and disease must remain as a potential risk today.

Captive Breeding

The hippopotamus does well in captivity and breeds readily for of the 99 specimens recorded by the International Species Inventory System (ISIS) in an incomplete census of zoos in 1985, 68% had been born in captivity. The breeding groups are small, however, as most zoos keep only a pair and very few more than three animals. Reproductive rates are low with only eight young born within the previous twelve months in the above sample and of these three died within a month of birth. This is well below the species' reproductive capacity in the wild and should it ever prove necessary to maintain the species in captivity for conservation purposes, a radical change in zoo husbandry would be required.

Conservation Measures Proposed:
An Action Plan

The hippopotamus, as a species, does not appear to be in any danger of extinction and there is no immediate cause for alarm over its future. It is, however, potentially vulnerable because of its specialized ecology, which renders it incapable of adapting to certain potential changes in its environment, such as the drying up of water courses or loss of feeding grounds. The objective of the Action Plan, therefore, is to ensure that the hippopotamus continues to exist as a species with viable populations in each of the states where it presently occurs. Many of the groups in west Africa include less than 50 animals each, which is below the minimum considered viable by population geneticists. In order to be reasonably free from the risk of extinction, each population should probably number 500. The primary objective, therefore, should be to build up all groups to at least this level. It is also important to ensure that all groups, however small, are protected in order to conserve as large a proportion as possible of the gene pool.

Sociological Aspects

Expanding human populations will exacerbate the ecological problems, for the potential of the hippopotamus to damage crops precludes an easy coexistence with agriculture. It must be accepted that the hippopotamus is also a dangerous animal and a threat to human life. Fishermen in particular are at risk and death or serious injury from hippopotamus attack is commonplace in their communities. Hence any action plan must take into consideration the need to reconcile conservation measures with the welfare of human populations. As information is lacking in many of these areas, the following research projects are proposed:

1. Assess the extent and cost of damage caused by hippopotamus to agriculture, particularly rice crops in west Africa.

2. Investigate the extent of injuries and death suffered by fishermen and others during attacks by hippopotamus.

   Particular attention should be paid to the events leading up to the attacks as there is evidence that the hippopotamus are sometimes provoked.

3. Assess effectiveness of various measures used to separate hippopotamus from human activities, e.g. the use of electric fencing to prevent hippopotamus from straying onto agricultural land.

   Experience from Lake Naivasha, Kenya, suggests that it is important to make the electrified wire conspicuous.

4. Investigate the possibility of cropping hippopotamus on a sustainable yield basis.

   Although such a large animal, the hippopotamus has a relatively short gestation of about eleven months and a lactation period lasting only twelve weeks. Hence its potential for reproductive increase is quite high but it is likely that cropping could be operated successfully only in those countries with populations numbered in several thousands rather than hundreds. An experimental cropping scheme is due to take place in Tanzania near Ifakara, inside the western border of the Selous Game Reserve. The effects on the behaviour and population dynamics of the animals should be monitored. The disturbance factor could be serious and very tight controls would be necessary to ensure that the exploitation is sustainable.

5. Assess, the extent to which the tusks of hippopotamus are used in trade, possibly as a substitute for elephant ivory, and whether there has been any increase since the transfer of the African elephant to Appendix I of the CITES regulations.

   If ivory poachers transferred their attention to the hippopotamus, the consequences for its survival in many countries would be serious. It is an extremely easy species to slaughter on a large scale because most of the animals within a region concentrate into

one or a few water bodies by day, though these factors also make it an easy species to protect.

Biological Aspects

An action plan for the conservation of the species as a whole is not appropriate as its status varies greatly from one country to another and the subject is best approached on a regional basis. The most important requirement is an up-to-date assessment of the status of the various populations, particularly those which are at risk or for which no information was obtained from the present survey. The analysis made above suggests that it is to west Africa that greatest attention should be paid. The following actions are recommended.

1. Assess the population status of the hippopotamus in countries for which no information was obtained in the recent questionnaire survey.

   Data are still required from Angola, Chad, and Rwanda, all of which historically contained flourishing populations of the species. When security considerations allow, the survey should also be extended to those countries for which information is incomplete. These include Cameroon, Ethiopia and Malawi.

2. Assess the population status of those countries in which the hippopotamus is present in low numbers and is giving cause for concern.

   These countries include Burkina Faso, Cameroon, the Central African Republic, The Gambia, Ghana, Ivory Coast, Mali, Nigeria, Sierra Leone, Somalia and Swaziland.

3. Estimate more precisely numbers in countries with large concentrations of hippopotamus, which are not properly censused during the present survey (e.g. Malawi and Zambia).

4. Conduct further studies of populations in areas of southern Africa that can be recognized as sensitive in terms of hippopotamus conservation (e.g. the Caprivi Strip in Namibia and the Okavango Delta in Botswana).

5. Identify the cause(s) of the decline in areas where populations have decreased in number.

   These are likely to be found in all range states even those in which numbers as a whole are stable or increasing.

6. Carry out a taxonomic study of the various populations to ascertain the existence of the alleged subspecies and, if appropriate, to map their distribution (and presence in zoological gardens).

7. Monitor all hippopotamus populations to detect future population trends. Improve current techniques used to count hippopotamuses.

International Co-operation

In view of the fact that many of the largest populations of hippopotamus occur in rivers that form international boundaries, an international approach to management should be encouraged in the governments of the countries concerned. Countries with shared populations of hippopotamus include Benin, Botswana, Burkina Faso, Cameroon, Central African Republic, Congo, Equatorial Guinea, Guinea, Ivory Coast, Malawi, Mozambique, Namibia, Rwanda, Sierra Leone, South Africa, Tanzania, Uganda, Democratic Republic of Congo Zambia and Zimbabwe. Some of the pairings are: Botswana/Namibia, Botswana/South Africa; Burkina Faso/Benin, Burkina Faso/Ivory Coast; Cameroon/Equatorial Guinea; Congo/Central African Republic; Guinea/Sierra Leone, Guinea/Ivory Coast; South Africa/Mozambique; South Africa/Zimbabwe; Tanzania/ Malawi, Tanzania/Mozambique; Tanzania/Uganda; Uganda/Rwanda, Uganda/ Democratic Republic of Congo; Zambia/Mozambique, Zambia/South Africa, Zambia/Democratic Republic of Congo, Zambia/Zimbabwe.

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Chapter 3.3

The Pygmy Hippopotamus (*Hexaprotodon liberiensis*)

S. Keith Eltringham

Status and Action Plan Summary

H. l. liberiensis is status category 4 (vulnerable) and *H. l. heslopi* is 'Indeterminate' but probably critically endangered or extinct.

The pygmy hippopotamus is mainly confined to Liberia, where it is widely distributed although it nowhere occurs in large populations. A distinct subspecies has been described from Nigeria and may still survive there. Another isolated population has been described

from Guinea Bissau but it was almost certainly based on a misidentification. The continued existence of the Nigerian population should be investigated and its current status established if it is found to be still present. The numbers of pygmy hippopotamus are unknown but are thought to total a few thousand at the most. It is a secretive, nocturnal animal that occurs in thick forest, usually alone or in pairs. It is hunted for meat throughout its range except in Guinea, where it is said not to be threatened. This may be because it is rarely encountered for it would be surprising if it were ignored by hunters unless it were associated with a taboo. It is not clear how far hunting for meat, or for trophies, is a threat to survival but given the low densities and scattered distribution of the species, any killing is likely to be detrimental to its survival. The main threat, however, is perceived to be loss of habitat through forest clearance and it is recommended that areas of relatively secure forests containing viable populations of the pygmy hippopotamus should be identified and given protected status. Attempts should also be made to devise methods for assessing population sizes. The species breeds well in captivity and the captive population of about 350 animals in 131 collections appears to be self-sustaining.

Introduction

The pygmy hippopotamus shows considerable differences from its larger relative, the common hippo, in many ways other than in size. It is indeed considerably smaller, weighing between 180 and 270 kg. Unlike the common hippopotamus, it occurs alone or in small groups and it is confined to forested regions close to rivers. It is also much less aquatic with little webbing between the digits, allowing the feet to spread laterally to a greater extent. This is presumably a terrestrial adaptation. It is more pig-like in shape with proportionately longer limbs and neck and a proportionately smaller head. In its general ecology and social behaviour it shows a closer resemblance to tapirs than to the common hippopotamus (Robinson, 1970). It is nevertheless recognizably a hippopotamus with such aquatic adaptations as strong muscular valves to the ears and nostrils. Its aquatic nature is evident from its skin physiology, which is as complex as that of the common hippopotamus, and the animal suffers damage to the skin if exposed to sunlight. The ranges of the two species of hippopotamus do not overlap.

Two subspecies are recognized. Most members of the species belong to the nominate race *H. l. liberiensis*, which occurs in Liberia, but the small population in Nigeria has been given subspecific status. Four skulls acquired by Heslop (1945) were examined by Corbet (1969), who placed them into a new subspecies *Choeropsis liberiensis heslopi*. With the change in the name of the genus (see Grubb, Chapter 3.1), this subspecies should now be referred to as *Hexaprotodon liberiensis heslopi* (Corbet, 1969).

An attempt was made in 1989/90 to obtain up-to-date information on the status of the species through the African Suiform Questionnaire Survey and related correspondence. Replies were received from eight persons, whose comments have been incorporated into the following account. Mentions in the text of names not followed by a bracketed date refer to these correspondents. A bibliography of the species has been prepared by Robinson (1981).

Former and Present Distribution

The past distribution of the pygmy hippopotamus was not very different from what it is today, but it is likely that the populations have become fragmented, for the animal has disappeared from many of its former sites. The distribution of the species is centered on Liberia, which includes the bulk of the population (Anstey, 1991). The species also occurs in the three countries (Guinea, Ivory Coast and Sierra Leone) that are contiguous with Liberia, mainly close to the shared borders. A second, isolated population may occur in Nigeria some 1,800 km to the east on the other side of the Dahomey Gap. Such a discontinuous distribution is very rare amongst forest vertebrates in west Africa and Robinson (1970) considers that there is insufficient evidence to confirm that the species ever existed in Nigeria despite the account by Heslop (1945), who shot one near Omoku in the vicinity of the Niger Delta. Others have been equally skeptical but Ritchie (1930) gave measurements of two skulls that were obtained in 1928 from the Niger Delta so there seems little doubt that the species did once occur in the country. Another isolated population has been reported from the Corubal River in Guinea-Bissau by Cristino (1958), who claimed to have shot a specimen but it is more probable that the animal was a young common hippopotamus. The present distribution of the species in Liberia is shown in Fig. 6.

Link to Fig. 6: Approximate present known and reported distribution of the pygmy hippopotamus, *Hexaprotodon liberiensis.*

Habitat and Ecology

The pygmy hippopotamus is rarely seen because of its secretive, nocturnal habits and consequently not much is known of its ecology. The most detailed field study is that of Robinson (1970) and a general account of its biology is given by Lang (1975). The pygmy hippopotamus is much less gregarious than the larger species, being usually found in ones or twos. As it is largely nocturnal it tends to spend the day hidden in swamps, wallows or rivers and sometimes in hollows under the banks of streams, which it is said to enlarge. It favors heavily forested regions but it is dependent on water and usually remains close to streams. It also used to frequent forests fringing the rivers that extend into Transitional Woodland and the southern Guinea savanna. Within the forest it follows well-defined trails or tunnel-like paths through swamp vegetation, which it marks by spreading its dung by vigorously wagging its tail while defecating, like its larger relative.

The species is exclusively vegetarian, feeding on leaves and roots of forest plants as well as on fallen fruit. The stomach has four chambers (Langer, 1988). The first three are covered with tough keratinised epithelium, only the last containing glandular epithelial tissue. There is evidence that microbial breakdown of plant material takes place in the first three stomach chambers, no caecum being present in this species.

From studies of captive animals (Lang, 1975; Tobler, 1991), the estrous cycle has been shown to average 35.5 days with estrus itself being 24-48 hours long. The average gestation length is 188 days after which a singleton young is born weighing about 5.7 kg. Twins are born very rarely, the incidence being approximately one in every 200 births. The young are born on land, and there is no evidence from captive births that a nest constructed. A survey of over 800 births indicates that these occur throughout the year (Tobler, 1991).

Conservation Status

The pygmy hippopotamus is identified as "vulnerable" in the IUCN list of threatened animals and the present survey suggests that this category is justified. Although its numbers have probably declined recently, there is, as yet, insufficient evidence to recommend that its status should be upgraded to "endangered".

Numbers are very difficult to estimate at all accurately but the species is present only in small numbers in each locality, although it is widespread throughout its range. In 1983 A. J. Peal considered that the population in Liberia was stable and was of the order of several thousands. He now considers that numbers are probably decreasing. Most correspondents did not attempt an estimate in the other countries but G. Teleki reports that his 1979/80 survey indicated a total population of 80 _ 10 for the whole of Sierra Leone, which effectively means Gola North and Gola East, near the Liberian border, and the Loma Mountains in the north-west. More recently, White (1986) reported the definite presence of the species on Tiwai Island, near Gola East, in the south-west of the country. Further sightings were made in 1986 including one of a female with a sucking calf, proving that the population was breeding. White estimated that the number using the island in 1984 was at least three adults and one sub-adult but that the total could be as high as ten. F. O. Amubode assumes that the pygmy hippopotamus still exists in Nigeria but provides no evidence that it does. Even fifty years ago, Heslop (1945) put numbers at no more than 30, split into several isolated groups, so it is likely that the subspecies has become extinct.

All correspondents in all countries reported that the species was present at low densities and was probably decreasing in numbers except in Guinea where the population was considered to be almost stable. All correspondents, again except in Guinea, also considered that the conservation status was giving cause for concern. The only optimistic feature is that there are many populations in Liberia, which although small, are widely dispersed over a large range. The species' biology precludes its occurrence in large numbers or at high densities and hence no population is too small to be worth conserving. Any long-term hope for the species relies on effective conservation within Liberia but the recent political disturbances in that country have probably made it difficult for any protective measures to be introduced.

Threats to Survival

The principal threat to the survival of the pygmy hippopotamus seems to be the destruction of forests in Liberia, particularly high forest. The civil war is unlikely to have had a direct effect, however, since the pygmy hippopotamus occurs in remote areas away from the main centers of fighting and is too secretive to be easily shot by the passing soldier. Human pressures are less in swamps and riverine areas. Deforestation also occurs elsewhere in its range but hunting for meat is a more immediate threat in the other countries where the species occurs. Hunting for meat was reported from Liberia as well. This was the only country where teeth were said to be the object of hunting. The animals in Sierra Leone may be persecuted by the local people because of the damage they cause in riverside gardens. A novel risk to survival, oil pollution, was suggested in Nigeria because the species occurs, or occurred, in estuaries close to the sea. The pygmy hippopotamus is not considered to be threatened in Guinea where there is no trade in meat or other products.

Conservation Measures Taken

The species is listed as vulnerable by IUCN (IUCN, 1990) and is included on Appendix II of CITES (The Convention on International Trade in Endangered Species of Wild Fauna and Flora). It is fully protected legally in all countries. It is protected in Liberia under the Wildlife and National Park Act of 1988 but enforcement of the regulations is loose except in Sapo National Park, where protection is good.

Captive Breeding

The latest edition of the International Studbook for the Pygmy Hippopotamus, which was published by Basel Zoological Gardens in 1991 (Tobler, 1991), lists a total of 820 animals. Of this number, 340 (131 males, 206 females and 3 of unknown sex) were alive on 31st December 1990 and were held in 131 collections throughout the world. The species breeds freely in captivity and most, if not all, of the specimens listed have been born in zoos to captive-bred parents. The world population of captive born animals has more than doubled since 1970.

Whilst the future of the species in captivity seems assured, the conditions under which it is kept need reconsideration given that most collections consist of a pair that are kept permanently together in a pool of water. Evidence from the wild suggests that pygmy hippopotamus come together infrequently and do not spend much time immersed in the water. The causes of death mentioned in the Studbook include many references to attacks by mates, maternal neglect and injuries inflicted by the mother. It is possible that many of these deaths are due to stress from the artificial conditions of captivity and greater attention to the way of life in the wild might help to reduce this mortality.

Conservation Measures Proposed:
An Action Plan

The future of the species in captivity seems more assured than in the wild. The biggest threat, although not immediate, is deforestation in Liberia. There is probably little that can be done at present to halt this universal trend, particularly given the anarchic situation in the country, but areas of forest least at risk and containing pygmy hippopotamus should be identified and conservation effort concentrated in such places. Sapo National Park is one such area. It is well protected and is known to contain the species for there have been two recent sightings in the park.

In view of the near-restriction of the pygmy hippopotamus to Liberia, it is in that country that any action plan should be concentrated but what is recommended for Liberia applies equally to other countries where the species occurs. There is little that can be done immediately and a conservation program cannot be effected until political stability returns to the country.

Objectives:

1. To ensure, as a first priority, that the species can continue to survive in the Liberian forests without further reduction or fragmentation of its range.

2. To establish more precisely the distribution and numbers of the species throughout its range but more particularly in Liberia, where the bulk of the population occurs.

3. To identify secure regions where conservation action can be concentrated.

4. To establish whether or not the isolated population reported from Nigeria still exists and if it does, to develop plans for its enhanced future protection.

   (The alleged population in Guinea-Bissau is so improbable that the time and money that would be involved in an attempt to establish its existence are unlikely to be justified.)

Priority Projects

1. Establish a reliable method for assessing the sizes of the various populations.

   It is unlikely that such an elusive creature can be counted accurately and attention should be paid to developing indirect techniques that will provide an index of density, as has been done with forest elephants. These may include, for example, counts of dunging areas, trails or nest sites.

2. Identify and give special protection to areas containing adequate populations of the species and which appear free from the threat of deforestation.

This does not necessarily mean according them national park status, which might be difficult to achieve. In any case, even if new parks were created they might not be large enough to contain viable populations. As the only national park in Liberia, however, special attention should be given to Sapo National Park particularly as the species was recently recorded there.

3. Monitor the species in protected areas on a permanent basis using techniques developed for census purposes.

4. Identify potential threats to the species in each area and take steps to remove them.

   Apart from the obvious problem of deforestation, attention should be paid to possible threats from meat hunting and the trophy trade. Education should play a prominent role in such projects in making local people aware of the rarity and uniqueness of the pygmy hippopotamus.

5. Mount expeditions to those regions of Nigeria where the species was last reported in order to look for evidence of its continued existence.

   If it is shown to survive there, special efforts should be made to assist the development of management strategies for its enhanced future protection and to determine the taxonomic as well as the conservation status of this population.

6. Coordinate the international captive breeding effort to take advantage of recent computer programmes for analyzing stud book data and to ensure that maximum use is made of the genetic potential of the existing captive population.

7. Study the behaviour of the species under a variety of captive conditions in order to generate information of benefit to their enhanced future husbandry, with particular reference to the habits of the animals in the wild.

8. This project is suggested in the light of evidence that the species is not being maintained in captivity in the most appropriate conditions and social units.

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Chapter 3.4

Review of Priorities for Conservation Action and Future Research on Hippopotamuses.

S. Keith Eltringham

Introduction

This chapter reviews the recommendations made in Chapters 3.2 and 3.3 concerning the research and conservation priorities for the two species of hippopotamus. The species are not very similar as the pygmy hippopotamus is essentially a forest animal that occurs singly or in small groups, in contrast to its larger, gregarious, grassland relative. It is also less aquatic. There are marked differences in diet. Whereas the large hippopotamus is almost entirely a grazer, the pygmy species is more catholic in its tastes, taking browse, roots and fallen fruit. They are, however, similar in feeding mainly at night. The common hippopotamus is widely distributed throughout much of sub-Saharan Africa, but the pygmy is more or less confined to Liberia with only remnant populations in a few neighboring countries. The common hippopotamus has been intensively studied in recent years but there is still much to learn about the behavioral ecology of the pygmy species. The principal threat to the survival of both species is loss of habitat. In the case of the pygmy hippopotamus it is the potential loss of the forest itself that is the problem. Two types of habitat are involved in the case of the common hippopotamus. It is unlikely to experience shortage of water in which to spend the day but it is vulnerable to the loss of grazing land, particularly to rice plantations in West Africa and to cereals in East Africa. The conservation status of the pygmy hippopotamus is notably worse than that of the larger species. Its numbers are much lower and although the precise population size is unknown, it probably numbers no more than a few thousand.

Objectives

1. To establish the distribution of the two species particularly in those range states for which information
  is sketchy or non-existent at present.

2. To identify populations that are at risk.

3. To maintain viable populations of both species within their present ranges.

4. To disseminate information about the conservation status of hippopotamus.

5. To investigate ways in which to exploit the commercial value of the common hippopotamus.

6. To encourage zoos to co-operate in building up and maintaining viable breeding groups in captivity.

Conservation Action Priorities

A. Conserve Populations at Risk

An essential prerequisite to conserving the species is to identify those populations, which are most at risk. This problem requires a knowledge of the numbers and distribution of each species. The recent questionnaire survey has provided useful data to this end but there is obviously much more to be discovered about the ranges of the two hippopotamuses. As the pygmy hippopotamus is largely confined to Liberia, it is in that country that most conservation effort should be concentrated. At the same time, the status of the species in the other range countries needs to be investigated and their conservation encouraged in order to maintain the maximum genetic diversity.

Conservation measures are urgent in the case of the pygmy hippopotamus, which is classed as vulnerable in the IUCN Red List of Threatened Animals. The status of the common hippopotamus is more satisfactory and there is no immediate risk of extinction. Nevertheless there are countries where the hippopotamus is of particular conservation significance, either on account of its rarity or of its status as an ecological keystone species. For both species the highest priority should be given to projects that fill gaps in the information acquired in the present survey about their numbers and distribution. Action is required as follows:

1. Establish the status of the species in those countries from which no information was acquired in the recent survey.

   In the case of the common hippopotamus, these are Angola, Chad and Rwanda, all of which once contained large populations of the species.

2. Extend the observations in those countries, which were only partially covered in the recent survey.

   These include all range states in the case of the pygmy hippopotamus. No information on its status was received from Guinea Bissau, where a population of the pygmy hippopotamus is said to occur, though most authorities doubt that it ever existed and consider that the original record was of a calf of the larger species. It does not seem worth the time and effort that would be required to disprove its existence there. On the other hand, the continued presence of a population of pygmy hippopotamus in Nigeria should be investigated especially as the original specimens that were collected were placed in a separate subspecies. The existence of this population was assumed, but not confirmed, by a correspondent in the recent questionnaire survey. Countries poorly covered in the case of the common hippopotamus included Cameroon, Ethiopia, Malawi, southern Sudan and Zambia.

3. Monitor those populations, which the survey found to be dangerously small and giving cause for concern.

The status of the pygmy hippopotamus in Liberia is unclear but the most seriously threatened population elsewhere is probably that in Sierra Leone. Of the countries containing the larger species, those with threatened populations include Central African Republic, Equatorial Guinea, The Gambia, Ghana, Ivory Coast, Mali, Nigeria, Niger and Sierra Leone.

4. Monitor populations in those countries in which the common hippopotamus is abundant and doing well in order to ensure that they continue to be secure.

Countries with large populations include Ethiopia, Kenya, South Africa, Sudan, Tanzania, Uganda, Zambia and Zimbabwe. The degree of political stability in these countries varies considerably and will influence the quality of the protection afforded to these populations as well as the feasibility of carrying out further surveys. Adequate funding is a further prerequisite for effective protection.

B. Conservation Management Hippopotamuses

As a large, herbivorous mammal, the common hippopotamus has a considerable impact on its environment, which does not endear it to agriculturalists, particularly peasant farmers, for a single animal is capable of destroying a year's harvest in one night. The hippopotamus can also be extremely dangerous and numerous cases are known of people being killed or injured, especially fishermen in their canoes. Consequently, hippopotamus populations need to be carefully managed in order to avoid confrontations between them and local people. National parks or equivalent reserves offer the best opportunities but there are still places outside national parks where hippopotamus will have to co-exist with people if they are to survive. Research should be directed towards devising management techniques based on cases where hippopotamus appear not to conflict with human interests.

The pygmy hippopotamus is less of a problem, partly because it is too small to be a serious threat to human life and partly because its smaller size limits the extent of any effects it has on vegetation, although reports were received of it raiding gardens. The rarity of the species makes it all the more important that such behaviour is reduced to a minimum. The security of both species would be enhanced if they could be shown to have a positive value that could be realized by the local people.

Because the main threat to both species is loss of habitat, conservation measures should be directed towards preserving the environment. The following are suggestions for some future action in this and other fields.

1. Identify the best area(s) for conserving both species.

In the case of the pygmy hippopotamus, criteria for assessing possible regions include suitable habitat, evidence of recent sightings, isolation from human interference and assurance that legal protection can be enforced. No one place fulfils all these requirements but the only realistic choice must be the Sapo National Park. This is large (1,207 sq. km) by West African standards and contains an extensive area of mature lowland forest, which according to correspondents, is well protected. The number of pygmy hippopotamus is unknown but is thought to be low. There have been two recent sightings. Its conservation in other areas must also be vigorously pursued as it is a feature of the species in Liberia that it occurs in small but widely dispersed groups and the protection of the Sapo National Park alone would certainly not ensure the survival of the pygmy hippopotamus. The choice of suitable conservation areas for the common hippopotamus is wider but in selecting such regions, attention should be given to ensuring adequate grazing areas as well as to access to water. For this it will be necessary to ascertain the grazing area necessary to support the hippopotamus in its various habitats to ensure that the animals are maintained within their carrying capacity.

2. Conduct pygmy hippopotamus status survey in Liberia.

Since deforestation is the greatest threat to the survival of the pygmy hippopotamus in Liberia, a survey of all the forests in the country should be made to identify those regions where the destruction of forests is minimal. It is in such places that the protection of the species is likely to be most successful.

3. Conduct a survey of human-common hippopotamus relations in places where the two already co-exist.

A good example of this is the township of Lake Katwe in the Queen Elizabeth National Park, Uganda. A key to the harmonious relations may be that the people do not molest the animals. Other areas should be identified where hippopotamus are tolerated, either because the human population is small or because the local residents, usually wealthy, like to see the animals, e.g. around Lake Naivasha in Kenya.

4. Examine ways of preventing hippopotamus, of both species, gaining access to cultivated areas.

Some progress has been made with this problem in The Gambia, where electric fences are said to be effective in keeping the animals away from rice fields. These and other barriers merit further investigation.

5. Investigate inbreeding and other potential problems relating the isolation of small, remnant populations.

The isolated nature of the small populations of the pygmy hippopotamus that occur in Liberia raises worries about the deleterious effects of possible inbreeding that may be taking place. Nothing seems to be known of the dispersal of young animals from these groups, which is presumably the natural way by which inbreeding depression is avoided. The problem could be investigated by examining the relatedness of the

members of these groups through genetic "finger-printing" to see how genetically heterogeneous they are. This would normally involve the taking of blood or tissue samples, which would not be an easy task, and the possibility of using alternative techniques should be investigated.

6. Develop guidelines for the enhanced future management of captive populations of both species.

Both species of hippopotamus breed well in captivity but this is of greater significance in the case of the much rarer pygmy hippopotamus, for which captive breeding may become an essential means of conserving the species. Present efforts to achieve a genetically diverse population in the world's zoos through selective breeding should be supported. Further research into the routine husbandry techniques and demographic management of the species is required in order to improve reproductive success amongst captive animals.

C. Management of Common Hippopotamus for Profit.

The pygmy hippopotamus is probably too rare for trade in its products to be viable, but the common hippopotamus has a commercial value on account of its meat, hide and teeth. The meat is palatable and is readily eaten throughout Africa when it is available. The traditional use of the hide for the manufacture of whips and shields has declined but new techniques for its use in the manufacture of shoe leather are being developed. The canine teeth, which resemble small elephant tusks, have always found a ready market amongst craftsmen for the production of carvings or for incorporation into ornaments and other wildlife trinkets. Incisor teeth, although less valuable, may also be used in this way. There is a fear that the banning of the ivory trade resulting from the recent listing of the African elephant on Appendix I of CITES will result in an increased demand for hippopotamus tusks. The evidence that this is happening is slight but it is certainly a possibility that needs further investigation. The rational exploitation of the hippopotamus has rarely been attempted and for its future success, several aspects require investigation. Some of these are listed below.

1. Establish the locations of hippopotamus populations that are large enough to sustain regular cropping. (If it takes place, the proposed cropping scheme at Ifakara in Tanzania could provide useful information in this context.)

2. Investigate improved ways of estimating sustainable yields from hippopotamus populations in terms of meat and ivory.

3. Establish the best techniques for the harvesting and processing of exploited hippopotamus populations.

4. Carry out market research into the sale of hippopotamus products.

5. Investigate the possibility of cross infection between hippopotamus and domestic livestock.

D. Regulation of Trade in Hippopotamus Products.

If the exploitation of the hippopotamus is extended along the lines suggested in Section C above, there is a danger that unscrupulous operators will attempt to extend their profits through illegal activity such as smuggling or over-cropping. At present, there is no legal requirement to control the trade as the common hippopotamus is not listed on any of the CITES appendices except Appendix III by Ghana. This has little effect other than on exports from Ghana. Actions to improve the monitoring of the trade in hippopotamus products and to establish a regulatory system include the following actions.

1. Conduct an investigation into the extent of the trade in hippopotamus products, particularly the teeth.

2. Promote the listing of the common hippopotamus on Appendix II of CITES in those regions where they are being, or are likely to be, over-exploited.

3. Investigate methods whereby curios carved from hippopotamus teeth can be distinguished by non-specialists, such as customs officers, from those made of elephant ivory.

E. Development of Education and Training Programmes.

It is probable that the great majority of the human population of Liberia is ignorant of the unique position of the country in holding most of the world's population of the pygmy hippopotamus. A public education campaign should therefore be mounted to impress upon the people that their country is principally responsible for the custody of this rare and vulnerable species. Given the political turbulence in this country in recent years, however, it may prove necessary to postpone conservation education operations until such time as stability is restored. If local people are to tolerate the presence of the common hippopotamus in their home areas, with the risks of crop damage and danger to life that this entails, it is important that they should be aware of the potential benefits that can ensue from the exploitation of the species. In the case of small populations unsuitable for exploitation but important for conservation, ways in which the potential conflict between people and hippopotamus can be minimized must be explored. The dissemination of the conservation message for both species will require trained personnel able to discuss management problems realistically and sympathetically with local residents. Some of the enterprises in this area that should have priority include:

1. Training of personnel to communicate conservation and management principles to local people.

Appropriate persons include biologists, social workers and teachers, though other persons with no formal qualifications would be suitable for training provided they were suitably motivated.

2. Development of conservation education programmes for both schoolchildren and adults in rural areas where the hippopotamus occurs.

3. Production of posters, pamphlets and other material to publicize the need to conserve the hippopotamus.

Future Research Priorities

There is much still to be learned about the basic biology of the pygmy hippopotamus and the effective conservation of the species depends on these gaps in our knowledge being filled. Future research on this aspect is probably best carried out in Liberia, where the species is most numerous, but political considerations may dictate that the smaller populations elsewhere are studied first. Although the basic biology of the common hippopotamus is now reasonably well known, certain aspects need to be clarified. From the conservation perspective, the most urgent requirement is up-to-date information on the numbers and distribution of the species, particularly in West Africa, where populations are small and vulnerable. Few observers in the present enquiry were able to record numbers and some improvements in survey methods are desirable. The following research projects should be given priority.

A. Pygmy Hippopotamus

1. The determination of the home range of the various age and sex classes.

2. A study of the reproductive biology of the species with particular reference to pair bonding, breeding rates and reproductive success.

3. A study of group size and composition, the permanence of social associations and the dispersal of the young after weaning.

4. An assessment of the role of the pygmy hippopotamus in the dispersion of the seeds of forest trees through frugivory.

5. An investigation the best ways of estimating the numbers of pygmy hippopotamus in its forest habitat.

6. A study of the circadian activity of the various age and sex classes.

7. A continuation of studies of the genetic relationships of captive pygmy hippopotamus in order to ensure that the captive population remains as genetically heterogeneous as possible.

B. Common Hippopotamus

1. A study of the social relationships between hippopotamus of various age/sex classes, with particular reference to the tenure of territories, the duration of the mother/calf bond and the dispersal of young animals on reaching maturity.

2. Measure the activity and time budgets of each class of hippopotamus.

3. Studies of habitat use and the carrying capacities of various vegetation types.

4. Investigate means of marking individual hippopotamus for behavioral research purposes.

   Studies of social relationships and activity are greatly facilitated by the ability to recognize individual animals and although this can be done on the basis of scars and other anatomical features, a reliable method of attaching artificial marks is urgently required. In radio-tracking studies this is obviously essential.

5. Investigate the effects of cropping on the social habits and population dynamics of the species.

   Such studies are required before any large-scale exploitation takes place. These can best be carried out at a cropping station and a suitable opportunity would be provided in the Selous Game Reserve in Tanzania if the proposed cropping of hippopotamus takes place there.

6. Conduct research into improved methods of census.

   Most studies have depended on counting the animals by day, when they are in the water. Aerial survey using photography seems to be the most promising method and ways of refining it, perhaps by using helicopters, should be investigated.

7. Conduct survey of hippopotamus diseases and of the parasites and disease organisms carried by them.

   This is particularly important in those regions where the species is likely to come into contact with domestic livestock. At least one disease of economic importance is now known to affect hippopotamus for antibodies to rinderpest were found to be widespread in animals from Uganda.

8. Re-investigate the taxonomy of the species in order to assess the extent of geographical variation and, if the currently described subspecies are found to be valid, to identify their ranges.

Chapter 4

The Afrotropical Suids:

Potamochoerus, *Hylochoerus* and *Phacochoerus*

4.1 Taxonomy and Description

Peter Grubb

Introduction

The recent African suids have been reviewed by Haltenorth (1963), Ansell (1972), and Groves (1981). The present contribution is based on the literature and on a study of museum specimens. There is a need to examine more museum material, especially unreported accessions, in the hope of reaching more definitive conclusions concerning systematics and distribution.

The pigs of tropical Africa are the survivors of a lineage, which radiated considerably during the Tertiary (Cook & Wilkinson, 1978; Harris & White, 1979), without ever attaining a species-diversity sufficient to rival that of the African bovid ruminants. One genus (*Potamochoerus*) still retains a relatively conservative morphology and is superficially similar to *Sus* in many features. The other two (*Hylochoerus* and *Phacochoerus*) are much more specialized. *Potamochoerus* includes two species: the red river hog (*P. porcus*) occurring in the rain-forest block, extending into gallery forests, and the bushpig (*P. larvatus*) distributed through both the Southern Savanna and the highland

forests and forest galleries of eastern Africa and Ethiopia. The single species of *Hylochoerus*, the forest hog (*H. meinertzhageni*), has a discontinuous distribution in the main forest blocks but also extends far beyond them in some gallery forests and in upland forests of East Africa. *Phacochoerus* species, the warthogs, are savanna pigs, which nevertheless have a wide ecological tolerance, ranging from mesic habitats into more arid zones (southern Sahara, Somali, and Southwest Arid Zones). A common and widespread species of warthog (*P. africanus*) is replaced in the Somali Arid (and formerly on the Southwest Arid/southwest Cape border) by a more specialized form - a separate species, the Cape or desert warthog (*P. aethiopicus*). Thus 5 species (and at least 12 subspecies - see below) of 3 genera of Afrotropical suids are recognized in this account:

1. The red river hog, *Potamochoerus porcus* (0 ssp.)
2. The bushpig, *Potamochoerus larvatus* (3 + ? ssp.)
3. The forest hog, *Hylochoerus meinertzhageni* (3 ssp.)
4. The common warthog, *Phacochoerus africanus* (4 ssp.)
5. The desert warthog, *Phacochoerus aethiopicus* (2 ssp.)

The Genus *Potamochoerus*
The Red River Hog and the Bushpig

The two species of 'bush pigs', the red river hog (*P. porcus*) and the bushpig (*P. larvatus*), are not unlike the Eurasian wild pig (*Sus scrofa*) in proportions, but are generally smaller, shorter limbed, and with different pelage. In boars there is an exostosis on each side of the snout, absent in all other living pigs, which extends laterally towards a hypertrophied apophysis on the canine sheath, these two bony knobs supporting a single large external cutaneous wart on each side of the snout, yet allowing the tendons of the nasal disc to tunnel through to their muscular origins. There are no infraorbital warts or swellings, as in the other Afrotropical genera. Compared with *Sus*, the skull is less elevated in the occipital region and the rostrum is less elongated. There are other differences in form and proportions, which suggest that *Potamochoerus* is not particularly close to *Sus* phylogenetically. The molars have thick enamel and are brachyodont and relatively simple.

Too many subspecific taxa of *Potamochoerus* have been recognized yet no convincing evidence has emerged to show that bushpig and red river hog intergrade or hybridize. As they are also clearly distinct morphologically, they are treated here as two separate species.

The Red River Hog (*Potamochoerus porcus*)

On average, this is the smallest African pig. Available measurements for greatest skull length (from occipital crest to tip of premaxillae) are 269-378 mm for adult females, and 327-405 mm for adult males. It is also quite the most brightly and strikingly colored of all wild pigs. The predominant color is bright russet orange with a white dorsal line starting behind the head, the hairs of which are only slightly longer than those of the flanks. The head is marked by a contrasting mask - black, with whitish muzzle, spectacles round the

eyes, and cheek whiskers. The pinna is elongated with a long terminal tuft of hair. The pelage on the snout and most of the face is bristly but on the forehead and the whole of the rest of the body it is short, soft and dense. There are scattered long bristles along the flanks.

Museum specimens were examined from Guinea Bissau, Sierra Leone, Liberia, Ivory Coast, Ghana, Togo, Nigeria, Cameroon, Bioko (?), Rio Muni, Gabon, Congo and Zaire (now Democratic Republic of Congo). The record from Bioko is based on teeth picked up in the field (Tervuren Museum), which have yet to be critically studied. The River Hog is also reliably recorded from Senegal, Guinea, Benin and the Central African Republic. There are no authentic records of this species in the present restricted sense from Sudan. It ranges from the main forest block into the Niokola Koba Park in Senegal (Dupuy, 1969), as far as the Pandam Game Reserve in Nigeria (Happold, 1987), and into the southern part of the Manova-Gounda Saint Floris Park, northern C.A.R. (Fay, in litt.), and may penetrate the savanna along gallery forest in the other countries.

I have been unable to differentiate any geographic variation from individual variation in this species and hence recognize no subspecies. (Synonyms: *albifrons*, *albinuchalis*, *mawambicus*, *penicillatus*, *pictus*, *ubangensis*).

The Bushpig (*Potamochoerus larvatus*)

In this species, the face is also bristly but bristly pelage extends from the head over the whole body. The bristly body hairs are very long and relatively sparse and they are particularly elongated along the back so as to form a well differentiated dorsal crest, which begins far forward, between the ears. The long bristles give the live animal a shaggy, crested appearance, very different from the trim, short-coated aspect of the river hog. The pinna of the bushpig is not so elongated, though it is still tufted. The head is never 'masked', though it contrasts in color with the body. Body color is variable between ages, individuals, sexes and populations, with polymorphism-polymorphism in some places. Too many subspecies have been recognized. The principle systematic division within the species is between the white-faced animals of eastern Africa and the remaining populations of both southern Africa and Madagascar, not between races of Africa and races of Madagascar (see later text). The following three (mainland) subspecies are recognized provisionally.

1. **White-faced Bushpig,** *Potamochoerus larvatus hassama* **(synonyms:** *daemonis, intermedius, keniae, arrhenii***).**

In this subspecies, adult males are usually black or almost wholly 'blond' (off-white). Subadult males and females have blackish markings on the face and the upper parts reddish, but they are sometimes wholly black also. In cranial dimensions, the white-faced bushpig is similar to the red river hog (skull length 327-353 mm in females, 341-377 mm in males) but the temporal ridges are usually more pinched-in and the braincase is never as convex and inflated. I have seen specimens from Ethiopia, southern Sudan (both west and east of the Nile), eastern Zaire (now Democratic Republic of Congo), Rwanda, Burundi, Uganda, Kenya and northern Tanzania. The white-faced bushpig is an animal of

elevated country, occurring in forest and other habitats with dense vegetation on nearly all the high ground of eastern Africa from the Virunga Mountains to Kilimanjaro and the Ethiopian highlands. It is not yet possible to identify any pattern of geographic variation over this wide area. Appreciation that only one subspecies occurs in these highlands has been hampered in the past by the considerable variation between specimens and the shortage of adequate comparative material.

2. Somali Bushpig, *Potamochoerus larvatus somaliensis*

These bushpig occur along the course of the Tana, Juba and Scebeli Rivers in northeast Kenya and Somalia (Funaioli & Simonetta, 1966). A Somali subspecies was differentiated by de Beaux (1924) on the basis of a single, small broken skull. I have seen two relatively small skulls from northern East Africa, a female from Kidori on the Tana River, Kenya, and a male from the southern Juba River, Somalia (greatest length 337 and 334 mm respectively). Neither of these specimens is fully adult for the hindmost cusps of the cheek teeth are not yet in wear. Even so, they are rather small for *P. l. koiropotamus* and more within the size range of *P. l. hassama*. Until more specimens can be examined and the pelage described, it is not certain whether this nominal subspecies should be synonymised with *hassama*. We might perhaps expect a subspecific difference because *hassama* tends to occur in a different kind of habitat and because the Somali populations are likely to be in contact with *P. l. koiropotamus* but geographically isolated from *P. l. hassama*. Relatively small skulls of boars from coastal southern Tanzania (334-367 mm in length) might indicate integration between *somaliensis* (= *hassama*?) and *koiropotamus*, but the scarcity of specimens makes this a speculative proposition.

3. Southern Bushpig, *Potamochoerus larvatus koiropotamus* (synonyms: *capensis, cottoni, johnstoni,*
 maschona, nyasae, congicus).

Typically, this subspecies never has the black-and-white polymorphism pattern so characteristic of male *hassama*. The face is predominantly gray with a broad blackish band over the muzzle. Sometimes the whole of the body pelage is blackish or 'blond' at least in boars, but usually the upper parts of the body are russet or brown, grading into the darker tint of belly and limbs. In dimensions, this is a larger animal than any other member of the genus and the largest specimens have very prognathous skulls (skull length 367-415 mm in males, excluding some small skulls from eastern Tanzania mentioned above; 345-395 mm in females). I have seen specimens from Zaire (lower Zaire River, left bank; and Katanga), Tanzania (north at least to Kilosa), Malawi, Zambia, Zimbabwe, Mozambique, Angola and South Africa. It is reliably recorded from Botswana and probably occurs in the Caprivi Strip, Namibia, and in Swaziland. However, the species appears to be absent from an area between Durban in Natal and East London in Cape Province, South Africa (see Stuart and Stuart, 1988), leaving an isolated in southern Cape Province (Fig. ///). This distributional hiatus may be natural, though there seems to be no comment in the literature. Some southern Cape animals have a strikingly white face (Plate ///), but not all museum specimens are like this, including the holotype. As little material has been available for study, it would be premature to treat the southern Cape animals as a valid subspecies. If in the future this proved to be justifiable, these pigs

would retain the name *P. l. koiropotamus* while bushpigs from Natal northwards would have to be called *P. l. nyasae*.

Biological Relationships Between the Red River Hog and the Bushpig

These two species are allopatric and their ranges are contiguous in some places. Sympatry may also occur in some areas, but this has yet to be confirmed. Along the lower Zaire River, below Kinshasa in Zaire (now Democratic Republic of Congo), for example, the two species are separated only by this river - the smaller *P. porcus* occurring on the right bank and the large *P. l. koiropotamus* (synonym: *congicus*) on the left (Angolan) side. The two populations are morphologically quite distinct with no indication of gene flow between them. A similar situation obtains around the Sudan-Zaire border, where museum specimens of *P. porcus* have been obtained close to the Sudan border in Zaire and a male *P. l. hassama* has been obtained nearby on the Sudan side, but no intermediates between these are known. In the Rift highlands of Zaire (now Democratic Republic of Congo), Rwanda and Burundi, the two species appear to be ecologically/altitudinally separated, with museum specimens from the mountain slopes all being *P. l hassama*, while those from lowland forest are *P. porcus*. No intermediate specimens are known and the two species have not been recorded from the same locality, but they appear to come very close to each other.

In Uganda, only *P. l. hassama*, the white-faced bushpig, is known from museum specimens, though Ghiglieri *et al.* (1982) observed wild pigs of the genus Potamochoerus in the Kibale Forest which they thought were intermediates between *'P. porcus koiropotamus'* (i.e. *P. larvatus hassama*) and *'P. porcus porcus'* because their polymorphism variation seemed to span the whole range exhibited by these taxa. However, they did not demonstrate that this variation is atypical for *P. l. hassama* - which shows all the polymorphism varieties that they observed. Since no special resemblances to *P. porcus* were reported in face pattern, type of pelage or ear shape, evidence of genetic introgression by this species cannot be said to have been established. It is possible that *P. porcus* has made a narrow penetration of Uganda between the Rift mountains by crossing the Semliki River, and it may have hybridized with *P. larvatus* in the Kibale Forest, but more convincing evidence is needed.

Kingdon (1979) also assumed that introgression had occurred between the red river hog and the bushpig, because he thought that East Africa populations of Potamochoerus show features intermediate between the two taxa, a view that is not accepted here. Lönnberg's (1910) so-called intermediate species, *P. intermedius*, from an unspecified locality in Uganda, is not intermediate at all but falls within the range of variation of *P. l. hassama*. De Beaux (1924) had already established that it was a representative of *P. larvatus*.

Bushpigs on Madagascar

It is widely appreciated that the bushpig is a newcomer to the Malagasy fauna. It is present on Mayotte in the Comoros (Benson, 1960) as well as on Madagascar itself. Whilst no tradition or cultural practice appears to have been described in the zoological

literature which could provide a clue as to how bushpigs were brought to the region, Simoons (1953) has cited references to the semi-domestication or at least taming of *Potamochoerus* along the northern edge of its range, and even its alleged later carriage to South America and to England (also see Vercammen *et al.*, this vol.). It may be argued that since the Malagasy bushpigs did not diverge naturally but only after human interference, they should be regarded as synonymous with the mainland *P. l koiropotamus*, which they resemble most closely; and any scientific names bestowed upon these feral populations should not be given currency. However, the mainland and island populations can be distinguished morphologically, so it would be premature to synonymise them when so little is known about their differentiation. To do so would also raise problems of nomenclature, in that the earliest name for the insular pigs - *larvatus* - has priority over the name *koiropotamus* and its rejection would flout the Rules of Zoological Nomenclature. Moreover, the unspoken consensus is to accept names based on populations which became feral in early historic, if not prehistoric, times. The deer *Cervus timorensis* (which was almost certainly introduced to Timor) provides a parallel example.

To complicate matters further, it is necessary to recognize two subspecies of Malagasy bushpigs, whose status can be settled only when further specimens become available. These subspecies are:

4. Malagasy Bushpig, *Potamochoerus larvatus larvatus* (synonyms: *edwardsi, madagascariensis*)

Lönnberg (1910) believed that this name applied to a West Malagasy race. He had examined the skull of an adult male from northwest Madagascar which was much smaller than any other specimen of the species ever recorded, but which otherwise resembled Cuvier's illustration of a skull in the original description of the species. Lönnberg surmised that the drier and harsher environment of West Madagascar would support a smaller-sized animal than the moister zone of eastern Madagascar and, indeed, the skulls of eastern specimens are larger (nominal subspecies *hova*) than Lönnberg's single specimen. Lönnberg had been informed that the Malagasy people distinguished two kinds of wild pig, a darker and a redder sort, and he matched this concept with his two-subspecies hypothesis. Specimens examined from western Madagascar are juveniles, so Lönnberg's views on coloration cannot be verified. His conclusions rest upon a single animal whose external appearance is not known, and we still do not know whether the bushpig of western Madagascar is really a small-sized form or whether Lönnberg was misled by an exceptional individual and all Malagasy bushpigs belong to a single subspecies.

5. East Malagasy Bushpig, *Potamochoerus larvatus hova*

The eastern Malagasy race, possibly valid as a subspecies, is known by both skins and skulls. With a gray head, black muzzle, russet upper parts and dark under parts, it cannot easily be separated *from P. l. koiropotamus* except in its smaller dimensions (skull length

359 mm in one female, 356 and 368 mm in two males) but available photographs suggest a sleeker animal with shorter hair.

The Genus *Hylochoerus*
The Forest Hog

Pigs of this genus belong to the single extant species, *H. meinertzhageni* - the so-called 'giant' forest hog. However, they overlap in size with *Potamochoerus* species and, contrary to the impression created in some popular accounts, the lowland races are not much larger than the red river hog and not as large as the largest bushpigs. Only the East African forest hogs are giants. Pigs of this genus are always coal-black in polymorphism when adult. Piglets are said to be plain colored (Dorst & Dandelot, 1970) and a piglet less than 10 weeks old from the Virunga National Park lacked any sign of stripes (d'Huart, in *litt.*), but specimens in the Natural History Museum, London, are dark brown with light brown stripes. The pelage is wholly bristly, the bristles much stouter than in *Potamochoerus larvatus*. The ears are not tufted and the nasal disc is very broad. There are no tusk apophyses and no rostral warts, but in boars the zygoma is thickened and pneumatised, supporting large infraorbital renoid swellings. The dentition is far more specialized than in *Potamochoerus* and hypsodont, with enamel pillars supported by cementum, which wears through to the dentine soon after eruption. The anterior cheek teeth tend to be lost during maturation. The structure of the skull and the facial musculature are adapted to a folivorous rather than an omnivorous diet (Ewer, 1970). The skull is broad in comparison with that of *Potamochoerus* and the tusks of the boars flare out, for their tips are not abraded through wear by the lower canines.

Recent reviews (Haltenorth, 1963; Ansell, 1972) recognized three subspecies of forest hog: *ivoriensis*, *rimator* and nominate *meinertzhageni* (synonyms: *ituriensis, gigliolii, schultzi*), though *ivoriensis* has been included as a synonym within *rimator* by Kuhn (1965). Other authors have remarked on the distinctiveness of *ivoriensis* or on the differences between *ituriensis* and *meinertzhageni*. Having examined available museum specimens, I concluded that it is indeed possible to recognize three subspecies (though not with the synonymy given above) each of which is associated with a distinctive region or environment.

1. West African Forest Hog, *Hylochoerus meinertzhageni ivoriensis*

This subspecies does not differ significantly from the next in dimensions (skull length in mm 333-372 for females, 355-397 for males), but the shape of the skull is distinctive and unlike that of other subspecies.

Specimens from Liberia, Ivory Coast and Ghana have been examined, and it has been reliably recorded from Guinea (Prunier, 1946). Records from Guinea Bissau (De Sa e Melo Cristino, 1958) are not sufficiently detailed to be acceptable (Ansell, 1972) and the same must be said for Baudenon's (1958) claim that it occurs in Togo.

2. Congo Forest Hog, *Hylochoerus meinertzhageni rimator* (synonyms: *ituriensis, gigliolii*).

Specimens from Cameroon, Congo and Zaire (now Democratic Republic of Congo) have been examined, and this subspecies has been reliably recorded from the highland forest on the Cameroon border of Nigeria (Hall, 1976; Happold, 1987; Dowsett and Dowsett-Lemaire, 1989), the Central African Republic, Gabon and southern Sudan west of the Nile. This Sudan population is almost certainly continuous with those of Zaire and C.A.R. In the C.A.R. it is now known to range well north of the main forest block (Fay, in litt.). The Nigerian population may be an isolated one. At the same time, the Forest Hog is absent from lowland forest in Nigeria, western Cameroon and western and southern Gabon. In Zaire it is absent from most of the forests south of the Congo (Zaire) River and Schouteden's (1945) evidence that it occurs here has never been supported by specimens.

Complete skulls have been examined from Cameroon, Congo and Zaire north of the Zaire River only, subspecific identity of populations in other countries or regions being inferred. There is some geographic variation in size, specimens from the western part of the range being on average smaller than those from further east. Greatest length of skull in mm is 330-377 (females) and 341-388 (males) for Cameroon and Congo, but 331-391 (females) and 362-404 (males) for Zaire (mostly in the east). The samples from which these measurements were obtained are widely separated geographically but cannot be differentiated subspecifically, so the nominal Ituri subspecies ituriensis is synomised with rimator, originally described from Cameroon.

3. Giant Forest Hog, *Hylochoerus meinertzhageni meinertzhageni* (synonym: *schultzi*).

Only this, the nominate subspecies, deserves the epithet 'giant'. Greatest skull length in mm is 381-427 (females) and 410-461 (males). It resembles the subspecies rimator in the shape of the skull, but differs not only in its great size, but also in the size of the tusks, at least in boars, which flare widely. The cheek teeth are also different in that the cementum is developed at the expense of the enamel pillars, which are therefore more widely separated.

I have seen specimens from eastern Zaire (Albertine Rift Highlands only), Uganda and Kenya and fragmentary esteological material from Ethiopia. Intergradation between the lowland forest rimator and this very large highland race presumably occurs along the foothills of the Rift Highlands. The species is reliably recorded from Rwanda and northern Tanzania, and from east of the Nile in the Imatong Mountains, Sudan (Cotton, 1936). From their dimensions (d'Huart 1978, and in litt.), specimens from Virunga and Kahuzi are also of this nominate race. It is also said to occur in Burundi, but d'Huart (1978) was not satisfied that this is the case. It has not yet been shown that the populations in Ethiopia, Sudan and Tanzania represent the nominate race.

The Genus *Phacochoerus*
The Common Warthog and the 'Desert' Warthog

The warthogs differ in proportions from the other Afrotropical suids. They are more unguligrade and have a proportionally huge head. The skull is very strongly modified

from the *Sus-Potamochoerus* form. The ascending process of the mandible is elongated; the maxilla is considerably deepened, accommodating enlarged, very hypsodont molars; the zygomatic arch is much deepened as well and the orbits are displaced postero-dorsally relative to the rostrum so that they rise above the drastically shortened braincase. Except for the wide spreading canine sheaths, the skull has become triangular in dorsal outline, broad at the back, narrowing towards the front. The lower tusks do not wear down the tips of the upper tusks, which are long and curved. The tusks of sows are relatively large in proportion to those of boars, compared with the condition in the other Afrotropical genera. The cheek teeth are even more specialized than those of Hylochoerus. They are far more hypsodont and the enamel pillars are more numerous, narrower and closely packed together. The full number of cheek teeth is quoted as 22 but usually many of these are absent from mature animals. The pelage is coarse and very sparse, except for a prominent dorsal crest of long bristles. In young animals especially there is often a fringe of white hairs on the cheeks. Both genal and rostral warts are present, the latter unsupported by bony excrescences.

Nowadays all scientific and popular accounts dealing with the existing African fauna recognize only a single species of warthog, though paleontologists have long recognized that there are two Holocene species from Africa. These species are very well defined and they were almost universally recognized as distinct in the zoological literature for over 140 years. Clearly there is a need for a full presentation of the evidence for the two-species theory, which amounts to a reappraisal of the genus, and this will be done elsewhere. In the meantime a summary of some of the relevant information appertaining to the two species recognized here will be given below.

Common Warthog (*Phacochoerus africanus*)

This species is very widespread, occurring in all nations, which extend into the Northern Savanna or the Southern Savanna and the bordering arid zones. I have examined museum material from Mauritania, Senegal, Guinea Bissau, Sierra Leone, Ivory Coast, Ghana, Mali, Burkina Faso, Niger, Nigeria, Cameroon, Chad, Sudan, Ethiopia (including Eritrea), Zaire (now Democratic Republic of Congo), Rwanda, Burundi, Uganda, Kenya, Somalia, Tanzania, Malawi, Zambia, Zimbabwe, Mozambique, Angola, Namibia, Botswana, Swaziland and South Africa. The species is reliably known also from Gambia, Guinea, Togo, Benin and C.A.R. The following names would be available if subspecies were to be recognized: *africanus* (Senegal), *fossor* (Chad), *bufo* (Sudan), *aeliani* (Eritrea), *centralis* (eastern Zaire), *massaicus* (Tanzania), *sundevallii* (Natal) and *shortridgei* (Namibia).

Systematic studies of the common warthog have been based almost entirely on skulls, as the sparsely-haired skins are rarely preserved and almost nothing is known about variation of the pelage. There is much variation in the form of the skull but very few biologists have studied warthog skulls to determine geographic variation in the species. Lönnberg (1908, 1909) tried to identify variation in proportions, but his samples were so small that he did not always successfully differentiate individual variation and geographic variation. Hollister (1924) later demonstrated that massaicus must be a synonym of

aeliani, though it now seems that he might have been wrong, and Hill (1942) could not distinguish Botswana specimens referred to shortridgei from animals from north-east Zaire, East Africa, Zululand and Transvaal (by implication, *centralis*, *massaicus*, *sundevallii* and *shortridgei* would be synonyms of *aeliani*). Lundholm (ms. quoted by Ansell 1972 and Meester *et al.*, 1986) regarded shortridgei as a synonym of *sundevallii*. Schwarz (1920) on the other hand was satisfied that the subspecies *fossor*, which he had named, could be differentiated from *bufo*.

Preliminary analysis of skull measurements indicates the following. West African skulls are very large, with relatively long post-orbital length. Specimens from the Sahel are smaller and may grade into the Eritrean population, with narrow intertemporal width but still with relatively long postorbital length. Central African populations also have very large skulls, but with shorter postorbital length. Kenya specimens are similar but smaller, and Southern African warthogs are smaller still, with narrow intertemporal width and short postorbital length. The analyses of ranges of means values of such cranial parameters (adult males only; from many small samples obtained from museum specimens and Hollister, 1924), therefore provide a basis for the definition of subspecies, but it becomes much more difficult to identify putative subspecies when the variance of samples is taken into account (Grubb, unpubl.). However, samples from the following areas are sufficiently differentiated in at least one measurement to be regarded as subspecifically distinct: Senegal/ Eritrea; Senegal/Kenya; Kenya/Eritrea; Eritrea/ Somalia; Natal/Malawi; Natal/Senegal. But relatively substantial samples from Zambia, Katanga, Kivu-Rutshuru and Kenya cannot be separated from each other or from Malawi or Natal.

Following these indications, subspecies *bufo* and *centralis* are certainly redundant and synonyms of *massaicus*; *shortridgei* is almost certainly a synonym of *sundevallii*. Peripherally distributed *africanus*, *aeliani* and *sundevallii* are distinct from each other, but they appear to link up - perhaps clinally - with other supposed subspecies. This is an interim report, and when material from critical areas is examined and larger local samples are assembled, it may prove necessary to regard this taxon as monotypic, exhibiting geographic variation of such a continuous nature that discrete subspecies cannot be identified. In the meantime, the following (four) subspecies may be recognized provisionally:

1. Northern Warthog, *Phacochoerus africanus africanus*

Range: Northern Savanna and Sahel region (including: Mauritania, Senegal, Guinea Bissau, Ivory Coast, Burkina Faso, Nigeria, Chad, Sudan, CAR, N. Zaire and S. Ethiopia).

2. Eritrean Warthog, *Phacochoerus africanus aeliani*

Range: Eritrea, Djibouti and Somalia only?

3. **Central African Warthog, *Phacochoerus africanus massaicus*** (synonyms: *bufo, centralis and (?)fossor*).

   Range: East and Central Africa (including: Kenya, Zaire, Rwanda, Burundi, Katanga, Zambia, Malawi and Angola).

4. **Southern Warthog, *Phacochoerus africanus sundevallii*** (synonym: *shortridgei*).

   Range: Southern Africa (including: Zimbabwe, Botswana, Namibia, Natal).

Cape and Somali Warthogs
(*Phacochoerus aethiopicus*)

For much of the last century and in this century also, at least among paleontologists, two species of warthog have been recognized. The Cape warthog was distinguished principally by its lack of functional incisors. The common warthog has two incisors in the upper jaw and usually six in the lower jaw. One or more may be lost, but their former presence can be identified in cleaned skulls from traces of the alveoli. Other distinguishing features of Cape warthog skulls and teeth have also been noted in the literature, but have hardly ever been reviewed and evaluated in a systematic manner. The natural distribution of the Cape warthog was never properly identified and few specimens ever became available, none after the mid-nineteenth century. The specific name of the Cape warthog is the earliest one of the genus, so when all warthogs were considered to be one species, the characteristics of the better-known common warthog became associated with the name of the less well-known species. It became the accepted view among zoologists that the Cape warthog was no more than an extinct geographic representative of the common warthog. Paleontologists on the other hand have recognized two kinds of warthog in fossil material from South Africa and have treated *P. aethiopicus* and *P. africanus* as two different species, believing that the former is now extinct (see Ewer, 1957 for an important review).

In 1909, Lönnberg noted that two male warthog skulls obtained in Somalia also lacked incisors. He created a new species, *P. delamerei*, on the basis of these specimens and noted other similarities with *P. aethiopicus*, though he was not convinced that these two taxa were immediately related to each other. Nevertheless, warthogs with a specialized incisor-less morphology and other characters were now known from South Africa and East Africa. Roosevelt & Heller (1922) noticed this discontinuous distribution between north-east and south Africa - between Somali Arid and Southwest Arid Zones - which recalls the distribution of other animals of dry environments such as the dikdik or oryx. In the interim, however, Lydekker (1915) had grouped all warthogs into one species, *P. aethiopicus* - the specific name properly associated with the Cape warthog. Since then, few neontologists have recognized the important divisions within the genus and there appear to be no acknowledgements in the literature of Roosevelt & Heller's (1922) perceptive observations nor of the anatomical features linking delamerei and aethiopicus which Lönnberg (1909) and Heller (1914) identified.

My own studies not only confirm differences between the common warthog and the Cape species, but that the Somali warthog and the Cape warthog are so alike that they should

be regarded as conspecific. The principle features of the Cape/Somali warthog, *P. aethiopicus*, in comparison to the common warthog, *P. africanus*, are:

- the skull is relatively small, but proportionately shorter and broader;
- the front part of the zygomatic arch is thickened by internal sinuses and swollen into a spherical hollow knob just in front of the jugal-squamosal suture (in the common warthog, the zygomatic arch may be robust but it is never quite so thickened and there is no formation of a knob);
- there is never any trace of upper incisors, even in relatively young individuals, and the lower incisors, even if present, are rudimentary and non-functional (whereas the common warthog always has two upper incisors, though these may be lost in very old animals, and usually six, functional lower incisors in the adult dentition, of normal suine form);
- in the Cape warthog (but not yet confirmed in the Somali form), the large third molars are very different from those of the common species in that no roots have been formed by the time all the enamel columns have come into wear, so that the columns are able to continue growing and extend the life of the tooth; and
- in the common warthog the skull roof behind the internal nares is marked by two deep and distinct 'sphenoidal pits', not found in any other African suid, while in the Cape/Somali species, these pits have expanded enormously, disappearing as distinct entities, so as to contribute to two vaults between the pterygoids, separated by a deep vomerine ridge.

Other differences have been described, but their validity may need further investigation. However, the characters of the incisors, cheek teeth, zygoma and sphenoid region are trenchant, discrete and functionally quite independent. There is no indication of intermediate states and no likelihood that the morphological differences merely indicate intra-population variation, particularly as one of the species is itself discontinuously distributed. One could not have better morphological evidence for the existence of two species. Furthermore they may even be sympatric in some places. The two subspecies of 'desert' warthogs may be described as follows:

Cape Warthog, *Phacochoerus aethiopicus aethiopicus* (extinct)

Cape warthog specimens in museums lack locality records but specimens subsequently identified as belonging to this species were obtained by Sparrman between the Sondags and Boesmans rivers, eastern Cape Province, and by Burchell on the upper Orange River, south of Hopetown, again in the eastern Cape. The full extent of the Cape warthog's former distribution remains unknown. Possibly it was restricted to the Karoo. There is no mention of this subspecies being obtained after about 1860.

Somali or Desert Warthog, *Phacochoerus aethiopicus delamerei*

This geographic representative of the Cape warthog is recorded from Somalia, both in the north and in Jubaland in the south, and from northern Kenya. Both this species and the common Warthog have been obtained in northern Somalia, where locality records for the common species form an enclave in the vicinity of Berbera, with sparse records of Somali warthog to the west, east and south. The two species may be parapatric or even

partly sympatric and ecologically segregated in northern Somalia, but this has yet to be confirmed. Their relative geographical disposition in Kenya (or eastern Ethiopia) cannot be assessed at all in the absence of adequate specimens or information.

Somali warthog from Kenya and Jubaland are larger than those from northern Somalia and it may be necessary to describe them as a separate subspecies. Not enough specimens are available, however, to determine whether this should be done.

Areas of interest for further research on the taxonomy of Afrotropical suids

Potamochoerus:

There is a need to obtain a better understanding of the distribution of the red river hog and bushpig, especially at the edges of their respective ranges, with a view to the assessment of their genetic and ecological relationships and the factors with affect their dispersion. Further studies of the systematics of this genus, especially the nature and extent of individual and geographic variation within and between selected regions/populations of *P. larvatus*, are also required:

Priority Projects:

1. Field studies in selected locations along the contact zone between the two species.

   These studies are needed to determine local relationships between the populations of these two species (i.e. are they parapatric or locally sympatric?, locally hybridizing or lacking any interspecific gene flow ?) and to identify the form of ecological segregation between them. Particular locations/questions requiring investigation include: a) in Sudan - is the red river hog present?; b) in Uganda - is there really hybridization in the Kibale Forest, or elsewhere, or is the red river hog absent from the country ?; and c) in eastern Zaire/Rwanda/Burundi - how is the apparent geographical segregation of the two species related to altitude and vegetation formation ?

2. Investigate aspects of the systematics, karyotype, geographical variation and distribution of the bushpig in East and South Africa.

   These studies are required in order to: a) establish the form of color polymorphism in the species; b) determine whether the Taru Desert and other inhospitable areas in Kenya and Tanzania promote the geographic isolation of bushpig populations, especially between upland and coastal lowland habitats, and to establish whether a lowland coastal and riverine subspecies, *somaliensis*, can validly be differentiated in these countries; and c) assess the systematic position of the (now?) isolated Cape Province population with respect to the Central and East African populations (see Fig. ///).

3. Investigate the origins, systematics and ecology of the Malagasy bushpigs.

Such studies should be designed to establish: a) the nature of the geographical variation on the island and the need or otherwise to recognize one or more Malagasy subspecies; b) to define more precisely any differences in morphology between the Malagasy and mainland African populations, using modern methods of genetic analysis where possible; c) by means of anthropological/archaeological studies, to attempt to determine the way in which bushpigs were brought to Madagascar and the social/cultural context in which this occurred; and d) to investigate the ecological role of the bushpig in relation to the native fauna and flora of Madagascar.

Hylochoerus

Further studies are required on the geographical variation and distribution of this species, both generally and in selected, critical areas so as to enhance our understanding of the diversity and systematic relationships of those populations.

Priority Projects:

1. Ascertain the external appearance and variation with age and sex of the different subspecies/regional populations.

   These studies, which should be undertaken by non-destructive means (namely by good quality photographic records), are needed to establish the distinctiveness of these taxa/ populations more fully in the eyes of conservationists and the public.

2. Clarify the systematics and karyotype of the species over its range.

   Photographic records, as well as osteological and soft-tissue material from hunter-killed animals, should be obtained in order to determine this genetic and geographic variation and, in particular, to determine the characters of Ethiopian, Imatong (Sudan), Tanzanian and Nigerian populations so as to establish which subspecies they represent.

3. Review all available distribution records and to conduct further field investigations to ascertain whether the species occurs or occurred formerly in those localities or countries for which detailed evidence of their occurrence is still lacking (e.g. Togo; see Fig. 8).

Phacochoerus

Geographical variation and, hence, the subspecific taxonomy of the common warthog, *P. africanus*, is still poorly understood owing to the shortage or absence of taxonomic material from key areas over the species' range. Further, and comparative, studies of both species, particularly in arid habitats, are also required in order to clarify their systematic and ecological relationships.

Priority Projects:

1. Undertake further basic studies pertinent to the alpha-taxonomy of *P. africanus* using new methods or involving previously unstudied material, in order to determine whether there really are discrete subspecies.

   These investigations should include the acquisition of additional taxonomic materials from selected regions, as well as photographs of adults from all different regions. The latter will enable an assessment of geographical variation in external appearance, as museum skins are too few or too distorted and misleading to provide much assistance.

2. Investigate the ecology and behaviour of both species of warthogs in arid environments.

   In the light of recent studies of the common warthog, *P. africanus*, in mesic or relatively mesic environments, comparative studies would be of particular interest in the Sahel (for *P. africanus*) and the Somali Arid zone (for *P. aethiopicus delamerei*). In terms of its morphology and in the extent to which it has, as a pig, extensively occupied an arid habitat, the latter is the most specialized of all living suids, at least in the sense of deviating most from an ancestral form, or in relation to a more generalized taxon such as *Sus*. The ecological constraints impinging upon its life history must be severe indeed, bearing in mind the problems faced by warthogs in well-watered habitats, and how it is able to overcome these is of considerable scientific interest, as well as relevant to its future management.

3. Make a thorough study of the geography and comparative ecology of *Phacochoerus africanus* and *P. aethiopicus* where they are likely to be in contact.

   These areas are northern Somalia, Jubaland, eastern Ethiopia and northern Kenya. These studies are needed to determine whether these species are sympatric, parapatric or whatever, and how they are ecologically segregated.

4. Investigate the distribution, variation, and population biology of the (now?) isolated northern and southern populations of the Somali warthog, *P. aethiopicus delamerei*, with a view to determining their relative taxonomic and conservation status and future management needs.

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Chapter 4.2

The Warthogs (*Phacochoerus africanus* and *P. aethiopicus*)

Paul Vercammen and Darryl R. Mason

Status and Action Plan Summary

Status categories: *P. africanus* is 1-2 (widespread and locally abundant or relatively secure), except for *P. a. aeliani* which is 'indeterminate'; *P. aethiopicus* is 4 (vulnerable) and 'extinct' depending on ssp.

With the exception of mature males, all warthogs live in small family units. They are largely diurnal and spend the night in burrows. They are predominantly grazers, but will eat a wide range of vegetable matter, including some agricultural crops. If enough food and water are available they can live their whole life in the same area, usually sharing their home range with other warthogs, though population density may be influenced by the availability of suitable burrows. Males will fight for females but are not known to defend a territory. Reproduction is seasonal, except on the equator, and litters normally range from two to five piglets.

Both currently proposed species are declining over the northern limits of their range, although the overall range of the common warthog, P. africanus, is expanding in some other areas in response to the opening up of former woodland. Hopes that the 'extinct' Cape form, *P. a. aethiopicus*, may survive in the far northern Cape Province have proved groundless as the warthogs in this area have functional incisors. However, the recent realization that the Somali warthogs, *P. a. delamerei*, are closely allied to the Cape form, and are ecologically adapted to an arid environment, make these animals a high priority for conservation attention, particularly as they not known to occur in any protected area over their limited range. However, given the current political situation in the Somali/Eritrea region, effective in-situ conservation measures for these animals, and for the Eritrean warthog, *P. africanus aeliani* (the most threatened subspecies of the 'common' warthog), are likely to be difficult, so captive-breeding of both forms is recommended as a priority and safeguard. Nonetheless, field status surveys of the distribution and abundance of warthogs, and/or comparative studies of their behavioral ecology, are required in these areas as soon as circumstances permit, as well as in certain other areas where the available data are insufficient to assess regional conservation and management problems and priorities at the present time.

Introduction

Warthogs are separated into their own subfamily, Phacochoerinae, and are amongst the most distinct and highly specialized of all suids. Following Grubb (this vol., Section 4.1) two living species, the common warthog, *P. africanus* (with c. 4 ssp), and the desert warthog, *P. aethiopicus* (with one living and one extinct ssp.) are distinguished. The latter species is differentiated from the more familiar, common form by various cranial and dental characters, including the absence of functional incisors, and by its smaller body size, though its external appearance, behavior and ecology remain poorly known. In comparison with other suids, warthogs appear less deep in the chest, with barrel-shaped bodies, which are sparsely haired, except for a distinct mane of long stiff hairs on the neck and shoulders. The face is flattened and bears one or two pairs of warts and, in both sexes, well developed tusks. The two species and their respective subspecies may be described as follows:

The Cape and Somali (or Desert) Warthog (*P. aethiopicus*)

A live warthog sent to Holland from the Cape Colony by Governor Tulbagh in 1765 was the first such animal to be described (Sclater, 1900). Although warthogs became largely extinct in the Cape, probably soon after the massive rinderpest epizootic at the end of the nineteenth century, specimens collected from this region had no functional incisors and were characterized by a number of other distinctive dental and cranial features (Grubb,

this vol., Section 4.1). In his review of the taxonomy of the African suids, the latter author suggests that the warthogs of Somalia are virtually indistinguishable from the extinct Cape form and advocates that the Somali population should be recognized as an isolated form of this species, both on the basis of its dental and skull characteristics and reported sympatry with *P. africanus* in northern Somalia. Accordingly, he advocates that the widely separated southern (or Cape) and northern (or Somali) warthog variants are referred to as *P. a. aethiopicus* and *P. a. delamerei* respectively. The external appearance, behavior and ecology of the Somali animals are almost unknown, though Fagotto (1985) reported that warthogs were the most widespread and abundant large mammals, and that groups (of up to 10-15 individuals) were still present throughout most of Somalia, even in very dry bushlands.

The Common Warthog (*Phacochoerus africanus*)

Warthogs with functional incisors, first described by Buffon in 1766 but not given a scientific name until 1788, proved to be much more widely distributed, occurring in almost all sub-Saharan countries, as far south as Natal Province (see Fig. 7). At least eight subspecies have been described, though Grubb (this vol.) suggests that the majority of these are synonymous and that only four subspecies should be (provisionally) recognized at the present time, viz:

- *P. a. africanus* - Sahel to central Ethiopia (now probably extinct in Mali and Niger)
- *P. a. aeliani* - northern Ethiopia and Djibouti
- *P. a. massaicus* - eastern and central Africa
- *P.a. sundevallii* - northern part of the southern African sub-region.

Link to Fig. 7: Approximate former and present known distribution of the desert warthog (*Phacochoerus aethiopicus* ssp.) and the common warthog (*P. africanus* ssp.).

Former and Present Distribution

Warthogs inhabit open and wooded savannas, grass-steppe and semi-deserts from Mauritania and Ethiopia in the north to Namibia and Natal in the south. The two species have allopatric ranges, as follows:

Phacochoerus aethiopicus has a discontinuous range between north-east and extreme south Africa, though it is evidently extinct in the latter region where it formerly occurred in the Cape Province and apparently in Orange Free State. The species is otherwise confined to a small area of north-east Africa from Kenya north of the Guaso Nyiro River throughout Somalia, probably extending into the Ogaden of extreme south-east Ethiopia. It is likely that the range of this species impinges on that of P. africanus in the Berbera region of north Somalia and, possibly, north-eastern Kenya and south-eastern Ethiopia, but it is not known whether true sympatry or intergradation between these populations occurs in these areas (Grubb, this vol.).

Reliable records of the historical distribution of warthogs in the Cape Province are sparse (du Plessis, 1969; Skead, 1980, 1987), but they were reported as far south as the Sundays River near present-day Port Elizabeth (Sparrman, 1789). Further inland, warthogs were recorded from the foot of the Zuurberg hills (Barrow, 1801) and in the Beaufort West district of the Karroo (Lichtenstein, 1815). Rookmaker (1989) provided further records of warthogs in south-central Cape Province, based on archives and literature up till 1790. Their former range also extended across the Orange River into the northern Cape and Orange Free State, where they were recorded from the sour-grass plains (Cumming, 1851) and along the Riet River (Bowker, cited in Mitford-Barberton, 1970), both localities south-west of present-day Blomfontein; and near the Rhenoster River, a tributary of the Vaal River, in the northwestern Orange Free State (Baines, cited in Kennedy, 1964). However, their occurrence in this region, where winter temperatures may fall to freezing, clearly depended on the availability of vleis (marshy depressions) and riverine foraging sites, as well as night-time shelter in aardvark burrows, rock crevices and reedbeds, but some localities would have been too cold. Moreover, relatively lush riparian corridors along seasonal watercourses enable warthogs to penetrate or reside in arid regions, as evinced by recent sightings of these animals in reedbeds at the mouth of the Ugab River in Namibia (B. Loutit, pers. comm.).

Warthog numbers in the Orange Free State and much of the Cape Province had probably already been substantially reduced by uncontrolled hunting when the infamous rinderpest epizootic that began in the horn of Africa in 1889 reached the Cape in 1896 (Mack, 1970). Consequent mortality of cattle and game across the continent was catastrophic (Plowright, 1982). Warthogs are highly susceptible to rinderpest and the epizootic was so virulent in southern Africa that it burned itself out completely (Scott, 1981). Because the reproductive potential of warthogs is high, their populations can recover quickly even after being decimated, but documentary evidence of the post-rinderpest situation vis-…-vis warthogs in the Orange Free State and Cape Province is lacking. Uncontrolled hunting and encroaching settlements may have eliminated warthog survivors even before the rinderpest, especially where habitats were marginal, and salient habitat factors may have changed. Whatever the causes, warthogs became extinct in the Orange Free State and over most of their former range in the Cape.

Unfortunately, hopes that the warthogs surviving in the far northern Cape (Meester *et al.*, 1986; Skinner and Smithers, 1991), including the Molopo River on the Cape side of the Botswana border (P. Novellie, pers. comm.) and the Alletasrust area of the Vryburg district (G. Fletcher, pers. comm.), may be living representatives of this species have also proved groundless as these animals have fully functional incisors like the *P. africanus* stock. Moreover, there is no evidence that the far northern Cape warthogs derive from sources other than the ancestral populations that would have had a much wider historical distribution southwards and into the Transvaal and Botswana.

The common warthog still has a very wide range extending from Senegal and extreme south Mauritania in the north-west to northern Ethiopia and Djibouti in the north-east, to Namibia, the northern Cape Province and Natal in the south. However, the continuous

expansion of the Sahel-zone has resulted in a marked contraction in the species' former range in the north since the early 1980's, and accounts for its probable extinction in Mali and Niger (J. Newby, pers. comm.). Recent data on its status and distribution are lacking from the southern Central African Republic, most of Zaire (now Democratic Republic of Congo), and from Angola, but elsewhere the species is reported to survive throughout much of its former range. Indeed, its range is expanding in some areas, such as Botswana and Transvaal Province, in response to the clearing of former wooded savannah and the creation of pasture. In addition, warthogs have been 'reintroduced' in Natal and eastern Cape Province (Skinner and Smithers, 1991; Mason, 1992; M. Somers, pers. comm.), though this stock could pose a threat to the genetic integrity of the native populations surviving in the northern Cape (also see later text). In north-east Algeria, a small breeding group that escaped from the Annaba Zoo in 1988, seems to have become established in the vicinity of the city and comprised 25-30 animals early in 1991 (K. De Smet, pers. comm.; Fig. 7).

Habitat, Ecology and Behavior

Warthogs occur over a wide range of altitudes from sea-level in the Gambia (A. Camara, pers. comm.) to 3,000 m on the Ethiopian plateaus (J. C. Hillman, pers. comm.). The distribution of both species is limited by the availability of suitable forage, cover and, increasingly, by human pressures. Warthogs occur on treeless open plains and in lightly wooded savannah, but avoid densely wooded vegetation without grazing. They are predominantly grazers, though they will also consume sedges, fallen fruits and certain forbs. During periods of drought they may be able to subsist without drinking water by rooting for succulent rhizomes and bulbs. Compared to bushpigs, *Potamochoerus larvatus*, warthogs appear much less dependent on the continuous availability of surface water. For details of the ecology and behavior of warthogs in southern Africa see Cumming (1975), Kingdon (1982), Mason (1982), Radke (1991) and Skinner and Smithers (1991).

Warthogs are largely diurnal and sleep at night in burrows, often using aardvark holes. While their body temperatures can evidently vary within a certain tolerance range (Cumming, 1975), warthogs usually cope with high temperatures by behavioral strategies, such as wallowing. Their sparse pelage and usual lack of substantial sub-dermal fat also facilitate heat dissipation, but these afford poor insulation against cold, to which warthogs are particularly susceptible. Low resistance to cold is ameliorated by sheltering in burrows, huddling together and, sometimes, by constructing grass nests. Infants are particularly vulnerable to cold exposure and malnutrition during drought, which together with predation and other mortality factors may result in juvenile survival rates of <50% during the first year (Mason, 1982, 1990). Lions are the most important predators of warthogs, probably followed by leopards. Adult warthogs usually run from wild dogs, but constitute formidable prey to leopards and cheetahs, which tend to hunt younger animals. By sheltering in burrows overnight, they largely avoid nocturnal predators, including hyenas, which are nevertheless wary of adult warthogs.

Adult males are not known to be territorial, but they contest mating priority. They are usually solitary or live in small, loose bachelor groups, unattached to the small family

units, which generally comprise one to three adult females and their young. One or two mature daughters may continue to associate with their mothers over several mating and farrowing cycles, but males generally leave their natal groups before the age of two years, often forming or joining bachelor groups. Warthogs breed throughout the year in equatorial regions, but under seasonal climatic conditions farrowing is cyclical and synchronized with the end of the dry season or, in regions of higher rainfall spread over most months of the year, during the short dry season. The gestation period is about 172 days; average litter size being 3 with a range of 1 - 7 (Mason, 1982). Unlike *Potamochoerus* (Vercammen *et al.*, this vol. Section 4.4) interbreeding with other suids has never been reported, even if several species live in the same region and use the same waterholes.

Threats to Survival

As indicated above the principal causes of mortality amongst free-living populations are climatic extremes (including low temperatures, excessive rainfall or drought) and predation. Owing to their preference for open savannahs, warthogs may benefit from deforestation, though desertification has undoubtedly contributed to the species' decline in parts of the Sahel.

Human persecution in reprisal for crop-raiding, or overhunting for meat, are probably the most important threats to *P. africanus*, and the latter factor undoubtedly contributed to the early extinction of the Cape population of *P. aethiopicus*. Warthogs are known to cause serious damage to various crops, most notably rice-fields in Guinea Bissau and peanut crops in eastern Zaire (now Democratic Republic of Congo; P. Chardonnet, pers. comm.; J.-P. d'Huart, pers. comm.). Damage to unspecified crops has also been reported from Gabon, Guinea and Mauritania. They are also regarded as competitors for grazing on cattle ranches in southern Africa.

Warthogs are easy to hunt and provide a large carcass. In non-Muslim countries, their meat is highly valued, both for local consumption and for trade in city markets, though in many countries, particularly in the west and north, warthogs benefit from the religious taboo relating to the consumption of pork. However, these taboos do not provide complete protection against human predation or persecution, since hunting by Christian and animist groups continues, as in Djibouti (A. Laurant, pers. comm.), or the Muslims themselves may hunt wild pigs to sell the meat to local non-Muslims or city markets, as in Senegal (A. Dupuy, pers. comm.) and Guinea Bissau (P. Chardonnet, pers. comm.).

There is some-small scale trade in warthog tusks as tourist curios in Somalia, Guinea Bissau and Senegal, but no significant international trade in warthog ivory has been documented to date. It remains to be seen if the controls on the elephant ivory trade will influence demand for warthog tusks in the future, as has been suggested (D. Cumming, pers. comm.).

Warthogs are also susceptible to various diseases, which may seriously affect local populations, as well as making them important targets for disease control programmes.

For example, outbreaks of rinderpest in Benin in 1981, the Central African Republic in 1983-85, and in north Zaire (now Democratic Republic of Congo) 1984, are reported to have resulted in the loss of up to 80% of the populations in these countries (A. Green, pers. comm.; J. M. Fay, pers. comm.; K. H. Smith, pers. comm.). Warthogs are a preferred host of the tsetse fly (D. Cumming, pers. comm.), for which attempted control measures have included costly and controversial game eradication campaigns. An indication of the scale of the latter is provided by the recorded total of 67,897 warthogs shot in Zimbabwe between 1933 and 1957/8 (Child & Riney, 1987). Because of the importance of warthogs as a vector of the tick-borne African swine fever virus (Rautenbach, 1982), which is fatal to domestic pigs, the transport of live warthogs or their meat is restricted in Botswana, Natal and Zambia (R. C. V. Jefferey, pers. comm.; P. L. Walker, pers. comm.).

Conservation Measures Taken

P. africanus is present in most of the protected areas throughout its extensive range, whereas *P. aethiopicus* is not known to occur in any protected area at present. It is possible that the range of the latter species extends into the only existing reserve in Somalia, Lack Badana National Park (3,340 sq. km), in the southernmost corner of the country, and even as far as the Samburu-Isiolo National Reserve (504 sq. km) in Kenya (P. Grubb, pers. comm.), though its presence in these areas requires confirmation. In theory hunting is forbidden in all national parks and wildlife sanctuaries, but is permitted during fixed seasons and/or on restricted permits in some reserves. However, such permits are rarely issued in most countries, except for legitimate scientific research purposes or population control. In practice, however, protective legislation is poorly enforced or totally unenforced in some countries or parts thereof (e.g. the Central African Republic, Nigeria, Togo and Zaire (now Democratic Republic of Congo)).

Outside protected areas, both species are in serious decline due to overhunting over most of their former ranges. In general, hunting regulations are reported to be more frequently violated than respected in most West and Central African countries, even inside most of the designated protected areas, though the Gambia and Ghana are among certain notable exceptions. Apart from Angola and Mozambique, designated national parks and wildlife reserves are well protected in all southern African countries, but farmers are free to control warthog numbers outside these areas.

As previously stated, the range of *P. africanus* is slowly spreading southward due to the 'restocking' of private and government game reserves in South Africa. This practice, together with accidental releases, has enabled the species to become established ('naturalized') outside its original range in Natal, (eastern) Cape Province and in Algeria.

Given the very low levels of international trade in live warthogs and warthog products at the present time, neither species is included on the CITES Appendices.

Captive Breeding

Due to their strange appearance, warthogs were among the first and most popular pigs to be exhibited in western zoos (e.g. in the Hague in 1765, in London in 1850, Brussels in 1856, in Hamburg between 1862 and 1872, and in Antwerp in 1867 (Vercammen, unpubl.). However, reproduction has been recorded only relatively rarely and has seldom met the demand amongst zoos for exhibition animals and it is only recently that serious attempts have been made to breed this species, e.g. in Frankfurt, Moscow and Los Angeles Zoos. Nonetheless, warthogs are now the most numerous exotic pigs in captivity, with the exception of *Sus scrofa*, though they continue to fetch high prices on the commercial market for live animals. The continuing demand for live warthogs amongst some U.S. zoos has even led to the highly undesirable practice of 'leasing' exhibition animals by animal dealers and breeders. Most of the warthogs currently held in captivity originated from East Africa, though no attempts have been made to maintain the integrity of particular subspecies. However, most of these animals are certainly P. africanus since, as far as is known, the only captive *P. aethiopicus* currently (1991) in captivity is an adult male, reputedly from northern Somalia, in a private collection in Qatar (C. Groves, pers. comm.).

Additional Remarks

Under favorable conditions and in the absence of large predators, warthog populations are potentially capable of increasing by up to 39% per annum (Somers and Penzhorn, 1992). As a result, the species is often kept on game ranches, where it is harvested on a commercial basis, e.g. in Burkina Faso (C. Spinage, pers. comm.), Zimbabwe (V. Wilson, pers. comm.) and South Africa, while population numbers in protected areas may have to be controlled by culling, e.g. in Lengwe National Park in Malawi (R. Bell, pers. comm.).

Conservation Measures Proposed:
An Action Plan

P. africanus has a vast range wherein numerous national parks afford adequate protection, although their long-term survival outside these reserves is rather doubtful given continued hunting pressure and/or the conversion of former habitat for human settlement and agriculture. In comparison, *P. aethiopicus* is almost certainly extinct in the southern part of its disjunct range, and its present status in the north is unknown, although warthogs were reported to be widespread and relatively abundant in Somalia in 1984 (Fagotto, 1984). Moreover, the occurrence of Somali warthogs has not been confirmed from any protected area. These considerations are manifest in the following recommendations, which also address the need for more information on the systematic relationships of these animals, and their current distribution, conservation status and utilization by local people over large parts of their range, where existing data are insufficient for the formulation of practical management measures at the present time.

Priority Projects:

Phacochoerus aethiopicus:

1. Conduct field status surveys.

   Field surveys are required to determine the present status and distribution limits of this putative species throughout its relatively restricted remaining range in the Somali Republic and north-eastern Kenya, possibly extending into the Ogaden of eastern Ethiopia, in order to formulate management recommendations and conservation measures for the enhanced future protection of core population areas. Particular emphasis should also be placed on determining whether this species is allopatric with P. africanus or whether sympatry or intergradation occurs at the limits of its range in the latter areas.

2. Conduct field studies of the species' habitat, ecology and behavior.

   These studies are important because the behavioral ecology of this species is virtually unknown and is of considerable scientific interest, both for comparison with the substantial data already available on the closely-related P. africanus and because this species may be one of the most specialized of all living suids. Such studies should also investigate the species' adaptations to arid environments and the functional significance of its loss of incisors.

Phacochoerus africanus:

3. Conduct field status surveys in northern Ethiopia and Djibouti.

   Additional distribution and status data are required for the most threatened subspecies, *P. a. aeliani*, which is insufficiently known in Ethiopia and is almost certainly endangered in Djibouti, with a view to the development of practical management plans for the enhanced future protection of the (now) isolated populations in these areas and/or the determination of areas of intergradation between this subspecies and the nominate P. a. africanus (i.e. within the easternmost limits of the range of latter form).

4. Collect additional distribution and population status data from south Central African Republic
   and Zaire (now Democratic Republic of Congo).

   This region is of particular interest as a transition zone between savannah and rainforest, but available data on warthogs are scanty. Field investigations and/or additional questionnaire surveys are therefore required, if only to improve understanding of the present range of this species and factors controlling its distribution.

5. Collect distribution and status data from Angola and Mozambique.

Almost no recent data are available from these countries, due largely to continuing political unrest, which precludes field investigations. However, it is doubtful if warthogs or other 'game' animals are adequately protected within the existing protected areas systems in these countries in the present political climate. Wide-ranging field surveys should, therefore, be conducted as soon as is opportune. Following an aerial survey in central Mozambique during 1990, J. L. Anderson (pers. comm.) reported marked decreases in wildlife populations due mainly to uncontrolled hunting, but noted freshly used warthog holes indicating the survival of these animals in some areas.

6. Conduct comparative studies of the ecology and distribution of *P. africanus* in West Africa.

Almost all available data on this species' behavior, ecology and habitat preferences are derived from field research conducted in East or South Africa. Comparative studies in selected areas in the westernmost parts of its range (i.e. from Mauritania in the west to Chad and Central African Republic in the east) would be of considerable scientific interest and potential importance to its future management in these regions/countries.

7. Discourage any further introductions of warthogs in the Cape Province, pending the results of
   genetic investigations.

Warthogs from Natal Province introduced by the Cape Directorate of Nature Conservation into the Andries Vosloo Kudu Reserve in the eastern Cape and the Rolfontein Dam Nature Reserve on the Orange River, could pose a threat to the genetic integrity of surviving native warthogs in the northern Cape. If significant genetic differences exist, there may be a case for encouraging control of the recently introduced populations.

P. aethiopicus and *P. africanus:*

8. Acquire additional taxonomic material from selected, critical areas.

As previously indicated (see earlier text; Grubb, Section 4.1, this vol.), a number of taxonomic questions, such as the affinities of the Phacochoerus spp./ssp. populations in eastern Ethiopia and north-central Kenya, and the distributional and genetic relationships between P. aethiopicus and P. africanus in this region can only be resolved by the acquisition and analyses of additional hard and soft tissue samples for comparative study.

9. Establish captive breeding programmes for the most threatened taxa.

The stringent veterinary regulations appertaining to the import and export of wild pigs which apply throughout the European community and in North America, make it very

difficult to supplement existing breeding stock outside Africa, particularly given the problem of isolating disease-free animals and the lack of suitable quarantine facilities in countries of origin. Consequently, the possibility of developing breeding programmes for both species in Africa merits consideration, both as a possible source of animals for future reintroductions and for research and educational purposes. In any event, the establishment of such programmes for the most threatened taxa, such as P. africanus aeliani and, especially, P. aethiopicus delamerei, is a priority.

10. Monitor trade in bush meat and tusk ivory.

Warthog populations are potentially susceptible to over-exploitation, particularly along the northern edge of their ranges. The possibility of commercial markets being created for warthog ivory, or for their skulls as curios around tourist centers, should be guarded against.

Acknowledgements

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Chapter 4.3

The Forest Hog
(*Hylochoerus meinertzhageni*)

Jean-Pierre d'Huart

Status and Action Plan Summary

Status category 3 - 5 (rare to endangered) according to subspecies or population.

The available data on the biology and distribution of this species are far from complete, though its conservation status is already a matter for concern in many parts of its former range. Three subspecies are recognized. Of these, the only truly 'giant' form, *H. m. meinertzhageni*, has the smallest range but appears relatively secure in its eastern montane habitats. However, various threats (including over-hunting for local markets and deforestation) are identified as causative factors in the diminution and fragmentation of the species' range and numbers in Central and, especially, West Africa. The lack of an adequate network of protected areas for the long-term protection of the smallest and most threatened race, *H. m. ivoriensis*, in West Africa is particularly worrying and is reflected in the conservation measures proposed. These measures also emphasize the need to assess the taxonomic (and conservation) status of the poorly known, isolated populations of the southern Ethiopian highlands, and to review of status of populations in the contact

zone between the Central African subspecies, *rimator*, and the eastern giant, *meinertzhageni*. Other proposals include the possible restocking of animals in newly protected forests in Rwanda/Burundi, assessment of population status in some still poorly known areas, the revision of protective legislation in several countries, and the creation of new parks and reserves in the most critical parts of its fragmented range. In addition, some specific recommendations concerning the most threatened populations in Central and West Africa detail needs for the allocation of forest concessions, studies of bush-meat markets and desirability of a captive-breeding initiative for *H. m. ivoriensis*.

Introduction

The 'giant' forest hog, *Hylochoerus meinertzhageni*, is one of the most recently discovered large mammals, being first described in 1904 from specimens collected near Kaimosi in Kenya. These specimens proved to be of relatively large size, since there is an east to west cline in body size in this species, with adult males of the nominate *H. m. meinertzhageni*, from the highlands of East Africa, reaching a body weight (>225 kg), total (head + body + tail) length (>230 cm) and shoulder height (>110 cm), greater than any other extant suid. By comparison, the largest male *H. m. ivoriensis*, reported by Rode (1944), weighed only 150 kg and measured 205 cm total length, 94 cm shoulder height. Apart from their body size, the enlarged, discoidal snout and antorbital protuberances are diagnostic, as is their relatively long, but sparse, bristly black pelage.

Forest hogs occupy a variety of essentially closed habitats over a wide altitudinal range. As such, the species is potentially a useful indicator of natural and human-induced changes in its forest habitat. As a social, sedentary species, it is susceptible to hunting pressure, though its population biology and other aspects of its ecology and behaviour remain rather poorly known owing to its retiring and essentially nocturnal habits. However, studies have been conducted in east Zaire (now Democratic Republic of Congo) by d'Huart (1978) and in Kenya by Kingdon (1979), whose accounts include references to earlier published data on the species' systematics, anatomy, pathology, behaviour in captivity, distribution and trophy measurements.

Seven subspecies have been described, but the most recent revision of the genus (Grubb, 1985 and this vol., Section 4.1), suggests that only three of these are valid, i.e.: *H. m. meinertzhageni* (East African highlands), *H. m. rimator* (Central Africa) and *H. m. ivoriensis* (West Africa). This treatment, which is followed here, does not recognize the separation of the two Central African populations (i.e. the western '*ituriensis*' and eastern '*rimator*') as distinct subspecies, but it acknowledges that the systematic relationships of the forest hog populations in Ethiopia remain unknown. It is probable that the Ethiopian hogs are derived from the *H. m. meinertzhageni* stock, since sightings have been reported in southern Sudan and eastern Uganda, on the right bank of the Nile (Cotton, 1936). However, given the wide and early separation of these two populations by the ancient eco-climatic montane boundary along the 4th parallel North, which might favor the evolution of a distinct race, it is possible that the Ethiopian population comprises a different, as yet described, subspecies (d'Huart, 1978; Yalden *et al.*, 1984; J. C. Hillman

in *litt*.). The approximate former and present distribution limits of all these forms is shown in Fig. 8.

Link to Fig. 8: Approximate former and present distribution of the forest hog, *Hylochoerus meinertzhageni* ssp.

Former and Present Distribution

Forest hogs are unevenly distributed through the still forested areas of west-central Africa. This distribution is similar to that of the bongo (*Boocercus eurycerus*), and although both species have habitat preferences, they are not confined to particular forest communities. In West Africa (south Guinea, Sierra Leone, Liberia, south Ivory Coast and south Ghana), the range of the subspecies *ivoriensis* now roughly corresponds with the least disturbed remnants of the lowland humid forests. In other parts of Guinea, Sierra Leone and Ivory Coast, the species also occurs in montane forests (e.g. in the Mamou Mts., Foutah Djallon, and Loma Mts.), and in gallery forests (Outamba N.P., Comoe N.P.) in the Guinea savanna zone. Some of these sites are now isolated, and it is certain that forest hogs have been extirpated from many intervening sites in the primary forest and in the Guinea savanna, in some of which they still occurred until recent times (e.g. in Guinea Bissau and in south Togo; d'Huart, 1978). Their present distribution is becoming increasingly fragmented, though the full extent of this process is poorly documented.

Western populations of the subspecies *rimator* (i.e. those between the rivers Niger/Benoue and Zaire/Oubangui - see Fig. 8) still occur in five countries from the Nigeria /Cameroon border to north Gabon, north Congo and extreme south-west Central African Republic. However, though their presence in Nigeria, where only four sites are known, was reported only as recently as 1976. The species is absent from Bioko Island (T. Butynski, in *litt.*) and is believed to be extinct in the vicinity of the Rio Muni in Equatorial Guinea. Forest hogs have also disappeared from many areas in west Gabon and south Congo, though recent data indicate their continued occurrence in numerous protected and non-protected areas in south Cameroon and south-west Central African Republic (Table 5). Further east, this subspecies remains almost continuously distributed along the right bank of the Zaire River to the southernmost limits of the equatorial forest in central-east Zaire (now Democratic Republic of Congo) in the south, to extreme north and north-east Zaire, east Central African Republic and south-west Sudan in the north. It occurs in all types of primary, secondary and gallery forests. The northern limit of its range is the vicinity of the Massif des Bongo, south of the Manovo-Gounda-St. Floris National Park, though the progressive fragmentation of the forest galleries linking the Massif to the forests in the south is likely to isolate this population in the future. This subspecies has also disappeared from several sites in north Central African Republic and north-west Zaire. Its reported presence in three sites on the left bank of the Zaire River (Schouteden, 1947) has never been confirmed.

In the easternmost limits of the forest hog's range (along the west branch of the Rift in east Zaire, west Uganda and Rwanda, and in some locations along the east branch in east Uganda, west and central Kenya and north Tanzania), the giant form, *H. m. meinertzhageni*, now survives only in isolated montane forests, from 1,000 to 3,800 m.

Some connecting corridors still exist within the complex of the Ruwenzori/Virunga N. P./Queen Elizabeth N.P. /Bwindi Forest/Virunga Volcanoes, but most of the remaining populations in this region are now isolated. A similar situation obtains in south-central and west-central Ethiopia (J. C. Hillman, in *litt*., Yalden *et al.*, 1984), where the fragmented populations of south-central Ethiopia are isolated from the nearest neighboring populations of Kenya and Uganda.

Habitat, Ecology and Behavior

In common with the red river hog, *Potamochoerus porcus*, *Hylochoerus* is more dependent on forest than the other African suids. Throughout its range, it inhabits a wide variety of forest types, including forest galleries, lowland humid forest (even in marshy areas), secondary forests, escarpment forests, lowland and montane dry forest, montane mosaics, montane forests up to 3,800 m in the Ruwenzori Mts. and certain thickets and woodlands. Within these habitats, however, it is more likely to occur where there is a convenient and permanent water source, thick understory cover in some parts of the home range, and a variety of vegetation types. The forest hog is an ecotonic species, which seems to prefer intermediate habitat zones, where the edge effect is maximized. In the central plain of Virunga National Park in Zaire (now Democratic Republic of Congo), forest hogs inhabit forest galleries (dominated by *Croton* sp., *Pterygota* sp. and *Rauwolfia* sp.), dry forests (*Euphorbia* sp., *Olea* sp.) and bush thickets (*Capparis* sp.). These three habitats constitute a sequence in the natural succession from forest to savanna, and forest hogs move from one habitat to the other.

On a continental scale, the variety of forest habitats occupied implies a high degree of adaptability to local climatic conditions. Mean annual rainfall, for example, varies from 750-800 mm in the Masai-Mara National Park in Kenya to 3,200 mm in western Liberia. Over most of its range, mean monthly midday temperatures vary between 20oC and 30oC, but night temperatures often fall to 0oC in some montane habitats where the species occurs.

Forest hogs feed mainly on grasses, selecting a few species preferentially at different times of the year. In forest, their diet also includes many dicotyledons. Carrion and eggs are consumed occasionally, and coprophagy and geophagy are common. Details of diet and foraging behaviour are given in d'Huart (1978) and Rahm & Christiaensen (1963).

Forest hogs are naturally retiring, and their shy and essentially nocturnal behaviour, coupled with a relatively low density population and forest habitat, accounts for the rather poor understanding of their ecology and behaviour over most of their range. In Zaire (now Democratic Republic of Congo), forest hogs live in family sounders in rather small territories, each of which includes resting sites situated in the densest thickets, a network of tracks, a water hole (which is also used for mud-bathing), saltlicks (where soil is dug out with the tusks), and latrines. Semi-diurnalism may be acquired in areas where the animals are not hunted, but the species is nocturnal over most of its range. In Virunga National Park, the hogs are active for about 10 hours per day, of which about 60% is spent grazing in savanna. The distances covered daily are between 8 and 12 km.

Sounders, usually of 6-14 individuals, are led by an adult male, but normally include one or more other adult males, as well as two or more adult females and dependent juveniles or infants. Sex ratio of sounders is usually about 1 male: 2 females. Larger groupings of several sounders have been reported occasionally. Fighting behaviour is less ritualized than in some other suids (e.g. warthogs) and can be violent. Combatants are often wounded, sometimes fatally. Sexual maturity is attained at 18 months in both sexes and reproduction is strongly seasonal. In the Virunga National Park, there are two distinct mating seasons in February/April and August/October; the corresponding birth seasons being in January/March and July/September, respectively. The gestation period is approximately 151 days, and 2-4 piglets are born in nests of tall grasses under piles of branches, constructed by the mother. Weaning occurs at about 9 weeks. Growth is relatively rapid and adult body size is reached by about 18 months. The juvenile mortality rate of approximately 50% is attributed to predators, crushing by the mother or weaning stress. Dispersal of young males and fighting amongst older animals are important mortality factors, as well as parasitism and, in older animals, extreme wear of teeth (d'Huart, 1973; Grzimek, 1963). The age structure observed in Virunga National Park was 67% adults, 15% subadults and 18% young. Maximum longevity is around 18 years and mean life expectancy (all age classes combined) exceeds 5 years in natural conditions. However, further studies are required to ascertain whether the behaviour, ecology and population biology of the hogs in Zaire is similar in other parts of the continent.

Population Status and Threats to Survival

According to the recent (1989/90) Pigs and Peccaries Specialist Group questionnaire survey, the population status of forest hogs was reported as 'giving cause for concern' in all west African countries, except Guinea and the Ivory Coast where this was thought to be 'satisfactory'. Elsewhere, its status was also reported as satisfactory except in Gabon and in Zaire (now Democratic Republic of Congo) where the extent of deforestation and hunting (i.e. poaching) pressure were causing concern.

As summarized in Table 5, the species is reported as having a 'restricted distribution at low density' over most of its range and that not all suitable habitats within the same biogeographical zone are occupied. The exceptions to this pattern are Guinea and the Ivory Coast, where the national population status was categorized as 'widespread at low density, but locally abundant', and the Congo, where the species is reported to be 'widespread at high density'.

However, there is some doubt about the accuracy of these reports, which, in the absence of any proper census data, are highly subjective. Indeed, the only population density estimates ever made were in Zaire and these ranged from 0.4 animals per sq. km in Gangala na Bodio (Cornet, 1957) to 2.6 per sq. km in Virunga National Park (d'Huart, 1978). Even these estimates may be rather unreliable, since they were extrapolated from spot samples over large areas, in only part of which forest hogs may occur. Local population densities may therefore be much greater. This may be the case in Zaire,

Uganda, Central African Republic and Sudan, where the species was reported to have a 'restricted distribution at low density, but locally abundant in the most suitable parts of its habitat'. However, the species was not reported to be 'very abundant' anywhere over its extensive range, except possibly in the immediate vicinity of well protected forests and neighboring cultivated areas. Forest hogs reportedly occurred in great numbers in this situation in the Rutshuru area of Kivu National Park, east Zaire, in 1950-1952.

Table 5. Population trends, status and occurrence in protected areas of the Forest Hog, *Hylochoerus meinertzhageni* ssp.

Subspecies	Country	Population Status	Population Trend	Legal Status	Protected Areas
H. m. ivoriensis	Guinea	W-LD-LA	U	NP	No data
Mts.	Sierra Leone	RD-LD	D	NP	Outamba N.P.; Loma Mts. N.P.; Gola N.R.(?)
	Liberia	RD-LD	D	G	Sapo N.P.; some F.R's.
	Ivory Coast	W-LD-LA	U	G	Tai N.P.; Comoe N.P.; Azagny N.P.(?)
	Ghana	RD-LD	D	G	Bia N.P.; Bia G.P.R., Nini-Suhien N.P., Ankasa Game Prod. R.
H. m. rimator (western populations)					
	Nigeria	RD-LD	U	GJK	Gashaka-Gumti G.R.;
W.R.;	Cameroun	RD-LD	D	H	Dja W.R.; Campo W.R., Douala-Edea Takamanda F.R.; Pangar Djerem W.R.
	Gabon	RD-LD	U	H	Ipassa-Makokou N.R.
	Congo	W-HD	I	H	Odzala N.P.
H. m. rimator (eastern populations)					
	Central African Republic	RD-LD-LA	S,D	HJK(+)	Dzanga-Sangha N.R; Zemongo W.R.; Manovo-Gounda St. Floris N.P.;
N.P.; G.R.; Mondo	Zaire	RD-LD-LA	S,D	HJK	Garamba N.P.; Maiko N.P.; Virunga Kahuzi-Biega N.P.Okapi N.P.; Luama Rubi Tele G.R.; Azande-Gangala- G.R.; Epi G.R.; Maika Penge G.R.;

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<div style="text-align:right">G.R.(?)</div>

H. m. meinertzhageni

	Sudan	RD-LD-LA	S	G	Bangangai N.R.; Bire Kpatuos N.R.; Mbarizunga N.R.
G.R.;	Uganda	RD-LD-LA	D	HJK	Rwenzori N.P.; Queen Elizabeth N.P.; Bwindi Forest N.P., Toro G.R.; Kigezi Kibale F.R.; Mgahinga F.R.
	Rwanda	RD-LD	D	JK	Nyungwe F.R.; Volcans N.P.(?)
	Burundi	(no data)	(no data)	(no data)	Kibira N.P. (?); Rusisi Valley
	Tanzania	RD-LD	U	GJK	Ngorongoro C.A.; Ngurdoto Crater N.P.
	Kenya	RD-LD	U	HJK	Aberdares N. P.; Mt. Kenya N.P.; Masai Mara G.R.
	Ethiopia	RD-LD	S	HJK	Bale Mountains N.P.

Key: Population status: W = widespread; RD = restricted distribution; LD = low density; HD = high density; LA = locally abundant. Population trend: U = trend unknown; S = stable; D = decreasing; I = increasing. Legal status: NP = no protection; G = total protection; H = partial protection; J = possession and/or national trade prohibited or regulated; K = international trade prohibited or regulated; (+) = stricter protection than any other taxon in same catergory. All data from Pigs and Peccaries Specialist Group African Suiform Survey (1989/90), excepting for some legal status data extracted from African Wildlife Laws (IUCN, 1986). See text for further explanation.

The principal threats to the species are habitat destruction and hunting pressure. Deforestation is undoubtedly the single most important reason for the diminution of its remaining range, especially in West Africa, where the lowland forests are being fragmented and destroyed at an alarming rate. Consequently, the species has already disappeared from most of its former range and in several countries it now occurs only in national parks and reserves.

Forest hogs are also widely hunted for food or in reprisal for their damage to crops. Subsistence hunting is generally not considered a particularly serious threat to their survival except possibly in lowland forests where their numbers have already been greatly reduced and the population fragmented. Nevertheless, subsistence hunting is practiced over most of their range, excepting much of East Africa and in some other areas where Islam predominates (mostly between 5° and 10° S), and the consumption of pork is taboo. Some tribal groups in the northern Congo also avoid hunting them or eating their flesh because of a local superstition, uniquely applied to this species, of calamity if they are killed. Elsewhere however, the species' social and sedentary habits make them a relatively easy target, especially for pygmies and other forest peoples who relish its meat (Carpaneto & Germi, 1989).

By comparison, commercial meat hunting for urban markets is a far more important cause of decline, especially in forested areas around cities. This trade represents an increasing threat to the species in north-east Zaire, Ghana, Liberia and Sierra Leone.

There is no significant trade of other body parts, though hog tusks are sold as ivory in Liberia. Allocation of excessive quotas of hogs in hunting concessions in the Central African Republic also constitutes a potentially serious threat.

Persecution of the species for damaging crops has been reported from Guinea, Liberia, Ivory Coast and Zaire (now Democratic Republic of Congo). In the Rutshuru area of Zaire, an 18 months pest control operation in 1945-46 led to the destruction of 329 bush pigs, 77 warthogs and 619 giant forest hogs (Hubert, 1957).

In common with other suids, forest hogs are important vectors of rinderpest, but no specific eradication scheme to combat the spread of rinderpest has ever been organized.

Table 6: Status of *H. meinertzhageni* ssp. according to the Pigs and Peccaries Specialist Group categories (Appendix One).

Subspecies	Populations	Status Category Nationally	Overall
H. m. meinertzhageni	Kenya, Tanzania, Uganda, E. Zaire	3	
			3-4
	Rwanda, Burundi:	5	
***H. m.* subsp?**	Ethiopia	Indeterminate (poss. 4)	
H. m. rimator (eastern populations, formerly *ituriensis*) **+**	S. W. Sudan, N. & N. E. Zaire, Central & N. Central African Rep.:	3	3-4
H. m. rimator (western populations)	S. W. Central African Republic, Congo, Gabon, S. Cameroon,		
			4-5
	E. Nigeria, N. W. Cameroon:	5	
H. m. ivoriensis	Guinea, Sierra-Leone, Liberia, Ivory Coast, Ghana	5	5

Conservation Measures Taken

H. meinertzhageni is accorded total protection or partial protection (i.e. hunting permitted only under license) in most countries where it occurs (see Table 5). The only exceptions are Guinea and Sierra-Leone, where the species has no legal protection, which is most unfortunate in view of the critical conservation status of the species in these two countries. Elsewhere, the existing protective legislation would probably be sufficient to ensure the survival of the species if the relevant laws were properly implemented, but this is seldom the case. According to the 1989/90 questionnaire survey, wildlife protection laws in a large majority of countries within the range of this species were either poorly

enforced, or not enforced at all. In some countries legislation was reportedly implemented only in national parks (e.g. Ghana, Liberia, Zaire) or in hunting concessions (e.g. Central African Republic, Gabon), though even this was questioned by other informants.

Although the forest hog is relatively well represented in the network of parks and reserves over its range (as listed in Table 5), it is doubtful if these areas are sufficient to ensure the protection of the species in several countries over the longer term. In West Africa, in particular, *H. m. ivoriensis* is already under heavy pressure from deforestation, and is now thought to be securely established in only three sites, i.e. Sapo N. P. in Liberia, Tai N. P. in the Ivory Coast and Bia N. P. in Ghana. In central-west Africa, the few large forest parks and reserves are unlikely to ensure the long-term protection of the western populations of *H. m. rimator* from the continued high levels of deforestation and hunting pressure, and additional protected areas for these populations are required as a matter of some urgency. The situation is less bleak for this race in central-east Africa, owing to the existence of several large parks and reserves in Zaire (now Democratic Republic of Congo), though the continuing pressure on these areas requires careful monitoring. Despite its much smaller range in East Africa, *H. m. meinertzhageni* is thought to be adequately safeguarded in its remaining montane forest habitats provided the existing reserves continue to be actively protected. In Ethiopia, forest hogs are reported in only one national park and in several non-protected forest areas and hunting concessions, but their overall status and management needs in this country need to be properly assessed.

On an international level, Hylochoerus is included on Class B of the African Convention on the Conservation of Nature and Natural Resources, which regulates or prohibits hunting, killing, capturing or trade of listed species. However, international trade in this species is negligible and it is not listed on the Appendices of CITES.

Captive Breeding

Relatively few animals have been kept in captivity, and no captive births have been reported. The maximum recorded longevities (a female in the Leopoldville Zoo, from 19.4.55 to 31.5.57, and a female in the Frankfurt Zoo, from 14.5.54 to 5.4.57) are less than 4 years. The species has been exhibited in only four other European collections (i.e. London Zoo: four males and two females from 1936 to 1938; Hamburg Zoo: three males and two females from 1938 to 1941; Antwerp Zoo: one male and two females in 1955; and Amsterdam Zoo: a female in 1954), in two collections in the U.S.A. (single females in the National Zoo, Washington, and in the Bronx Zoo, New York, in 1939) and in a few African zoos (e.g. Nairobi, Abidjan and Monrovia), though none of these animals survived for more than a few months. Grzimek (1963) and Mohr (1960) suggest that these failures might reflect a lack of knowledge of the species dietary requirements and other basic ecological needs. As far as is known, there are no forest hogs in captivity at the present time.

Conservation Measures Proposed:
An Action Plan

Given the varying status of this species in different countries within its range, it is hardly practicable to identify a single set of recommendations. The following priority objectives and recommendations are therefore directed at only the most threatened forms and/or topics of foremost research interest.

Objectives:

1. To promote the survival of the most threatened subspecies and those populations whose taxonomic status is uncertain.

2. To propose legislative revisions that could improve the protection and management of particular, threatened populations.

3. To identify topics of research interest which will provide a better understanding of aspects of the species' biology and future management requirements.

Priority Projects:

1. Assess the taxonomic and conservation status of the forest hog population in Ethiopia and carry out field surveys in selected areas.

   The population in Ethiopia currently attributed to *H. m. meinertzhageni*, but which may represent an as yet undescribed taxon. Field surveys are also required as a matter of some urgency to: a) ascertain the distribution and status of the populations in south-central Ethiopia (possibly extending into the Sudan-Ethiopia border area around the 4th parallel N.); and b) develop of practical management initiatives to enhance protection of some or all of those populations, with particular emphasis on the regulation of hunting and the creation of additional reserves.

2. Assess management options for enhanced future protection and/or restoration (including possible restocking with translocated hogs) of the *H. m. meinertzhageni* populations in the newly created Nyungwe (Rwanda)/Kibira (Burundi) complex and in Mgahinga Forest Reserve (Uganda) where the local hog population has been depleted by over-hunting.

3. Re-evaluate the systematic relationships of the western and eastern populations of the subspecies *rimator*, which were formerly treated as two separate subspecies in the interface (or intergrade?) zone of the Zaire and Oubangui Rivers.

   These two populations were formerly treated as two separate subspecies (i.e. *rimator* and *ituriensis*, respectively). The present separation of *meinertzhageni* and the easternmost populations of *rimator* (formerly *ituriensis*) along the western Rift, should also be reassessed in order to the identify possible local intergradation between these taxa.

4. Assess forest hog status in the north-western corner of Zaire (Bosobolo, Gemena, Businga areas) and gazette the projected Mondjo N.P. as the westernmost protected area for the eastern form of *rimator* (formerly *ituriensis*).

5. Promote conservation measures for forest hogs in the Central African Republic.

This will require: a) revising hunting quotas for this species; b) enforcing protective legislation; c) developing incentives to halt fragmentation of forest galleries along tributaries of the Oubangui river; and d) develop special conservation measures for the Massif des Bongo.

6. Assess status and management needs and promote conservation of the most threatened western populations of *H. m. rimator*.

Actions required include: a) surveys of their distribution and abundance in the northern Congo, especially between the Sangha and Oubangui Rivers; b) evaluation of the need for additional protected areas in north Congo, north Gabon and south-west Cameroon; c) creation of additional forest reserves in south Cameroon, as recommended by IUCN for EEC funding (Gartlan, 1988); d) securing the small populations inhabiting remnant forest sites along the Nigeria/Cameroon border, especially in the Obudo Ranch and Takamanda Forest Reserve area, where a trans-boundary conservation scheme should be initiated; and e) evaluating the level of implementation of both traditional and sport hunting legislation in Gabon and its effect on Hylochoerus populations.

7. Promote early implementation of measures designed to protect remnant populations of the smallest and most threatened subspecies, *H. m. ivoriensis*.

This should be done with particular reference to: a) improving protection measures for the now isolated populations in the Guinea Savanna zone of Guinea, Sierra Leone and Ivory Coast; b) promoting creation of large, new protected areas in lowland forest of Liberia, Ivory Coast and Ghana, where forest hogs still occur in relatively large numbers; c) revising forest land tenure and concession allocation systems and the implementing traditional hunting legislation in all range states, with a view to better conservation of forest mammals in general; d) investigating the bushmeat market and other related activities to ensure that utilisation of forest game is sustainable and to develop alternative sources of income for rural people; and e) initiating captive breeding and research programmes for this subspecies in the zoo community.

Acknowledgements

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Chapter 4.4

The Bush Pigs (*Potamochoerus porcus* and *P. larvatus*

Paul Vercammen, Armin H. W. Seydack and William L. R. Oliver.

Status and Action Plan Summary

Status categories 1-2 (widespread and locally abundant or relatively secure) - both species.

The bushpig, *Potamochoerus larvatus*, and red river hog, *P. porcus*, remain relatively widely distributed and are locally abundant in some places, and neither is considered threatened over the majority of their known ranges at the present time. Both species live in small family groups, usually comprising 4-10 individuals, and are rarely observed in larger numbers. They are usually sedentary and territorial. In most areas they are predominately nocturnal, but tend towards diurnalism if undisturbed. Reproduction is seasonal with litter size from one to six, but generally only one or two young are reared successfully. Both species, but particularly bushpigs, are notorious for their depredations on crops. There is evidence that the conversion of former forest to secondary scrub and

agriculture has resulted in an increase in their numbers in some areas, and attempts to control or eradicate them have usually proved unsuccessful.

As neither species is considered threatened, priority recommendations are primarily directed towards: a) the resolution of outstanding questions pertaining to their systematic relationships and the distinctness of some regional populations of P. larvatus; b) the need to conduct more field studies on their ecology, behaviour, management and socio-economic importance to local people; and c) obtain additional field status data in areas where they remain poorly known.

Introduction

Following Grubb (this vol. section 4.1), two species of 'bush pigs' are recognized: the red river hog *Potamochoerus porcus* (0 ssp.) and the bushpig, *P. larvatus* (4 + ? ssp.), though the genetic and distributional relationships of the two species remain uncertain in the interface between their respective known ranges.

Both species are of medium body size, with an elongated snout and a long, often brightly colored coat. The red river hog, *P. porcus*, is always bright rufous in color, with a distinct white dorsal stripe and crest, long white whiskers and eartufts. The species occurs only in Equatorial [West] Africa, from Senegal in the extreme west, and east and south to eastern Zaire (now Democratic Republic of Congo). Geographical variation is slight, though there is an east (largest) to west (smallest) cline in body size in specimens from eastern Zaire and Cameroon, respectively. However, any such geographic variation is considered insufficient to warrant subspecific separation (P. Grubb, this vol. and in litt.)

The bushpig is light red to brown, gray or predominately black in color, sometimes with, but often without, the distinct white masks and long eartufts characteristic of P. porcus (for a full description of regional variants see Grubb, this vol.). *P. larvatus* has a relatively wide range, extending from Somalia in the north-east, to east and south Zaire in the west, to Natal and Cape Provinces of South Africa in the south (Fig. 9). The four, currently recognized subspecies are:

P. l. hassama, eastern Africa;
P. l. koiropotamus, Angola and south-eastern Africa;
P. l. larvatus from Mayotte (Comoro Is. and western Madagascar); and
P. l. hova from eastern Madagascar.

However, the Madagascan/Comoron populations are almost certainly introduced, and there is not yet enough evidence to justify the recognition of two possibly distinct populations in eastern Somalia/northern Kenya (i.e. *P. l. 'somaliensis'* - herein considered as *P. l. hassama*) and southernmost, apparently isolated population in Cape Province (i.e. *P. l. 'nyasae'* - herein considered as *P. l. koiropotamus*; P. Grubb, pers. comm.).

Link to Fig. 9: Approximate former and present known distribution of the red river hog, *Potamochoerus porcus*, and the bushpig, *P. larvatus* ssp.

Former and Present Distribution

P. porcus remains relatively widely, but now patchily, distributed through much of it its former range in Equatorial West Africa from Senegal/Gambia in the west, through the Guineo-Congolian rain forest zone, extending northwards into the Sudanian transitional zone (Stuart and Adams, 1990). In central and eastern Africa, it occurs at least as far north as southern Chad and at least as far east as Virunga and Garamba National Parks in eastern Zaire (now Democratic Republic of Congo). The species may also occur in extreme south-western Sudan (Hillman, 1982; J. C. Hillman, pers. comm.), though the animals reported from this country so far are P. l. hassama (P. Grubb, pers. comm.). Further east and in south-eastern Zaire the species is replaced by P. larvatus (see below). However, the precise limits of the ranges (or intergradation ?) of these two species in this region and elsewhere in southern Zaire, and hence also their ecological and systematic relationships, has yet to be established (P. Grubb, pers. comm. and this vol., section 4.1).

P. larvatus hassama occurs in Eritrea and Tigre Provinces of Ethiopia in the north, (presumably) extending through south-western Sudan on both sides of the Nile. The subspecies *P. l. somaliensis* (if valid) replaces *hassama* in the vicinities of the Tana, Juba and Scebeli Rivers in Somalia, N. E. Kenya, and perhaps as far south as Tendaguru on the coast of north Tanzania. The identity of the bushpigs in central Tanzania remains uncertain, so the northern limits of the range of *P. l. koiropotamus* are provisionally given as southern Tanzania and south-eastern Zaire. This race has by far the largest range of any of the currently recognized subspecies, though it should be reassigned to '*P. l. nyasae'* if the (now ?) isolated population in the southern Cape (the origin of the holotype) is shown to be subspecifically distinct (Grubb, this vol.). It otherwise occurs throughout south-eastern Africa, at least as far south as Natal Province in South Africa, as well as in a few isolated locations in west and central Angola.

As previously stated, the origins and distinctness of the Madagascan subspecies, *P. l. hova* and *P. l. larvatus*, is problematic. The eastern 'race', *P. l. hova*, closely resembles *P. l. koiropotamus*, but is smaller in size than the mainland form and the nominate *P. l. larvatus* from western Madagascar and Mayotte. Clearly, more specimens are needed to elucidate the validity of these subspecies, which are reported to occur in all terrestrial habitats on Madagascar, except in the environs of the major townships and the deforested central plateau (M. Nicoll and F. Rakotondraparany, pers. comm.).

Data on the former distributions of both of these species are sketchy and imprecise. However, there has been an evident contraction in the recent range of P. porcus, particularly in the west and extreme north of its range. The expansion of the Sahel zone and, hence, a reduction in cover and the availability of open water, has resulted in a similar contraction in the range of P. larvatus in parts of N. E. Africa. Nonetheless, both species seem to have maintained their presence over the majority of their former ranges, and recent, localized expansion in their ranges has been reported in some areas, e.g. in Botswana (Lloyd and Millar, 1983).

Habitat, Ecology and Behavior

The distribution of both species is apparently limited by the continuous availability of food, water and cover, and they are only rarely reported in open woodland, savannah or other more arid and open habitats.

The only field study to have been conducted to date on *P. porcus* was by Oduro (1989) in Nigeria. From this and other (mostly anecdotal) sources, it appears that this species occurs in a wide range of habitats, including lowland rain forest, gallery forest, dry forest, savannah woodland, and mixed scrub and cultivated areas.

From what is known, *P. larvatus* also occurs in an astonishingly wide range of habitats from sea-level to montane forest (up to 4,000 m on Mt. Kilimanjaro), to gallery forest, flooded forest and swampland, woodland, and mixed scrub and cultivation areas. The species was the subject of a recent, intensive study by Seydack (1983, 1990, 1991). Earlier accounts of its natural history include those of Phillips (1926), Maberly (1967), Attwell and Bearder (1976) and Breytenbach (1979). General accounts of the species' biology are also provided by Sowls and Phelps (1968), Skinner et al. (1976), Ghiglieri *et al.* (1982) and Kingdon (1982).

Both species are predominately nocturnal, though a clear seasonal trend amongst bushpigs in the southern Cape towards more diurnal activity during winter suggests that temperature regulation, rather than hunting pressure, may be the underlying factor in the daily activity patterns of this species. During periods of inactivity they shelter in dense vegetation, and they may construct bad weather nests during cold and wet spells. Average daily movement distances for bushpigs were found to be 3 km, ranging between 0.5 and 5.8 km (Seydack, 1990).

They are omnivorous, and may be potentially important dispersers of seeds. The diet of Cape bushpigs was found to comprise 40% subterranean plant parts (mostly tubers, rhizomes and corms), 30% herbage, 13% fruit, 9% animal matter and 8% fungi (Seydack, 1990). Field studies of this species in Uganda have revealed that bushpigs often associate with groups of foraging monkeys in order to feed on discarded fruits (Ghiglieri *et al*., 1982). They are also opportunistic predators, and consume a range of invertebrates, smaller vertebrates and carrion.

Most reports indicate that both species typically live in family groups of 9 -15 individuals, though *P. larvatus* group sizes in South Africa were found to range from 1 to 10, with average of 2.4 individuals (Seydack, 1990). Similarly, in Madagascar groups seldom comprise more than 5 individuals (M. Nicoll, pers. comm.). Contrarily, Oduro (1989) recorded *P. porcus* groups of 1 - 15 (x = 10.56) with an immature/adult age ratio of 2:1 in Nigeria, and much larger groups of 30-60 red river hogs have been observed on occasions in Guinea and E. Zaire (L. Macky and J. Hart, pers. comm.).

Population density estimates in the southern Cape ranged from 0.3 to 0.5 bushpigs per sq. km, and average home range sizes in the Knysna Forest ranged between 3.8 and 10.1 sq. km (n = 8), with an average of 7.2 sq. km (Seydack, 1990, 1991). The home ranges of the pair-bonded adults in this study area were spatially exclusive, i.e. resource territoriality was actively maintained through defense and patrolling. This study also confirmed the earlier anecdotal accounts of Maberly (1967), Attwell and Bearder (1976) and Skinner et al. (1976) of a monogamous mating system in which adult boars play an active role in the rearing and defense of the young.

Reproduction in both species is apparently seasonal, with piglets being most frequently reported towards the end of the dry season or coinciding with the onset of the rainy season. Nearly 75% of births in the bushpig population in Cape Province studied by Seydack (1990) occurred during the spring (September to November), which agrees with earlier records suggesting farrowing taking place during the spring and summer (Sowls and Phelps, 1968; Tinley, 1977). Available data indicate that both species have a similar gestation period of c. 120 days, and litter size of 1-6, with a mode of 3 (Oduro, 1989; Neurohr, 1991; Seydack, 1991).

Mortality due to starvation has been recorded in all age classes of *P. larvatus* in the southern Cape. However, inclement weather and predation were predominant mortality factors for immature animals according to Seydack's (1990, 1991) findings, whereas intraspecific strife played a significant role in adult mortality.

Threats to Survival

Although habitat destruction is not considered a major threat to the survival of either of these species over most of their ranges at the present time, deforestation coupled with intense hunting pressure has inevitably resulted in marked range contractions in some countries/regions. In Benin, (north) Equatorial Guinea and (possibly) south Sierra Leone, for example, P. porcus is reported to be rare or absent outside existing protected areas (A. Green, pers. comm.; A. Blom, pers. comm.; G. Teleki, pers. comm.), though precise data are difficult to obtain owing to the species' secretive and nocturnal behaviour. Similarly, *P. larvatus* is reported to be scarce or absent outside the better protected areas in Burundi (P. Chardonnet, pers. comm.), though it is doubtful if this species is as seriously threatened as many of the other larger mammals in this country.

Indeed, both species are apparently highly adaptable and may even benefit by the opening up of former forested areas by the creation of secondary habitats, the provision of cultivated foodstuffs and reductions in the numbers of their natural predators. Both bushpigs and river hogs are notorious for their depredations on crops. In Zaire (now Democratic Republic of Congo) and Malawi, for example, bushpigs are reputed to cause more damage to agriculture, particularly maize crops, than any other species (R. Bell, pers. comm.). For these reasons, and because they are sometimes regarded as important vectors of livestock diseases (see below), they are widely persecuted by farmers and they

are frequently targeted in wildlife control programmes. Generally speaking, all such eradication attempts have been unsuccessful, largely because of the species' cryptic lifestyle and relatively high reproductive potential.

Both species are also hunted widely for subsistence purposes, though they undoubtedly benefit from taboos on the consumption of pork in many parts of their ranges. Amongst some Zambian tribes, for example, bush pig meat is considered to be unhealthy, even dangerous, because the animals are reputed to harbor various diseases, including epilepsy. These beliefs may have been influenced by the spread of Islam, which effectively affords these animals a good deal of protection against hunting in many African countries and in some parts of Madagascar. However, even in predominantly Muslim countries, it is doubtful if they are completely free of hunting pressure, since some Muslim groups discriminate between the 'red' meat of Potamochoerus (which is eaten) and the 'white' meat of other suids (P. Chardonnet, pers. comm.), whilst many others permit hunting by non-Muslim groups (e.g. in Sierra Leone; G. Davies, pers. comm.) or even hunt wild pigs themselves in order to sell the meat (e.g. in Guin,a Bissau, P. Chardonnet, pers. comm.). Seventy-eight percent of hunters interviewed in Gabon by Lahm (1990) cited the sale of red river hog meat as amongst their most important sources of revenue, and that only about one-third of their gained bush-meat was retained for domestic consumption. In Gabon (M. Nicoll, pers. comm.), Zaire (K. H. Smith, pers. comm.) and Guin,a Bissau (P. Chardonnet, pers. comm.) most animals killed by hunters and farmers are used for local consumption, though there is some local trade to village or city markets. With the exception of a few live individuals exported to zoos (see later text), there is no international trade in these species, or their meat, hide or other products, as far as is known.

Potamochoerus spp. are allegedly host to or vectors of tick-borne diseases, such as trichinosis, African swine fever and probably trypanosomes (W. Odura and F. Amubode, pers. comm.). However, the significance of this has yet to be verified.

Dorst and Dandelot (1970), Lever (1985) and Oliver and Brisbin (this vol.) cite records of the occurrence of feral pigs (Sus scrofa) in several parts of Sudan and in South Africa. Some of these animals became naturalized as early as 1925, either as a consequence of allowing domestic stock to range freely or by their deliberate introduction in an effort to control the pine tree emperor moth (*Nudaurelia cytheria*), whose pupae are readily consumed by these animals (Thomas & Kolbe, 1942). Hybridization between *P. larvatus* and *S. scrofa* was recorded in the Transvaal in the early 1970's, when an (escaped) domestic sow was mated by a male bushpig and the resulting progeny (a litter of eight) were reported to have bushpig characteristics (Smithers, 1983). Simoons (1953) also cited references to the interbreeding of *Potamochoerus* with domestic pigs in the Congo and in the Niger Delta. More recently, Eurasian wild pigs (*S. scrofa*), introduced for hunting purposes, have become established in a more or less free-ranging state in Burkina Faso, Gabon and, probably, Zaire. In the Wonga-Wongue Presidential Hunting Reserve in Gabon, these animals are reported to have interbred with *P. porcus*, and that their hybrid offspring are running wild (East, 1990). Whilst it is important to stress that evidence for such intergeneric hybridization remains anecdotal and that putative hybrids

have yet to be critically examined and described, introductions of *S. scrofa* apparently pose a threat to the genetic integrity of local Potamochoerus populations, as well as a risk of disease transmission.

Conservation Measures Taken

Both species are known or are likely to occur in all of the principal protected areas within their respective ranges. In all countries with an existing protected areas network, hunting is forbidden or is restricted to permit holders. In most countries such permits are usually given only for scientific research purposes, although they have also been issued on occasions (e.g. in Malawi; R. Bell, pers. comm.) to reduce the numbers of these animals following repeated complaints from local farmers about their damage to crops in neighboring areas.

Outside designated national parks and wildlife reserves, protective legislations are more varied. In Guinea, Liberia and Sierra Leone, for example, *Potamochoerus* spp. remain unprotected and can be legally hunted at all times, whereas in most other countries they are treated as game animals which can only be hunted during an open season. In only a very few countries, such as Burundi, where they are now confined to a few isolated locations, are they protected at all times and throughout their remaining range. In theory, in those areas where hunting is controlled the number of animals taken by one hunter is limited and/or confined to particular age/sex classes. In Gabon, for instance, hunting permits are issued for no more than 2 adult P. porcus, whilst in Nigeria sows with piglets or immature animals are protected at all times.

However, in many African countries, particularly in west and central Africa, law-enforcement is problematic, and in several countries it is virtually non-existent. In Benin, Central African Republic, Gabon, Ghana, Nigeria, Sierra Leone, Liberia, Sudan and Zaire (now Democratic Republic of Congo), for example, poaching is rife even within many nominally protected areas. By comparison, wildlife protection laws in some other countries, such as Zimbabwe, Botswana, Namibia and South Africa, are sufficiently well enough enforced to largely preclude the poaching of these animals within protected areas, though farmers may still be permitted to exercise control of their numbers elsewhere.

Captive Breeding

Both species are extremely rare in captivity outside their countries of origin, though specimens have been exhibited at intervals in various collections in Europe and the U.S.A. since the middle of the 19th century. However, they have been bred only very occasionally, and never in sufficient numbers to be self-sustaining, let alone meet the undoubted demand for exhibition purposes. Longevity was also very poor amongst the early captives, though a female red river hog was maintained at the Frankfurt Zoo from 1959 to 1979, whilst another female of the same species currently held in the Duisburg Zoo is close to breaking this 20 year record (Gewalt, 1988).

A small group of red river hogs has been maintained and bred in the Duisburg Zoo since 1979, though these animals are all descended from a single wild-caught pair from Togo. These animals, and another wild-caught pair from Togo recently imported by the Los Angeles Zoo, are thought to be the only specimens of this species held anywhere outside Africa at the present time. Moreover, the prospects for any further exports are diminishing with the imposition of increasingly stringent veterinary regulations concerning the movement of wild pigs throughout the European Community and in North America.

Additional Remarks

These species are maintained in a number of collections in Africa. However, few if any efforts have been made to develop properly structured research or captive breeding programmes within their countries of origin, or to explore their evident commercial potential for pork production. Although there is no evidence that *Potamochoerus* has ever been truly domesticated, Simoons (1953) has cited references to the semi-domestication or at least taming of *P. porcus* by various peoples along the northern border of the rainforest zone, as well as early accounts which suggest the species was taken to South America, where it was encountered in feral and tamed states, and to England, where it was alleged to have been used for cross-breeding with domestic pigs, *S. scrofa* (see earlier text). The (presumed) introduction of *P. larvatus* to Madagascar and the Comoro Is. might also reflect an earlier, and hitherto largely unsuspected, cultural and economic importance attached to these animals amongst some ethnic groups, which undoubtedly merits further investigation. In the Iyiocha Forest Reserve in southern Nigeria, for example, local tribal groups accord *P. porcus* the status of "king of the forest" (W. Oduro, pers. comm.). If an animal is killed, its carcass is carried to the traditional chieftain's palace before it is allowed to be butchered, and the meat is shared among the members of the chief's clan, and only a portion is given to the hunter.

Conservation Measures Proposed:
An Action Plan

Given that both species remain widely distributed, are well represented in numerous national parks and reserves, and are maintaining their numbers outside these areas in many parts of their ranges, neither species should be regarded as threatened at the present time. Indeed, in some areas there may even be a need to instigate more rigorous population control measures, as in some parts of Madagascar where (introduced?) bushpigs are reported to pose a serious threat to some native wildlife species. However, whilst species' conservation per se is not an issue at present, these species are threatened in some countries/regions, and efforts should be made to conserve these populations. In addition, very few field studies have been conducted to date, and many basic aspects of their systematics, biology and management requirements are poorly known and merit further investigation.

Objectives:

1. To obtain a better understanding of the distribution, genetic variation and systematic relationships of these species.

2. To obtain distribution and population status data in those areas where this information is lacking at present.

3. To encourage further studies of the population biology, ecology and behaviour of these species, and their socio-economic importance to tribal societies.

4. To promote the development of management programmes designed to: a) protect remnant populations in countries/regions where either species are threatened, or b) ensure the sustainable harvesting of these animals in areas where they remain abundant as an important resource for local people.

Priority Projects:

1. Obtain additional cranial, skin and cytogenetic specimen material (and photographs) from particular key locations, with a view to the resolution of outstanding systematic questions.

   Various questions pertaining to the geographic and genetic variation in these species, and their systematic relationships, remain unresolved at present owing to the absence or shortage of comparative specimens from particular key locations. These locations and questions include: a) Madagascar: further research is needed to check the validity of the subspecies *hova* and *larvatus*, and the relationships (and possible origins) between these animals and those of the African mainland; b) east and south Zaire and neighboring countries: obtain comparative specimens in the contact zone between *P. porcus* and *P. larvatus*, investigate reports of polymorphism in some of these populations, and reassess the distribution and taxonomic status of these animals in the light of these results; and c) Somalia and north-east Kenya: obtain additional, comparative taxonomic materials to assess the validity of separating *'P. l. somaliensis'* from *P. l. hassama*, and obtain more details about the distribution and status of bushpigs in this region. (Also see Grubb, this vol.).

2. Promote field studies on the biology and ecology of *P. larvatus* and, particularly *P. porcus*.

   Very few field studies have been conducted on either of these species and, as far as is known only one such study (in southern Nigeria by Oduro, 1989) has been undertaken on *P. porcus*. Further, comparative studies are required in order to obtain a proper understanding of their natural history and possible future management needs.

3. Collect population distribution and status data in selected areas.

At present, available data are inadequate or entirely lacking from a number of regions/countries, including Sudan, northern Ethiopia, south-east Somalia, central Zaire, Togo, Angola and Mozambique. In some of these areas, however, continued political unrest may preclude data collection in the near future, and may be a cause for concern in respect of its implications for increased hunting pressure to provide bush meat to military and displaced persons, and the ineffective protection of designated parks and reserves.

4. Investigate occurrence and status of introduced and feral pig populations, encourage their control or eradication, and discourage any future introduction attempts.

Updated data are required on the distribution and status of all naturalized pig populations, and the threats these pose to the genetic integrity and health of native wild pigs and other species. In particular, recent reports of *P. porcus X S. scrofa* hybrids in Gabon and elsewhere should be investigated, and voucher specimens of presumed hybrids (skeletons, skins, blood and cell samples) should be obtained because of their scientific interest. Nonetheless, support should also be given to the control or removal of these animals, just as similar support should be given to the control of any introduced populations of *P. larvatus* in those locations in Madagascar or the Comoro Islands where they are known or presumed to pose a primary threat to native wildlife species. (Also see Oliver and Brisbin).

5. Encourage anthropological (including archaeozoological) research on the socio-economic significance of Potamochoerus and other native wild pigs amongst ethnic groups, and promote studies designed to investigate the possible future use of these animals for domestic husbandry. (Also see Oliver *et al.* this vol., Chapter 4.9).

Acknowledgements

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<center>Chapter 4.5</center>

Review of Priorities for Conservation Action and Future Research on Afrotropical Suids

Jean-Pierre d'Huart and William L. R. Oliver

Introduction

The research and conservation action priorities for the three genera of Afrotropical suids, based on the recommendations made in the preceding chapters 4.1 to 4.4, are reviewed and summarized below as an 'Action Plan' for the Afrotropical Region. This review does not include the North African populations of the Eurasian wild pig, *Sus scrofa*, which are treated elsewhere.

The Afrotropical suids have large and distinct distributions across the continent, incorporating a wide range of natural habitats, from semi-desert, open- and wooded savannah, lowland and upland forests, forest galleries and miombo woodland. Within this array, however, each genus is broadly adapted to a particular range of habitat types: *Phacochoerus* from semi-deserts to wooded savannah; *Potamochoerus* from forest galleries to scrub, woodlands and rainforests; and *Hylochoerus* from dense lowland forest to forest galleries, highland dry and wet forests.

Although these suids are widely distributed in Africa, the results of the 1989/90 questionnaire and a review of the available literature reveal that in many countries basic data on their distribution, conservation and legal status are lacking. Nonetheless, some of the major gaps in our knowledge have been identified and can be prioritized for future investigation. The principal threats to the survival of these animals - habitat destruction and over-hunting - vary in importance from country to country, but it is nevertheless possible to highlight some of the problem areas within the (known or presumed) ranges of each of the recognized taxa.

Priorities for future research and conservation action are summarized below, though it is important to note that the socio-economic context for conservation action is unfavorable in most African countries owing to the pressure on natural resources consequent upon the burgeoning of human populations, often coupled with a lack of any appropriate environmental policies, protected area networks, or adequate public education and staff training programmes. The prospects for conserving large, representative areas of remaining natural habitats and their associated wildlife in many parts of Africa are bleak, though growing interest in sustainable utilisation offers hope for some wildlife species. This is particularly true in the case of the suids, owing to their relatively short reproductive cycle, their prolificity and their rapid growth rates.

Objectives:

1. To continue efforts to determine the current distribution and status of all species and subspecies of Afrotropical suids, and compare these data with available information on their former ranges, occurrence in protected areas, etc., in order to assess population trends and identify taxa most at risk.

2. To determine the major threats to each taxon, formulate and (where possible) assist implementation of appropriate measures for their conservation, including creation of additional protected areas.

3. To promote development of properly structured captive breeding programmes as part of the overall strategy for the conservation of the most threatened taxa.

4. To encourage sustainable development programmes, including the limited cropping of healthy suid populations as a means to encourage the rational use of wildlife resources and provide local people with an incentive to preserve habitat.

5. To promote more applied research into the population dynamics, ecology, behaviour and other aspects of the biology of Afrotropical suids, particularly the most threatened and/or least-known taxa.

6. To promote public awareness of the importance of conserving African suids in particular, and nature conservation in general.

Conservation Action Priorities

A. Conserve Taxa and Populations at Risk:

Whilst highest priority must be given to developing conservation strategies for those taxa known to be most at risk, there is also a pressing need to ascertain the actual status and possible future management requirements of taxa or isolated populations for which data are presently unavailable or inadequate. The recent questionnaire survey has provided much useful information the status of these animals in many African countries, but more is needed on the taxonomic affinities of some of the least known forms and/or their status in some of the most politically unstable countries or regions, before any definitive assessment of the overall priorities may be made. In the interim, however, the following taxa/populations are all considered threatened:

- *Phacochoerus aethiopicus aethiopicus*   -   extinct

- *P. aethiopicus delamerei*   -   status category 4

- *P. africanus aeliani*   -   indeterminate

- *Hylochoerus meinertzhageni meinertzhageni* - status categories 3 to 4,
- depending on population

- *H. m. rimator* - status categories 3 to 5,
- depending on population

- *H. m. ivoriensis* - status category 5

- *H. m. ssp. ?* (S. Ethiopia) - indeterminate.

Actions needed to develop conservation strategies for these taxa include:

1. Conduct field surveys to determine the present status and distribution of P. aethiopicus delamerei over its restricted range in Somalia, N. E. Kenya and E. Ethiopia, and formulate appropriate measures for the protection of core population areas.

2. Conduct field status surveys of *P. africanus aeliani* over its restricted range in N. Ethiopia and Djibouti in order to develop management plans for the enhanced future protection of representative populations.

3. Investigate the taxonomic and conservation status of the isolated population of *H. meinertzhageni* in southern Ethiopia, which may be a new subspecies, and develop management initiatives for the enhanced future protection of the core population.

4. Promote radical implementation of measures designed to protect remnant populations of *H. m. ivoriensis*, the smallest and most threatened subspecies of forest hog, ideally by:

   - the enforcement of the protective legislation appertaining to the now isolated populations in Guinea, Sierra Leone and Ivory Coast;

   - the creation of new protected areas of lowland forest in Liberia, Ivory Coast and Ghana;

   - the revision of the forest land tenure system, the forest concession allocation system, and the implementation of hunting legislation in Sierra Leone, Liberia, Ivory Coast and Ghana; and

   - investigation of the bushmeat market with a view to the development of alternative sources of income for rural people as well as the sustainable utilization of forest game in Sierra Leone, Liberia, Ivory Coast and Ghana.

5. Promote the development of properly structured captive breeding and research programmes in the local and international zoo community for each of the most threatened taxa of Afrotropical suids, namely: *P. aethiopicus delamerei*, *P. africanus aeliani* and *H. m. ivoriensis*; all of which forms have ranges which are wholly or largely confined to politically unstable countries/regions. These programmes should also be used to facilitate the collection and dissemination of useful biological data, the development of conservation-education initiatives, and serve as a source for possible future reintroductions.

B. Conservation Management of Afrotropical Suids:

In many African countries the conservation infrastructure is ineffective and cannot ensure the protection of representative populations of Afrotropical suid species. Some countries still lack any meaningful system of protected areas, whilst the majority lack the resources or political will to ensure the continuous, proper protection of designated wildlife areas or the policing of other relevant legislation. Thus, in addition to actions designed to protect those taxa which are already threatened by habitat destruction and hunting pressure throughout their limited ranges, it is also important to consider the future management of populations which are not yet seriously threatened, but which are nonetheless of some conservation interest or importance. For example, some national parks, such as Garamba and Virunga in Zaire (now Democratic Republic of Congo) and the Queen Elizabeth in Uganda, protect sympatric populations of three species of suids, one of which, H. meinertzhageni, has a restricted and (now) highly fragmented range. This situation resembles the sympatric occurrence of the three species of tayassuids in the dry Chaco of central South America, but is unparalleled amongst suids elsewhere. It also raises two particular issues concerning future management, namely: a) the identification and protection of representative populations of taxa likely to become threatened unless pre-emptive action is taken, and b) the identification and protection of areas which are of particular significance to the conservation of more than one taxon.

However, there are other equally relevant issues, including: a) the inadequacy of data on the distribution and conservation status of wild suids in some countries/regions; b) the inadequacy of existing legislation or protected area systems in certain countries and/or the infrastructure to enforce relevant legislation; and c) issues influencing human attitudes to the management wild pig populations. Thus, whilst the preceding chapters of this Action Plan have emphasized particular requirements for the enhanced protection of representative populations/habitats of each species, more general priorities for the future conservation of African suids and the foremost requirements for some potentially threatened taxa have been identified and are incorporated in the following recommendations:

1. Conduct a general review of existing protected areas in all African countries, with a view to the creation of additional reserves in key locations currently unrepresented, or inadequately represented, within the existing national or regional network, and which are of importance to two or more suid taxa.

2. Conduct general reviews of wildlife and habitat management policies outside designated protected areas in order to develop projects that promote both the sustainable utilisation of natural resources and the implementation of relevant legislation. As far as the suids are concerned, this could include cropping schemes where pig populations are healthy and/or cause damage to crops. In countries that permit hunting, special attention should be given to regulating the timing of closed seasons and the size of hunting quotas in different locations.

3. Conduct repeat questionnaire and/or field surveys in areas where basic distribution and status data are still lacking, but which are known or believed to be of importance to one or more taxa.

4. Promote further investigations into the circumstances and extent of damage caused to crops by the various species of Afrotropical suids, with a view to developing management strategies that circumvent, contain or adequately compensate for such damage.

5. Encourage further studies into the importance of wild suids as vectors of livestock diseases and zoonoses, using least-destructive methods.

In addition to the general studies outlined above, the following, more specific projects are also strongly recommended:

6. Collect additional distribution and population status data on *H. meinertzhageni* from N. W. Zaire, N. Congo, N. Gabon, S. W. Cameroon and S. E. Nigeria, and encourage the gazetting of new protected areas where isolated viable populations of *H. m. rimator* still exist.

7. Promote new conservation measures for *H. meinertzhageni* in the Central African Republic by the revising the present hunting legislation, improving law enforcement, protecting forest galleries along the tributaries of the Oubangui River, and protecting the "Massif des Bongo".

8. Evaluate the impact of both traditional and sport hunting on *H. meinertzhageni* in Gabon, with a view to developing appropriate management recommendations.

9. Investigate the desirability/feasibility of augmenting the *H. meinertzhageni* populations in the Nyungwe (Rwanda)/Kibira (Burundi) National Park forest complex and in the Mgahinga (Uganda)/Virunga (Zaire)/Volcans National Park (Rwanda) Massif, using translocated hogs of the same subspecies from elsewhere in this region.

10. Collect additional distribution and population status data on *P. africanus* ssp. from the Central African Republic, Zaire (now Democratic Republic of Congo), Angola and Mozambique, where available data are insufficient for the elaboration of appropriate conservation and management plans.

11. Collect distribution and population status data on *Potamochoerus* spp. from Sudan, N. Ethiopia, S. E. Somalia, Central Zaire, Togo, Angola and Mozambique, where the current lack of information prevents the formulation of appropriate conservation and management plans.

12. Investigate occurrence and status of introduced and feral pig populations (particularly the reports of free-ranging *P. porcus x Sus scrofa* hybrids in the Wonga-Wongu, Presidential Reserve in Gabon, and the introduction of Natal warthogs into reserves in the Cape and Orange Free State Provinces), with a view to their eradication or control and to discourage any future introduction attempts (also see Oliver and Brisbin, this vol.)

C. Management of Afrotropical Suids for Profit:

Outside the predominately Muslim countries (5ø-10øN) all the Afrotropical Suids are important sources of protein for traditional hunters throughout their ranges. However, in some countries where Muslims constitute a minority population, they hunt wild pigs in order to sell them to the Christian or other sectors of the community. Suids constitute a significant part of the bushmeat market because wild pork is widely regarded as a delicacy and because each adult animal produces 30-60 kg of meat. Unlike sport hunting, subsistence and commercial hunting is virtually uncontrolled in most countries. The importance of bushmeat in terms of value and volume is therefore mostly unknown, though it is thought to be very high. The impact of legal and illegal hunting on suid populations has never been assessed in spite of its evident potential as a renewable, and valued resource. Actions needed to enhance and develop the sustainable management of healthy suid populations include:

1. Identify areas where suid population levels are sufficient to support a limited offtake through traditional hunting practices, with a view to promoting the sustainable management of these populations.

2. Determine the monetary value, volume and origin of the suids involved in selected local bushmeat markets and assess the sustainability of this practice and its importance for the local economy.

3. Assess potential and possible options for the local, commercial ranch management of each species of Afrotropical suid with the view to developing small-scale wild pig breeding in rural areas and the distribution of their products through local markets.

4. Investigate the possible socio-economic consequences to local communities of a transition from poaching to legal hunting and from hunting to husbandry prior to developing strategies aimed at more sustainable suid management, perhaps through the development of pilot schemes.

D. Regulation of the Trade in Afrotropical Suid Products:

The primary economic interest in these suids is for their meat, which constitutes the major incentive for hunters. Wild pig meat is in great demand at local markets, though no international trade (even between neighboring countries) in the flesh of these animals has been reported. Hides and tusks are sometimes used to make traditional ornaments or medicines, but these are essentially by-products of meat hunting. Neither the trade in tusks nor the trade in live animals have ever been considered as a threat to these species, or of sufficient magnitude to merit their inclusion on the Appendices of CITES. Both T. Milliken and D. Cumming (pers. comm.) have suggested that the international ban on elephant ivory might result in increased demand for suid (particularly warthog) tusk ivory (along with that of hippos, walrus, narwhal, etc.), but examination of the trade statistics and reports from some Central African countries have yet to reveal any significant increase in levels of trade in these items. Nonetheless, the possibility of such trade, which could constitute a potentially serious threat to these animals, merits careful monitoring in the future. As a first preventative measure, the CITES Management Authority and/or the relevant African scientific authorities might include a special warning about the tusks trade in their instructions to customs officers.

E. Development of Training and Education Programs

The training of wildlife officials and public awareness and education programmes, particularly in rural areas, are key components in any nature conservation effort. The training of local biologists, rangers and wildlife administrators merits funding priority by aid agencies and specialized NGO's, since future research, protection and management of wildlife populations and habitats will depend on their motivation and competence. Concepts involving parallels between wild and domestic species, such as relative productivity, hunter vs. breeder economies, genetic diversity, etc. are also germane to the needs of suid conservation, and could be usefully pursued in wildlife management forums, teacher training programmes and school curricula. Particular priorities include:

1. Production and distribution of education materials.

   Posters, leaflets, strip cartoons, stickers and, especially, T-shirts, printed in the principal local (rural) languages, are all useful aids for stimulating interest in wildlife topics and popularizing protective legislation. However, the useful distribution of such materials in remote communities is often problematic and may require careful targeting, with priority being given to areas of particular interest and concern to suid conservation.

2. Development and implementation of conservation education programmes in rural areas.

   Given the sheer magnitude of need, priority should be given to teaching the teachers, particularly in areas where human pressure constitutes the main threat to suids and other wildlife. The most appropriate and cost-effective ways of achieving this are by

means of mobile units, incorporating audio-visual materials, the conduct of local teacher training workshops and the production of pamphlets describing aspects of the biology and importance of these animals, their interactions with people and the environmental issues they represent. Any such teaching aids, which should also include simple drawing, quiz and essay exercises, should be in form that can readily be duplicated locally.

3. Organize workshops and training programmes for biologists and wildlife managers.

The lack of trained personnel in many countries/regions can only be addressed through the organization of local, provincial and national/regional workshops which provide professional wildlife researchers, rangers and administrators with the opportunity to obtain field experience of the realities of studying, monitoring and protecting wildlife populations and to exchange ideas and expertise. The provision of grants to enable selected students and career wildlife officers to attend conferences, training programmes and advanced degree courses in wildlife research and management elsewhere should be encouraged, though this should not take precedence over the organization of local programmes.

Future Research Priorities

The recent and current reviews of the taxonomy, distribution and conservation status of the Afrotropical Suids have also revealed numerous and often quite basic gaps in our knowledge of their systematics and biology which must be tackled in order to develop the most appropriate conservation and management strategies for these species. This concern is exemplified in the revelation of the 'Somali warthog', *Phacochoerus a. delamerei*, a living representative of a taxon thought to be extinct. Similarly, the (albeit preliminary) clarification, even simplification, of the subspecific taxonomy of the warthogs, the bushpigs/river hogs and the forest hogs, has redefined the regional genetic diversity of these animals, provided a basis for the interpretation of conservation data and assisted the identification and weighting of various future research priorities. Other priorities identified below reflect the fact that the African suids have been the subject of very few detailed behavioral-ecological studies, and that most of these have been undertaken in southern Africa. Comparative data are therefore required on representative populations of these animals in other areas in order to improve our understanding of their biology and future management requirements. In line with these considerations, the foremost priorities for research on Afrotropical suids include:

1. Investigate the systematic and ecological relationships between *P. aethiopicus* and *P. africanus* at the edges of their respective distributions in northern Kenya, eastern Ethiopia and north-west Somalia, and determine whether allopatry, sympatry or intergradation occurs in these areas.

2. Conduct field studies of the behaviour, ecology and habitat requirements of *P. aethiopicus*, a species virtually unknown at the present time, but which may be one of the most specialized of all suids. The development of management recommendations

for the enhanced future protection of representative populations of this species, based on these data, should constitute another primary objective of these studies.

3. Conduct analyses of all available museum material of *P. africanus*, and obtain such additional material (including photographs of adults, and blood or other tissue samples for cytogenetic analysis) as may be necessary (e.g. from presently unrepresented sites and/or presumed intergradation zones), in order to re-assess the subspecific taxonomy of this species which is unsatisfactory at the present time. Possible genetic differences between the northern and southern Somali populations of *P. aethiopicus delamerei* also merit investigation in this context.

4. Undertake comparative studies of the behaviour, ecology and distribution of *P. africanus* in western Africa, from where very few recent data are available at present.

5. Use least-destructive means (including good photographs) to clarify aspects of the subspecific taxonomy of *H. meinertzhageni*, in particular: (a) the subspecific status of the Ethiopian, Imatong (Sudan), Tanzanian and Nigerian populations; the precise systematic relationships of the western and eastern populations of *H. m. rimator* (formerly treated as two subspecies: *ituriensis* and *rimator*, respectively); and (b) the separation of *H. m. meinertzhageni* and the easternmost populations of *H. m. rimator* along the Western Rift.

6. Review all available records to assess the past and present distribution of *H. meinertzhageni* ssp. in order to ascertain the extent and current trends in the reduction of this species' range, with a view to the establishment of additional future conservation requirements.

7. Investigate outstanding questions about the systematic relationships between, and geographic and genetic variation in, *P. larvatus* and *P. porcus* by the acquisition of additional photographic, cranial, skin and cytogenetic specimen materials, from key locations along the interface zones between these species. Particularly important areas in this context are the junction between lowland and upland forest in eastern Zaire and southern Sudan, and the vast but poorly studied complex of riverine forest and savanna ecosystems in southern Zaire.

8. Undertake field studies in selected locations along the interface or intergrade zones between *P. porcus* and *P. larvatus* in order to determine their ecological relationships and means of segregation.

9. Promote further field studies on the biology and ecology of *P. larvatus* and (especially) *P. porcus* in order to obtain a better understanding of their population dynamics, social behaviour, ecology and possible future management needs of each of these species.

10. Investigate the origins, systematic relationships and ecology of the Malagasy bushpigs, with a view to the development of management plans for the control (and/or protection?) of particular populations.

11. Encourage research on the socio-economic significance of all Afrotropical suids, and promote pilot studies to investigate their possible future use for ranching or domestic husbandry.

Chapter 5

The Eurasian Suids

Sus and *Babyrousa*

5.1. Taxonomy and Description

Colin P. Groves and Peter Grubb

The Genus *Sus*

According to the major review of the genus *Sus* by Groves (1981) at least 5 species and 24 subspecies are recognized. A more recent study by Hardjasasmita (1987), is at variance with Groves' review, in that it recognizes several additional species and subspecies from Indonesia. However, as this author does not provide any new evidence to support his conclusions or to counter those of Groves' we do not see any need to modify the latter's treatment of the wild pigs of this country. Nevertheless, some important new evidence suggests that two additional species should be recognized from the Philippines (see below), making a total of 7 species and (approximately) 22 subspecies, as follows:

1. The Eurasian Wild Pig, *Sus scrofa* (c. 17 ssp.).
2. The Pigmy Hog, *Sus salvanius* (0 ssp.).
3. The Javan Warty Pig, *Sus verrucosus* (2 ssp.).
4. The Bearded Pig, *Sus barbatus* (3 ssp.).
5. The Philippine Warty Pig, *Sus philippensis* (0? ssp.).
6. The Visayan Warty Pig, *Sus cebifrons* (0? ssp.).
7. The Sulawesi Warty Pig, *Sus celebensis* (0 ssp.).

Groves (1981) also drew attention to a 'mystery' pig, *S. bucculentus*, which is known from only two skulls from Cochin China (now extreme south Viet Nam), collected in the late 19th Century. This animal is evidently closely allied to *S. verrucosus*, but its external appearance and present status are entirely unknown.

The pigs of this genus may be separated into two groups, the non-warty pigs (2 spp.) and the warty pigs (5 or 6 spp.), these groups being differentiated by various cranial and

dental characters and the development of conspicuous facial adornments or 'warts' in adult males of the warty pigs alone.

The Non-warty Pigs of the Genus *Sus*

The two species are sympatric, *S. scrofa* occurring over the entire known range of *S. salvanius*, namely the sub-Himalayan alluvial tract of the northern Indian sub-continent, so they must be specifically distinct. Moreover, *S. salvanius* has a number of highly distinctive characters (e.g. extreme reduction in body size, rudimentary tail and only three pairs of mammae), which serve to differentiate it from *scrofa* and, indeed, all other wild pigs. These characters have led some authors to annex the species as a separate genus or sub-genus, *Porcula*, though Groves considered it more closely allied to *scrofa* than to other members of the genus, and believed that most of the species' diagnostic features are correlated with the reduction in body size.

In both species the male's lower canine has the inferior surface narrower than the posterior surface. The female's canines are like small versions of the male's. The preorbital fossa is shallow with sloping borders.

1. The Eurasian Wild Pig (*Sus scrofa*)

A moderate to large sized pig with a relatively short muzzle and no face warts. Females 88.8-95.3% of males in condylobasal length in various populations; about 80% of male body weight. Relatively long-limbed, especially in northern races; medial false hooves as long as lateral; ears relatively large; tail relatively long, with simple tuft; head not large compared to body; snout disc perpendicular to axis of head; back rounded. No warts or gonial whorl. Often well-haired; hairs all agouti; general color brown with a tendency to blackish, grayish or rufous; face, cheeks and throat with a grizzling of whitish hairs or more strongly expressed markings; underside dark; bristles of nape long, in some races forming a distinct narrow nuchal crest or mane which extends down the back; under-fur thick and woolly or absent. Piglets longitudinally striped, stripes gradually fading after five to six months. Four to six pairs of mammae.

There is considerable variation in size, with sample-means for greatest length of skull in males ranging from 275 mm (Ryukyu Islands) to 466 mm (Ukraine). In general, insular pigs are smaller than those on the adjacent mainland, and southern pigs are smaller than northern ones. In Groves's (1981) revision of this species, no groupings of subspecies were recognized, but four regional groupings are used here in an informal sense in order to distinguish certain features amongst the 17 currently recognized subspecies (Fig. 10, section 5.2):

- Western races. Mane poorly developed except in the nominate race and adjacent attila; under wool thick. Sample-means of greatest length of skull in males 308-466 mm. Mostly high-skulled races, though lybicus and some scrofa are low skulled. The following (6) subspecies are included:

S. s. scrofa (northern low-skulled and southern high-skulled populations may be subspecifically distinct): North Spain, North Italy, France, Germany, Benelux, Denmark, Poland, Czechoslovakia, Albania (?);

S. s. meridionalis: Andalusia; also Sardinia & Corsica (though the island populations are almost certainly feral, having arrived in the Holocene, probably as primitive domestic stock - see Vigne, 1988);

S. s. algira: Tunisia, Algeria, Morocco on the coastal side of the mountains;

S. s. attila: Hungary, Ukraine, Central Byelorussia east into Soviet Central Asia as far as the Aral Sea; south to the northern flank of the Caucasus and the Mesopotamian Delta, Iraq;

S. s. lybicus: Transcaucasia, Turkey, Levant, Palestine, Yugoslavia (also extinct in Nile Delta, though this was probably a feral population – see: Verpmann, 1987 - as there is no record of this species of the species in Egypt in any archeological sites of Noelithic, Bronze or Iron Age); and

S. s. nigripes: flanks of the Tienshan Range in Central Asia and (according to Russian authorities) ranging west to the Caspian Sea, south to northern Iran, Afghanistan, western and southern Mongolia and China, and east as far as Novosibirsk.

- Indian races. Under wool sparse (*davidi*) or absent; mane long and thick; snout and mouth-gonion bands fairly well defined (*davidi*) or absent. Sample-means of greatest length of skull in males 365-490 mm (339 mm in Bopeta - see below). All are high-skulled races, except for davidi, which is low skulled. The (4) subspecies included are:

  S. s. davidi: Pakistan and north-west India to south-eastern Iran;

  S. s. cristatus: Sub-Himalayan region from Ludhiana, Punjab, through Nepal and Sikkim to Nagaland and North Burma; Uttar Pradesh; Madhya Pradesh; probably Kolhapur; Bihar; Bengal south through Burma and western Thailand to Isthmus of Kra;

  S. s. affinis: southern India and most of Sri Lanka; and

  S. s. subsp: Bopeta, Central Province, Sri Lanka (based on a single very small skull).

- Eastern races. A definite whitish streak from angle of mouth to lower jaw; under wool thick except in moupinensis; mane poor or absent. Sample-means of greatest length of skull in males 327-474 mm (275 on Iriomote). Mostly high-skulled races, except for ussuricus. The (6) subspecies included are:

S. s. sibiricus: Mongolia, Transbaikalia;

S. s. ussuricus: Soviet Far East, Manchuria, Korea;

S. s. leucomystax: Honshu, Shikoku, Kyushu;

S. s. riukiuanus: Ryukyu Islands (including at least Ishigaki and Iriomote;

S. s. taivanus: Taiwan;

S. s. moupinensis: Coastal China south to Vietnam and west to Szechwan.

- Indonesian race (or banded pig), *S. s. vittatus*. Body hair sparse, no under wool, mane fairly long, a broad reddish brown band along middle of muzzle, broadening at angles of mouth and on sides of upper lip, where it extends backwards to disappear on sides of neck Greatest length of skull in males, 284-380 mm in sample means. Range: Peninsular Malaysia; the offshore islands of Terutau and Langkawi; Sumatra; Riau Archipelago (includes Bulan, Jeri, Ungar Batam and Karimun); Java and offshore island Peucang; Bali; Lombok; Sumbawa; and Komodo.

2. The Pigmy Hog (*Sus salvanius*)

This is the smallest of the living suids, with greatest length of skull in males averaging only 179 mm; body weight is 6.6-9.7 kg in adults, head and body length 55-71 cm (mean, 58 cm) (Oliver 1980); female about 87% of male in condylobasal length. Relatively short-limbed; hind limbs long relative to forelimbs; medial false hooves relatively short; ears small; tail very short, barely tufted; head moderate in size; snout disc perpendicular to axis of head; back short, rounded. No warts or gonial whorl. Hairs all agouti-banded; little or no mane; underside wholly dark. Piglets faintly striped. Only three pairs of mammae. The pigmy hog is confined to the tall grass savannah or terai of the Himalayan foothills and now restricted to northern Assam (Oliver, 1980).

The Warty Pigs of the Genus *Sus*

The warty pigs have sometimes been referred to as the 'verrucosus group' distinct from the two, non-warty species (above), one of which (scrofa) is sympatric with verrucosus and barbatus over parts of their ranges. Hybridization between scrofa and all five species of warty pigs has been recorded, albeit in captivity in most instances. Since all of the warty pigs have parapatric distributions, they are considered conspecific by some authors and, unlike the non-warty Sus spp., their separation is based exclusively on morphological characters.

The 'warty pigs' are so-called because the adult males typically develop three pairs of warts, namely 'infraocular' (= infraorbital) warts on the cheek (malar) swellings; 'gonial' warts on the jaw angle; and 'preocular' (= preorbital) warts above the canine root flanges.

The relative development of these warts, which continue to enlarge throughout life, are diagnostic for three 'Sundaic' species, the infraorbital warts being most developed in verrucosus and the preocular warts being most developed in celebensis. The facial warts are reduced in barbatus, in which the gonial warts are concealed by the growth of the cheek whiskers, the 'gonial whorl' or 'beard', and in the two eastern (Wallacian) Philippine species, *philippensis* and *cebifrons*. The warts may also be present, though very small, in females of these species. The structure of the canine is also characteristic of warty pigs, the inferior surface of the lower canine being broader than the posterior surface, so that a section of the tooth is more or less an equilateral triangle. The females have diminutive canines, which tend to point simply down (upper teeth) or up (lower). The preorbital fossa is always deeply excavated with over-hanging, shelf-like borders.

3. The Javan Warty Pig (*S. verrucosus*)

This species and the next are distinguished by the great elongation of the face. Size medium to large; sexual dimorphism in size greater than in other species; males very large - more than twice the weight of females; female condylobasal skull length 80.3 and 83.3% of male measurements in two populations; relatively long limbed; ears large; tail relatively long, tufted simply; head large, heavy compared to body; back long, straight; snout disc somewhat oblique to axis of head. Three pairs of warts; infraorbital pair largest; long tuft of hair on gonion marks spot where gonial wart will emerge late in life in males. Body hairs red to yellow with black tips, or pure black; a broad mane extending to rump; underside sharply marked off, yellowish. Piglets faintly striped, when very small only. Six pairs of mammae. Two subspecies are recognized, as follows:

S. v. verrucosus: Java and, formerly, Madura, where it is now extinct; and

S. v. blouchi: confined to Bawean

The nominate form is much larger, with sample-means of greatest skull length 408-429 mm in males; the recently described Bawean race (Groves, 1981) having a skull length of only 354 mm.

4. The Bearded Pig (*S. barbatus*)

S. barbatus is closely related to *S. verrucosus*, but is typically distinguished by the bushy gonial tuft of hair enlarged into a cheek-beard; much smaller warts; and often a still more elongated skull. Size medium to large; females relatively larger in relation to males, 88.2-93.6% of males in condylobasal skull length. Relatively long limbed; ears relatively small; tail long with large terminal tuft divided into distinct anterior and posterior parts; head large, heavy; snout disc quite oblique to axis of head; back straight, long. Two pairs of warts in males; whorl on gonion but no gonial wart; warts small or absent in females. Hairs agouti or uniform (black); broad long mane, extending to rump; underside wholly dark. Piglets striped, but pattern fading before six months. Six pairs of mammae. The three currently recognized subspecies, are:

oi: Peninsular (West) Malaysia, Sumatra, Bangka and Palau Bintang in the Riau Archipelago;

barbatus: Borneo and the westernmost of the Sulu Archipelago (Sibutu and Tawitawi); and

ahoenobarbus from Balabac, Palawan and offshore islands, and the Calamianes group.

The subspecies differ in size, coloration and hair development. The nominate race of Borneo is large, with a well-developed beard. *S. b. oi* is somewhat variable over its disjunct range, but is also very large, has coarse bushy hair over the top of the snout and a smaller beard. *S. b. ahoenobarbus* is much smaller and darker. Sample-means of greatest length of skull in males are 359-365 mm, against 435-505 mm in the larger races.

5. The Philippine Warty Pig (*S. philippensis*)

Following Sanborn (1952), the wild pigs of the main (Wallacian Region) Philippine archipelago (i.e. excluding the Palawan group of islands in the Sundaic Region) have generally been assigned to the species *S. celebensis*. However, Groves (1981) rejected this arrangement on finding that their cranial characters aligned them with *S. barbatus* and not *S. celebensis* - a view subsequently endorsed by Mudar (1986) - whilst acknowledging that they might merit separation as full species. Recently-photographed captive adult boars from Panay (*S. 'barbatus' cebifrons*) and from Luzon and Mindanao (*S. 'barbatus' philippensis*) are unlike *S. barbatus* and differ amongst themselves. Furthermore, skulls of *S. 'b.' cebifrons* from Negros in the central Philippine 'Visayas Region' recently examined by C. P. Groves show several differences from skulls of *philippensis*. This new information is yet to be fully reported but it has led to a reappraisal of the systematics of Philippine pigs. It now seems appropriate to recognize two separate species on the Philippines (excluding the Palawan Region), namely *S. philippensis* and *S. cebifrons* - a treatment that corresponds with the systematics of the Philippine deer (Grubb and Groves, 1983).

The Philippine warty pig, *S. philippensis*, occurs on most of the larger, outermost islands (Mindoro, Mainit, Luzon, Catanduanes, Samar, Leyte, Biliran, Mindanao, Basilan and Jolo) in the eastern Philippines. It is a black pig, sometimes with a pale snout-band and red-brown patches in the mane. It is smaller than *S. barbatus ahoenobarbus* but somewhat larger than *S. cebifrons* (means of greatest skull-length measurements are 318-335 mm in adult males). A boar from Luzon strongly resembles *S. celebensis* in the distinct crest and prominent preorbital warts, though these features are less strongly expressed in another male from Mindanao. This variation may reflect differences between island populations, a conclusion that is to be expected in view of faunal provincialism in the Philippines (Heaney, 1986). Therefore, it will be necessary to reconsider the systematics of the species, as it may prove to be polytypic.

6. The Visayan Warty Pig (*S. cebifrons*)

This is a smaller pig occurring allopatrically to *S. philippensis* on the west central islands of the Philippines. Skull length is 299 mm (mean of two males from Negros) and recently determined features of Negros skulls distinguish this species from *S. philippensis* as well as from other, better-known warty pigs. The external appearance is not well known but boars from Panay have a long mane extending to the rump and large facial warts, while skins from Negros have white hairs on the shoulders and sides. The species is reliably recorded from the Visayan Islands of Cebu, Siquijor, Guimaras, Negros and Panay - identified as the Negros Faunal Region by Heaney (1986). However, it is already extinct over the majority of its known, former range (see later text).

7. The Sulawesi Warty Pig (*S. celebensis*)

This is a short-faced species, like the Eurasian wild pig, of small size (sample-means of greatest length of skull 256-331 mm in males, females 85.4-90.4% of males in condylobasal skull length in different populations), though there is some evidence of a north (smallest) to south (largest) cline in body size on mainland Sulawesi, extending onto the offshore islands. The species is characterized by its (relatively) very short legs; small, short ears; long, simply tufted, tail; large, heavy head; short, slightly convex, back; and somewhat oblique snout disk. The preorbital wart is typically the most developed of the three pairs, though the gonial wart, which is marked only by a whorl in younger animals, does become obvious late in life and may hypertrophy. The warts remain small in females. The pelage is usually black, often with white or yellow hairs intermixed, but some specimens are predominantly red-brown or even yellowish in color, the underside being uniformly dark in young animals, but becoming paler, eventually light yellow, with age. A distinct yellow snout band is usually present. The mane is rather poorly developed, but forms a conspicuous tuft or 'crest' on the crown, especially in young adult males. Piglets striped to at least six months of age. There are six pairs of mammae.

The distribution of this species is most unusual (Fig.15, section 5.7). It occurs as a native form only on Sulawesi and offshore islands (i.e. the Togian Islands, Pulau Salayer, P. Butung, P. Peleng and P. Lembeh), but it has been introduced onto Buru, Halmahera and Seram, and some of the Lesser Sunda Islands (Timor, Flores and P. Roti) and the west Sumatran Islands (Simaleue and Nias) as a domesticated or feral form. Indeed, as Groves has shown, it is evident that the species has been truly domesticated (probably in the early Holocene on Sulawesi), and transported to the Moluccas, where it has also hybridized with *S. scrofa*, thereby giving rise to the second species of Sus ever to be described, 'S. papuensis', the domestic and feral pig of New Guinea. The so-called *'S. timorensis'* (from Timor), *'S. floresianus'* (Flores), *'S. mimus'* (Simeulue) and *'S. niadensis'* (Nias) are also all variously modified *celebensis*-pigs, some of which are still maintained as domesticates, whilst others (like those on Buru and Seram) were either released to be hunted whenever required for eating or have been allowed to revert to the wild state.

The Genus *Babyrousa*

8. The Babirusa (*B. babyrussa*)

This extraordinary animal is confined to Sulawesi and some neighboring islands. Three extant subspecies are widely recognized (Groves, 1980). These are:

B. b. babyrussa: Buru and the Sula Islands (Mangole, Taliabu and, formerly, Sulabesi).

B. b. togeanensis: Togean Islands (Malenge, Talatakoh, Pulau Batudaka, Batone and Pangempong).

B. b. celebensis: northern peninsula of Sulawesi at least as far west as Bumbulan and from Pulau Lembeh.

A fourth subspecies, *B. b. bolabatuensis*, described from an early Holocene (?) skull from Bola Batu caves near Watampone, may also survive in still-forested areas of central and south Sulawesi. Indeed, a recent skull from Gunung Melema, Moa, near Kulawi, could be ascribed to this race, though it also resembles the skulls of the Buru and Sula Islands' animals, which may have originated from this region of Sulawesi (see later text).

The subspecies differ in size, hairiness and characters of the skull and teeth. Leaving aside the problematical *bolabatuensis*, nominate *babyrussa* is the smallest and the hairiest. Indeed, this subspecies is sometimes referred to as the 'golden' or 'hairy' babirusa, on account of its relatively long (>5cm), yellowish pelage, in marked contrast with the barely discernable, short, sparse pelage of the most familiar form, B. b. celebensis, from the (north) Sulawesi mainland. The latter subspecies is also the largest, the Togian Islands', *togeanensis*, being intermediate in body size between these forms.

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Chapter 5.2

The Eurasian Wild Pig, *Sus scrofa*

William L. R. Oliver, I. Lehr Brisbin, Jr. and Shunjo Takahashi.

Status and Action Plan Summary

Status categories: all subspecies are 1-3 (widespread and locally abundant to potentially at risk), except *riukiuanus* which is 4 or 5 (which is vulnerable or endangered) according to population.

The Eurasian wild pig has one of the widest geographic distributions of all terrestrial mammals, and this range has been greatly expanded by human agency. The species now occurs in pure wild or barely modified feral form on all continents excepting Antarctica, and on many oceanic islands. It is the ancestor of most (but not all) ancient and modern domestic pig breeds, and there is evidence to suggest that it was independently domesticated in several different parts of its range, including S. E. Asia, the Far East and Asia Minor. As a wild form, it has constituted a primary resource of subsistence hunters since the earliest times, and it is one of the most important targets for recreational hunting wherever it remains sufficiently abundant. Over-hunting and changes in land use have resulted in the fragmentation of its range and its extermination throughout the British Isles, Scandinavia, parts of North Africa, and relatively extensive parts of its range in the (former) U.S.S.R. and northern Japan. Nevertheless, the species remains widely distributed and is often locally abundant. As a result of its depredations on crops it is regarded as a pest in many countries, where it remains unprotected outside designated wildlife reserves or is managed as a game animal.

Action plan priorities for this species focus on threats from habitat loss, over-hunting, disease and genetic contamination to the smallest and most threatened subspecies, *S. s. riukiuanus*. The Ryukyu wild pig is the only one of the (c. 16) recognized subspecies to be in included in the IUCN Red List, where it is presently accorded 'vulnerable' status. However, it is probably already 'endangered' on four (Ishigaki, Iriomote, Tokuno Shima and Okinawa) of the six islands on which it occurs, as a result of habitat loss, hunting pressure, hybridization with domestic pigs and introduced diseases. Other priority recommendations include the need for additional data on the distribution and status of certain other (less-known) subspecies, including a tentatively assigned form (subsp. *nov*.) from the central highlands of Sri Lanka; the resolution of questions relating to the genetic distinctness and range limitations of some of the continental races; and the ecological and genetic relationships between this and other species of *Sus* in those areas where sympatry occurs.

Introduction

S. scrofa is the antecedent of the overwhelming majority (but not all) domestic and feral pig populations. In its native form it has one of the largest ranges of any wild ungulate and, together with its domestic and feral derivatives, it has one of the most extensive distributions of all mammals. In different parts of this range it is naturally sympatric with at least three congenors (*S. salvanius*, *S. barbatus* and *S. verrucosus*), though it or its derivatives have been introduced by human agency into areas supporting all other (formerly allopatric) congenors (*S. celebensis*, *S. cebifrons* and *S. philippensis*) and non-congenors (*Potamochoerus*, *Hylochoerus*, *Phacochoerus* and *Babyrousa*), as well as the New World Tayassuids (*Tayassu* and *Catagonus*). Where introduced populations have become naturalized and abundant they are generally regarded as environmental pests (Oliver and Brisbin, this vol.), as well as posing a threat of disease contagion and/or genetic contamination to native suids, including endemic populations of this species (see later text).

S. scrofa has been studied extensively in Europe, North Africa and in the (former) U.S.S.R., and much comparable research has been conducted on the introduced, mostly feral, populations in the U.S.A., Australia and New Zealand (Briedermann, 1990). Available data indicate that the basic diploid number of 38 chromosomes (similar to domestic pigs) is found in eastern and south-east Asian populations, but this number decreases by Robertsonian translocations over the species' extensive range such that the continental European populations have only 36 chromosomes (Bosma *et al.*, 1984). Eurasian wild pigs are also markedly variable in size, pelage and some other characters, and an enormous number of subspecies, and several different species, have been described. However, in a major review of the genus *Sus*, Groves (1981) argued that many of these named forms were synonymous or, in some cases were actually naturalized feral or hybrid (with *S. celebensis*) populations. Groves accordingly recognized only 16 subspecies, including a previously undescribed form, *S. s. davidi*, from Pakistan and north-western India, though he also drew attention to a small, as yet unclassifiable, skull from Central Province, Sri Lanka, which may represent another new subspecies. Only a few of the currently recognized subspecies, such as the insular *taivanus* (Taiwan) and

riukiuanus (Ryukyu Is., south Japan), have clearly defined ranges, and precise data is lacking on the range limits/intergradation zones of many of the continental forms. Groves and Grubb (this vol.) have therefore distinguished four 'subspecies groupings', based on both geographic and morphological criteria, as follows:

1. 'Western races' of Europe (*scrofa* and *meridionalis*), North Africa (*algira*) and the Middle East (*lybicus*), extending at least as far east as Soviet Central Asia (*attila* and *nigripes*);

2. 'Indian races' of the Sub-Himalayan region from Iran in the west (*davidi*) to north India and adjacent countries as far east as Burma and west Thailand (*cristatus*), and south India and Sri Lanka (*affinis* and subsp. *nov*.);

3. 'Eastern races' of Mongolia and the Soviet Far East (*sibiricus* and *ussuricus*, Japan (*leucomystax* and *riukiuanus*), Taiwan (*taivanus*), to south-east China and Vietnam (*moupinensis*); and

4. 'Indonesian race' (or banded pig) from the Malay Peninsular, Sumatra, Java, Bali and certain offshore islands (*vittatus*).

Former and Present Distribution

S. scrofa is one of the most widely distributed terrestrial mammals, and has by far the largest range of all suiformes. It occurs throughout the steppe and broadleaved forest regions of the Palaearctic, from western Europe to the Soviet Far East, extending southwards as far North Africa, the Mediterranean Basin and the Middle East, through India, Indo-China, Japan (including the Ryukyu Chain), Taiwan and the Greater Sunda Islands of South-east Asia. Populations east of Bali are probably all introduced. It has been extinct in the British Isles since sometime in the 17th century, despite attempted introductions of new stock from Europe (Harting, 1880). It is also extinct in southern Scandinavia, over extensive portions of its recent range in west-central and eastern parts of the (former) Soviet Union (Heptner *et al.*, 1961), and in northern Japan (Chiba, 1964, 1975). The species was last reported in Libya in the 1880's, and it became extinct in Egypt in about 1902 (Hufnagl, 1972; Fig. 10).

Link to Fig. 10: Approximate former and present distribution of the Eurasian wild pig *Sus scrofa* ssp. Modified after Heptner *et al.,* 1961; Groves, 1981).

Habitat, Ecology and Behavior

The Eurasian wild pig occupies a wide variety of habitats, from semi-desert to tropical rain forests, temperate woodlands, grasslands and reed jungles; often venturing onto agricultural land to forage. The species is omnivorous, though stomach and fecal contents analyses indicate that vegetable matter, principally fruits, seeds, roots and tubers, constitutes about 90% of the diet (Spitz, 1986). A field study of the Indonesian wild pig,

S. s. vittatus, in Ujung Kulon National Park in Java, indicated that these animals are predominately frugivorous, feeding on about 50 species of fruits, especially those of strangling figs (Ficus spp.), and that they are important seed dispersal agents (Pauwels, 1980). By comparison, analyses of the stomach contents of wild pigs (also *S. s. vittatus*) in agricultural areas of West Malaysia by Diong (1973), revealed that sugar cane, tapioca and rice were the commonest food items, but that usually more than one type of food had been eaten, even where a single cultivated crop was abundant. Other items commonly consumed by these pigs included soil, earthworms, roots and other vegetable matter and, in mangrove areas, mollusks, crabs and other arthropods and even fishes. The consumption of invertebrate and small vertebrate prey may be a necessary component of the diet, since a study of free-ranging domestic pigs in Papua New Guinea revealed that animals fed *ad libitum* lost weight when denied earthworms (Rose & Williams, 1983). In common with its feral derivatives (Oliver & Brisbin, this vol.), *S. scrofa* has also occasionally been reported to predate larger vertebrates, such as deer fawns and (tethered) goats (Hoogerwerf, 1970), though it is possible that such incidents involve only a few individuals in the population; an aspect also noted by Pauwels (1980) when referring to the predation of sea turtle nests by wild pigs in Udjung Kulon. Similarly, a large boar (*S. s. cristatus*) in Royal Chitawan National Park, Nepal, which was seen to displace an adult leopard from its kill, a domestic buffalo calf, which it then partly consumed (W. Oliver, pers. obs.), was reported by Park staff to regularly commandeer such kills, but that no other individual pigs had been seen to do this.

Wild pigs are normally most active in the early morning and late afternoon, though they become nocturnal in disturbed areas, where activity usually commences shortly before sunset and continues throughout the night. A total of 4 to 8 hours are spent foraging or traveling to feeding areas. Feeding is generally a social activity (even solitary males may join feeding groups) which also provides an opportunity for display and other agonistic behaviors (Beuerle, 1975). Radio telemetry studies in southern France indicate that they generally travel between 2 and 15 km per night, though this is often within an area of only 20 to 150 ha. However, the home range estimates for adult females and adult males over a 2-3 month period varied from 500-1,000 ha and 1,000-2,000 ha, respectively. During this same period, subadults covered an area of 500- 5,000 ha, and after 6 to 12 months they may have covered more than 10,000 ha; the larger home ranges of these animals being related to their expulsion from their natal groups and then undergoing a wandering phase. Movements over long distances (50 to 250 km) have also been recorded in Europe, but the extent and purpose of these movements has yet to be studied (Spitz, 1986). Experiments in which tagged animals are released and subsequently recovered provide evidence that they disperse freely over even larger areas (500 to 750 km2), which may also indicate the area occupied by large population units. The density of free-ranging *S. s. scrofa* in Europe rarely exceeds 5 individuals/km2 (Spitz, 1986), though much higher concentrations have been reported elsewhere, e.g. 27-32/ km2 on Peucang Island in Ujung Kulon National Park, Java (Pauwels, 1980) and 32.2-72.1/km2 in sugarcane areas in the Punjab, Pakistan (Shafi & Khokhar, 1985).

Wild pigs are gregarious, forming herds or 'sounders' of varying size depending on locality and season, but usually of between 6-20 individuals, though aggregations of over

100 have been reported (Prater, 1971; Legakul & McNeely, 1977; Briedermann, 1990)). The basic social unit is a nucleus of one or more females and their last litters. Animals peripheral to this comprise subadults from previous litters, and adult males during the mating season. However, the latter tend to stay in relatively close contact with 1 or 2 female groups at other times of the year, and subadult males or mixed sex groups of subadults may also form longer-term associations (Spitz & Janeau, 1990). The dynamics of the basic group include the isolation of the preparturient female, her re-entry with young, entry of nulliparous females, the arrival of adult males with the simultaneous departure of subadult animals (Spitz, 1986). In contrast to its domestic derivatives, reproductive activity in S. scrofa tends to be seasonal and positively correlated with the relative availability of principal foodstuffs or related climatic factors. In tropical countries, such as Sri Lanka, peak estrus activity has been recorded during the wettest months of November and December (Santiapillai and Chambers, 1980). However, social organization may also play a role in modulating the timing of reproductive events, since farrowing is often synchronized amongst females in the same social groups, which suggests a mechanism for synchronizing the onset of estrus (Spitz, 1986).

Wide fluctuations in the numbers of animals killed by hunters, particularly in the (former) U.S.S.R. and in France, suggest cyclic changes in the numbers of wild pigs available for hunting. Annual recruitment into the total population depends on reproductive rate (i.e. the number and prolificacy of females) and juvenile mortality, both of which factors may be influenced by the availability of foodstuffs and other external factors (Spitz, 1986). In western Europe, litter size is usually between 4 and 7 piglets (Briedermann, 199), though Harrison and Bates (1991) cite reports of 5 and 7-10 piglets per litter as being usual in Iraq and Armenia, respectively. Pauwels (1980) recorded an average litter size of 6-10 piglets at the beginning of the breeding season in Java, but this number dropped to only 2-4 piglets per litter towards the end of the breeding season. In the Ryukyu Islands, S. Japan, there is evidence that the wild pigs (*S. s. riukiuanus*) have two breeding seasons per year, though it remains uncertain whether individual sows normally produce litters twice a year (Yasuma, 1984). Juvenile mortality averages 15% in the first three months in western Europe, though between 50% and 75% mortality have been reported by the end of the first year of life (Jezierski, 1977; Briedermann, 1990). These mortality rates are thought to be highly dependant on such external factors as predation and climatic hazards, at least in wilderness areas (Spitz, 1986). Similarly, Pauwel (1982) suggested that the principal causes of juvenile mortality in wild pigs in Ujung Kulon were predation (particularly as a consequence of the accidental separation of infants from their mothers), along with differences in the relative rate of development of litter-mates and various parasite-related causes. These factors resulted in only about 15% of all progeny surviving to independence.

Threats to Survival

Habitat destruction and hunting pressure, either for food, sport or in reprisal for crop damage, are the principal threats to this species, particularly in areas near human habitation. In Afghanistan, Hassinger (1970) cited reports of the decrease in the numbers of wild pigs in the Pul-i-Khumri District in the 1950's as a result of the draining of marshlands for agricultural purposes and hunting by Europeans; but noted that they were still numerous in other districts where: "they invade the fields and cause serious damage during the harvest". In parts of Perak and Johore in West Malaysia, Diong (1973) reported that the numbers of wild pigs (*S. s. vittatus*) had diminished drastically as a result of increased hunting pressure, particularly for commercial purposes, and that most hunting methods, whether with guns, dogs or snares, was entirely non-selective. Nonetheless, wild pigs are still included in Malaysia's 'Agricultural Pest Ordinance, 1977', on account of their damage to a variety of crops, including sugar cane, tapioca, rice and even coconuts. Lay (1967) also remarked upon the damage to crops by wild pigs in Iran which: "...brings great wrath upon them, usually ineffectual, from the local farmers". In Pakistan, the expansion of the sugar cane industry in the 1960's and early 1970's brought about local increases in the numbers of wild pigs (*S. s. davidi*), whose depredations in the cane fields (estimated at an annual loss rate of Rs.5 million in 1978) led to the development of control measures, including the use of poison baits (Shafi & Khokhar, 1985).

Although actually referring to wild pigs in India, it is clear that Prater's (1971) opinion that: "No animal is more destructive to crops and, in cultivated areas, it is impossible to make a plea for its protection", would find popular support in many other countries. In the Ryukyu Islands, S. Japan, the endemic *S. s. riukiuanus* is actively regarded as an environmental pest, and bounties are paid to farmers for killing them by the Japanese Government, despite the fact that this taxon is recognized internationally as being seriously threatened throughout it extremely restricted range (see later text). In various places in Indonesia, most notably in Java, deliberate attempts have been made in the past to eradicate wild pigs altogether by means of organized shooting parties and poisoning campaigns. However, despite many thousands of wild pigs being destroyed in this way, it is clear that this has had little lasting effect on these animals which, according to Hoogerwerf (1970), have: "remained further removed from extinction than any other species of game in Java". This situation evidently obtains in a number of other countries, including Vietnam (R. Ratajszsak, pers. comm.) and Taiwan (K. Newell, pers. comm.), where wild pigs are reported to survive in a number of nominally protected areas where all or most of the other principal 'game' species have been eradicated by sustained hunting pressure.

In these and many other (non-Islamic) countries or local communities, wild pigs often constitute the single most important game animal to subsistence and/or recreational hunters. Sport hunting accounts for about 30 to 50% of animals heavier than 20 kg in southern France, though this figure may be as high as 50 to 75% in some heavily populated countries, where hunting remains largely or wholly uncontrolled (Spitz, 1986). For example, the wild pig population inhabiting the 25,000 ha of broadleaved woodlands

around Monticiano in Italy, has apparently been able to sustain its numbers despite an annual hunter-kill rate of about 50% (c. 500 animals) of the population (Devitt, 1984).

According to figures produced by the Japanese Environment Agency a total of 1,279,453 (or x 63,973 per annum) wild pigs were harvested in Japan between 1970 and 1989 (incl.), of which 1,083,858 (85%) were taken by hunters, and the remaining 195,596 were destroyed as crop pests during the closed season. The great majority of these animals are *S. s. leucomystax* from the main islands of Honshu, Shikoko and Kyushu, and this subspecies is evidently able to withstand high levels of harvesting to judge from contemporary reports of marginal expansions in the overall range of this subspecies (Hanai, 1982; Takahashi, 1980). Unfortunately, however, these totals do not differentiate between the numbers of S. *s. leucomystax* and those of *S. s. riukiuanus* from the three small islands of Amami Oshima, Tokuno Shima and Kakeroma Jima, which are also included in these figures. As previously indicated, the latter subspecies is declining rapidly in numbers on these islands, and on the neighboring island of Okinawa, largely as a result of over-hunting (Barber *et al.*, 1984; H. Obara, pers. comm.). This conclusion is also borne out by official figures on the annual harvest of S. s. riukiuanus from two other islands, Iriomote and Ishigaki, in the Ryukyu chain between 1965 and 1981, which indicate a downward trend in the numbers of these animals (Yasuma, 1984) and a marked increase in the amount of effort required by local hunters to obtain smaller catches (Hanai, 1982). Nonetheless, according to these figures an average of 530 and 190 wild pigs were still being taken annually on Iriomote and Ishigaki, respectively; of which slightly more than 50% were killed as 'agricultural pests', i.e. mostly out of season, often with a Government bounty being paid. Moreover, it is certain that these totals are a serious underestimate - perhaps by as much as 50-100% - of the actual numbers killed, since many hunters operate without licenses and do not declare their catches (Barber *et al.*, 1984; Yasuma, 1984). Formerly, virtually all of these pigs were consumed locally but, following the restoration of electricity (and, hence, refrigeration) in 1972, commercial traders began operating on the islands, and the majority of carcasses are now exported to gourmet markets in Osaka, where they realize relatively high prices and ensure a continued demand for wild-caught meat (Yasuma, 1984).

Wild pigs are also susceptible to a variety of highly contagious diseases which can decimate their populations. Santiapillai et al. (1991) referred to a catastrophic crash in the wild pig population of Ruhuna National Park in Sri Lanka in 1989 owing to an outbreak of swine fever, but that population numbers had apparently recovered by June 1991. Many wild pigs are also reported to have died during an outbreak of disease in the Kanto Region on Honshu Island, Japan in 1877 (Yanagida, 1913). It is possible that this was hog cholera, contracted from domestic pigs which were imported to the region at that time (Chiba, 1975), and this may have been one of the factors contributing to the extirpation of S. s. leucomystx throughout the north of their range on this island (Fig. 10). An outbreak of severe skin disease (tentatively identified as sarcoptic mange) on Iriomote, which was first noted in 1976, had spread throughout the Island by 1980, and infected up to 83% of the *S. s. riukiuanus* population according to data based on hunter-killed samples (Yasuma, 1984).

The Ryukyu pigs are also threatened by genetic contamination through contact with free-ranging domesticates. On Ishigaki Island, interbreeding with domestic pigs has been so prevalent that it is doubtful if the remaining wild stock can be considered genetically pure (Obara, 1982). Moreover, it is unlikely that this problem will be confined to Ishigaki, given that the meat from wild x domestic hybrids or 'ino-buta' is popular and local farmers will continue to produce it. Indeed, *ino-buta* have been farmed commercially on Iriomote for many years, often in poorly controlled conditions. As a result, feral *ino-buta* have become established on the adjacent, smaller islands of Sotobanare and Uchibanare, and it is claimed that a number of these animals have crossed onto Iriomote at low tide; thereby posing a further, serious threat to the remaining wild stock there (Yasuma, 1984; Takahashi & Tisdell, in press).

Similarly, Genov *et al.* (1991) reported that the traditional practice of rearing 'domestic' pigs in semi-wild conditions in Bulgaria has resulted in their hybridizing with the wild boar populations in the eastern and north-eastern parts of that country, and that genetically pure wild boars now occur only in the Rila-Pirin-Rhodopes Mountains in the south of this country, where domestic pigs are not reared in the wild. The principal threat to the survival of the Monticiano population in Italy, lies not so much with the high annual hunter-kill rate but with the fact that the genetic integrity of the native population has been seriously compromised by the introduction of Central European boars after World War II, which have interbred with these animals. Indeed, the introduction of non-native wild pigs, by hunting interest groups in the belief that these were more desirable because of their larger size and reputed greater fecundity, has been so widespread in Italy that the only surviving pure-bred native stock is thought to be in the presidential reserve in Castel Porziano, near Rome (Devitt, 1984).

Conservation Measures Taken

Generally, few, if any, practical measures have been taken in any country for the specific purpose of conserving wild populations of any subspecies of *S. scrofa*, except in the sense of maintaining stock levels for hunting, particularly for sport hunting. Thus Genov *et al.* (1991) reported a gradual increase of the wild boar population in Bulgaria in the late 1950's following legal measures to regulate hunting, and because of the reintroduction of animals from breeding farms in the north-east of the country, in the Balkan Range and Sredna Gora. Even in this instance, however, other factors may also be operating, since similar increases in the local wild pig populations in Spain, France, Switzerland, Czechoslovakia and eastern Russia have been described by Sáez-Royuela & Tellería (1986), who simply attributed this trend to a progression to a more temperate climate and, hence, progressively milder winters of benefit to these animals.

Somewhat ironically, local wild pig populations are also reported to be increasing in numbers in several countries as a consequence of the spread of Islam. For example, the north-west African race, *S. s. algira*, although extinct in Libya, is thought to be expanding in neighboring Algeria where it is designated a game animal but, as the meat is now seldom eaten in this country, hunting pressure has been greatly reduced since colonial times (Kowalski & Rzebik-Kowalski, 1991). These authors also cite earlier

reports of wild boars hybridizing with domestic pigs, but the latter are no longer kept in Algeria.

As previously stated, *S. s. riukiuanus* has been included in the IUCN Red List since 1982, where its 'vulnerable' status reflects a widespread concern about the environmentally destructive development of the Ryukyu Islands and the growing number of threats to the ecosystems and endemic species of Iriomote and other islands in this region. In 1978, these concerns led to the passing of a resolution at the 14th IUCN General Assembly in Ashkhabad, which called upon the Government of Japan to take immediate steps to ensure the conservation of Iriomote Island and its endemic taxa, and for the subsequent designation of the whole of the Nansei Shoto Region (often referred to as the 'Galapagos of the East' on account of the high percent endemicity of its fauna and flora) as a bio-geographical priority region in the World Conservation Strategy. In 1982, the 'Nansei Shoto Conservation Project' was launched by WWF-Japan, with initial emphasis being placed on the conduct of wildlife and socio-economic surveys on Iriomote and Amami Oshima (Obara, 1984a,b). In the interim, however, the desired increased protection of the Nansei Shoto Region was clearly at odds with the Japanese Government's regional policies, and the development of the islands continued - a circumstance which led to the passage of a another resolution, condemning Japan's treatment of the region, at the 16th General Assembly of IUCN in Costa Rica in 1986. Unfortunately, this also appears to have had little affect, as evinced by further major development plans, including the controversial Ishigaki Airport extension, and recent plans to construct a new dam and road on Iriomote Island. Although one third of Iriomote has been designated as a national park, the proposed road will cut through the park and will also increase access by poachers who have already reduced the wild pig to less than half of its numbers before the park was created (Brazil, 1988).

Captive Breeding

Of all wild pigs species, *S. scrofa* is by far the most widely maintained and bred in captivity, though general perceptions about the relative abundance of this species has resulted in diminished interest in its propagation. Many zoos, particularly in western Europe, have therefore disposed of their stocks of these animals, mostly to 'wild boar breeding farms', which have escalated in number to meet growing demands in the gourmet meat markets and for commercial diversification. In addition, increasingly restrictive quarantine and other veterinary regulations appertaining to the international movements of all live suids, has made it extremely difficult to establish new breeding programs.

Contrarily, since these animals are most easily acquired in their countries of origin, local stocks are most likely to be pure-bred and, hence, most valuable for research and conservation purposes. In this situation, priority should be given to the establishment of national or regional breeding programmes for each of the rarest subspecies, especially *S. s. riukiuanus*. Unfortunately, although there were at least 13 (6 males, 7 females) individuals of this subspecies were in captivity in Japan in 1990, these were located in

five separate collections, and there is still no coordinated plan for its long-term management on either a national or international scale (JAZGA, 1990).

Conservation Measures Proposed:
An Action Plan

As a general rule, *S. scrofa* is both highly adaptable and highly resistant to a variety of degradative processes, and may thrive under conditions of habitat modification and hunting pressure which have devastated other forms of wildlife. In addition, most subspecies are well represented in protected areas in their relatively extensive ranges. Nonetheless, there are reasons for concern about a number of distinct populations of S. scrofa, of which the Ryukyu pigs are undoubtedly the most seriously threatened. Indeed, *riukiuanus* is the only subspecies of *S. scrofa* to be included in the IUCN Red List of Threatened Animals (IUCN, 1990), where it has been accorded the status of 'vulnerable' since 1982, but is already thought to be 'endangered' on at least four of the six islands in the Ryukyu Chain which constitute its entire, and therefore extremely restricted, range. This particular form is also the most distinct, and (with an average adult male body weight of only about 45 kg; Barber *et al.*, 1984) by far the smallest, subspecies. It is therefore of some interest as a potential genetic resource, as well as being one of the principal 'flagship' animals for increased conservation activity in the crucially important Nansei Shoto Region. For all of these reasons, the following recommendations are mostly confined to the immediate and longer-term management requirements of this taxon.

Objectives:

1. To promote local interest in, and the enhanced future protection and management of, the Ryukyu Islands' dwarf wild pig, S. s. riukiuanus, and any other threatened native subspecies may be identified in the future;

2. To promote further applied research on the taxonomy, distribution, conservation status and biology of the species, particularly the least known forms;

3. To discourage any future releases of any specimens of any subspecies of this species, or its domestic and feral derivatives, outside their known former ranges, and encourage the eradication or control of such introduced populations as may exist at present; and

4. To investigate the cultural and economic significance of these animals to local people, particularly in S. E. Asia, and their potential genetic importance in terms of: a) possibilities for their further domestication and/or b) an enhanced understanding of the origins and relationships of present day domestic and wild populations.

Priority Projects:

1. Provide all appropriate support to any existing or proposed future conservation initiatives in the Nansei Shoto Region, relevant to the enhanced future management and protection of the Ryukyu Island's dwarf wild pig, *S. s. riukiuanus*.

Given the often highly politicized nature of conservation issues in this Region, and widespread governmental and local ambivalence, disinterest or even hostility towards the conservation needs of these animals, actions primarily directed towards their enhanced future protection are unlikely to engender local support over much of their remaining range (but also see below) and could well prove counter-productive. For these and other reasons, priority should be given to supporting programmes directed towards the conservation of biodiversity, which is, in any event, of obvious overriding importance.

2. Conduct (preliminary or repeat) status surveys on all (six) islands in the Ryukyu Group known to support remnant populations of *S. s. riukiuanus* (i.e. Iriomote, Ishigaki, Okinawa, Tokunoshima, Amamioshima and Kakerome), and implement emergent recommendations.

Recent data is lacking on the distribution, status and future management needs of these animals on each of these islands, but particularly Kakerome (a U.S. Naval Base) and Tokunoshima which are not known to have been surveyed in this context. Any such surveys should also try to assess current local attitudes to these animals, current population trends, the extent of domestic consumption versus commercial trade in the flesh of these animals and the hybrid 'inobuta', the level of hybridization/genetic purity of each population (i.e. from interviews and the collection of blood and other tissue samples from hunter-killed specimens for comparative molecular genetic studies of populations on each of these islands, the status of existing protected areas (if any) and options for the enhanced future protection of representative populations on each island, etc. A special effort should also be made to alert the U.S. Navy to the biological importance of the forested lands under their jurisdiction on Okinawa and Kakerome, and to enlist the support of that authority in the implementation of recommendations for the future protection and benign management of these habitats and species.

3. Promote development of a coordinated breeding programmed for *S. s. riukiuanus*, both nationally and internationally.

Despite international recognition of their precarious status, there has been a perplexing and regrettable lack of interest within the Japanese zoo community to develop any coordinated breeding program for these animals. In fact, a reasonable number of potential founders already exist in a few collections in the country, some of which are breeding these animals, but further, concerted efforts should be made to encourage

those collections to collaborate in the development of such a program and to extend this program to other reputable collections elsewhere - preferably under the aegis of a structured 'conservation education and research program' in the best interests of these animals and the issues they represent.

4. Collect, evaluate and disseminate data on the taxonomic relationships, distribution and conservation status of other, less-known forms, with a view to the resolution of certain outstanding taxonomic problems and the development of recommendations for their enhanced future protection, if so required.

Additional data is needed on the distribution and status of some, poorly-known subspecies and populations, including a tentatively assigned form (subsp. *nov*.) from the central highlands of Sri Lanka and the insular *taivanus* (Taiwan). Efforts should also be made to resolve outstanding questions relating to the genetic distinctness and range limitations of many of the continental races, which are poorly understood at present.

5. Promote further research on the biology and ecology of all less-studied populations, particularly those in extreme habitats, or in areas of sympatry with other species of *Sus*.

Most of the information on this species has originated from studies conducted in Europe or on the feral populations in the U.S.A., Australia and New Zealand. Priority should therefore be given to studies of other populations elsewhere, particularly those in semi-desert regions or other extreme habitats, and/or studies focused on the ecological and genetic relationships between this and other species of *Sus* in those areas where sympatry occurs (e.g. with *S. barbatus* in the Malaysian Peninsular and Sumatra, and with *S. verrucosus* on Java).

Acknowledgements

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Chapter 5. 3

The Pigmy Hog
(*Sus salvanius*)

William L. R. Oliver and Sanjoy Deb Roy

Status and Action Plan Summary

Status category 6 (critically endangered).

This species has the highest priority rating of all suiformes, and is considered to be amongst the most endangered of all mammals. Pygmy hogs are now reduced to only two known, isolated populations in the few remaining tall grasslands of north-western Assam. These are in the Manas Wildlife Sanctuary (391 sq km) and its buffer reserves, and in the small Barnadi Wildlife Sanctuary (26.6 sq km). The size of these populations is unknown, though the Barnadi population may number less than 50 individuals and the Manas population is unlikely to be more than a few hundred individuals, and may be considerably less. Unfortunately, Manas is also seriously threatened following the recent (February 1989) invasion of the Sanctuary by an extremist faction of the All Bodo Student's Union (ABSU), who have wrested control of a large part of the core area and facilitated the influx of large numbers of wildlife and timber poachers. The principal recommendations for this species are: 1) the immediate return of control of the Sanctuary to the relevant authorities by any possible means, and the restoration and enhanced future protection of this area; 2) the early initiation of field status surveys designed to: (a) determine the species' current distribution and priority requirements in the environs of Manas, (b) identify any other possibly surviving, remnant populations elsewhere in the region, and c) identify suitable sites for possible future reintroductions; 3) the establishment of a properly structured captive breeding program, both as a safeguard against the species' possible imminent extinction and as a source for future reintroductions; and 4) the initiation of a medium to long term field studies on the species' behavioral-ecology and habitat management requirements.

Introduction

The pygmy hog is the world's smallest suid and is therefore a potentially extremely valuable genetic resource. It is also one of the most useful indicators of current wildlife habitat management practices - particularly the effects of widespread, too-frequent burning and other exploitative and degradative pressures - in the few remaining tall grasslands of the northern Indian subcontinent (Oliver, 1980, 1981, 1984; Bell and Oliver, 1991a).

S. salvanius is a monotypic species (Groves, 1981; Grubb and Groves, this vol.), which is sympatric with *S. scrofa* throughout its limited known range. Relatively few characters other than the extreme reduction in body size (i.e. males c. 65 cm head + body length, c. 25 cm shoulder height, c. 8.5 kg wt.; females somewhat smaller; Mallinson, 1977; Oliver, 1980) are truly diagnostic, though the vestigial tail (c. 3cm) and possession of only three pairs of mammae are specific characters. In addition, there are some important changes in the proportions of the body in comparison with other members of the genus (e.g. reduction in the size of the forequarters, ears and length of the facial skeleton), which effect a marked streamlining of the body. These factors, together with its diminutive size, enable pigmy hogs to move with great rapidity through their extremely dense, early successional, tall grassland habitat, to which they are evidently restricted and supremely well adapted.

Link to Fig. 11: Approximate former and present known range of the pygmy hog, *Sus salvanius*.

Former and Present Distribution

Most records of this species appertain to the narrow alluvial tract known as the '*terai*' or '*duars*', which extends south of the Himalayan foothills from north-eastern Uttar Pradesh in the east, through southern Nepal and northern West Bengal to north-western Assam and adjacent parts of extreme south Bhutan (Fig. 1). The presence of pygmy hogs has never been confirmed from north-eastern Assam or southern Arunachal Pradesh, though it is possible that they occur there (Oliver, 1981; Pandya, 1990). However, the species is known to have occurred in some areas south of the Brahmaputra River in south and south-eastern Assam. Contemporary records from the latter areas include eyewitness reports in the Goalpara District of south-west Assam in the late 1950's/early 1960's (Oliver, 1979a, 1980) and from the Surma Valley in Cachar District, south-east Assam, where one of us (SDR) saw a freshly killed animal in 1968. No trace of the species' continued existence in these areas was found during the course of brief surveys in 1977 and 1978 (I. K. Bhattacharyya, pers. comm.), though their former occurrence in the Cachar region lends credence to the occasional, unconfirmed reports of their recent occurrence in parts of north and north-east Bangladesh (Oliver, 1984, 1985).

Unfortunately, the species is almost certainly extinct over most of its known or presumed recent range in the *terai* and *duars* regions. Occasional rumors of pygmy hogs in south-eastern Nepal, for example, have not been verified, despite repeated attempts to locate them (Griffiths, 1978). A U.S. expedition from the Hormel Institute spent four weeks searching unsuccessfully for pygmy hogs in 1964 (T. Reed, pers. comm.). A University of East Anglia expedition team also failed to find any trace of these animals during a six-month survey of tall grasslands in south-east Nepal, and concluded that remaining habitat was so limited that it was unlikely that the species survived there (Rands *et al*., 1979). A similar, three months survey of all remaining grassland in the reserve forests, wildlife sanctuaries and national parks of northern Bangladesh, northern West Bengal, north-western Bihar, north-eastern Uttar Pradesh and south-western Nepal in 1984, also failed

to reveal any definite evidence of surviving animals, though several new populations of the closely-associated hispid hare, *Caprolagus hispidus*, were described (Oliver, 1984; Bell and Oliver, in press; Bell *et al,* in press).

All recent, confirmed reports of this species therefore originate from the reserve forest belt of north-western Assam, where at least seventeen pigmy hogs were captured in the vicinity of the Barnadi Reserve Forest, in Darrang District, in March/April, 1971; most of which were retained for a captive breeding venture on neighboring tea estates. The circumstances surrounding this event, which was hailed by several authors (e.g. Tessier-Yandell, 1971; Mallinson, 1971) as the 'rediscovery' of the species, were made rather more remarkable by the coincidental first reporting of the species in the Manas Wildlife Sanctuary, approximately 60 km west of Barnadi. The species was subsequently reported from a number of separate areas in the environs of the Manas Sanctuary (Deb Roy, unpubl.), and in the Khalingdaur Reserve Forest, approximately 5km east of Barnadi (Ranjitsinh, 1972). The continued occurrence of small numbers of pygmy hogs in Barnadi R.F. was confirmed during the course of a two months survey of the reserve and unclassed state forests of north-western Assam in 1977, which also revealed the recent (c. 1975) extinction of the population in Khalingdaur R.F., but their continued existence in a number of other areas in the region, namely: Subankhata R.F., Darranga R.F., Corromore U.S.F., Rowta R.F., Balipara R.F. and Gohpur R.F. (Oliver, 1979a, 1980). However, all of these other populations were reported to be of small size and highly susceptible to encroachment and exploitation pressure, and all of them are known, or believed likely to have been lost since that time (Oliver, 1981, 1984; Deb Roy, in *litt*.; P. Lahan, pers. comm.). Accordingly, by the mid-1980's, the only known, viable population (i.e. undoubtedly surviving and of presumed reasonable size) was in the Manas Sanctuary and the contiguous Koklabari and Manas Reserve Forests. In 1981, the Barnadi Reserve Forest was finally upgraded to a Wildlife Sanctuary for better protection of the pygmy hog and the hispid hare, and small numbers of both species have recently been confirmed as surviving in this area (S. K. Sharma, pers. comm.; N. C. Kalita, pers. comm.; Oliver, 1990a, 1991).

Habitat, Ecology and Behavior

Adult male pygmy hogs are distinguished by their relatively larger size, more robust appearance and exposed tusks. They are usually seen by themselves, but are reported to join estrous sows during the rut and to associate loosely at other times of the year with the basic social units of (usually) four to six individuals, comprising one or more adult females and accompanying immatures. Reproduction is strongly seasonal, with almost all recorded data indicating a single, well defined birth peak, which coincides with the onset of the monsoon (i.e. in late April and May in western Assam). Litter size varies from two to six, but is usually three to four (Mallinson, 1977; Oliver, 1979b, 1991). The species is also unusual amongst the suids in that nests are constructed and utilized by both sexes at all times of the year, and nest-building is not, therefore, associated only with farrowing or inclement weather (Oliver, 1980).

All recent data indicate that this species is dependent on early successional riverine communities, typically comprising dense tall grasslands, commonly referred to as 'thatchland', but which, in its pristine state, is intermixed with a wide variety of herbaceous plants and early colonizing shrubs and young trees. These grasslands, or 'mixed thatch-scrub', are a feature of the successional continuum between primary colonizing grasses on the new alluvium deposited by changing water courses, through to deciduous riverine forests and, in drier areas, the Sal (*Shorea robusta*) forest climax vegetation. Tall grasslands may also form an understory during later stages of this succession, particularly near water courses, or in forest clearings and abandoned cultivation and village sites. In relatively undisturbed areas, the grasslands are maintained by prolonged inundation during the monsoon and/or by periodic burning. In disturbed areas, they are maintained by regular burning, grazing pressure, and/or regular harvesting of the thatch grasses for roofing and domestic animal fodder. There are many species of tall grasses, which dominate in different situations. The most important of these communities for pigmy hogs are those which tend to be dominated by *Saccharum munj*, *S. bengalensis*, *Themida villosa* and *Narenga* spp., which form characteristic associations of 2 to 3m height, during secondary stages of the succession on well drained ground. These communities are not, therefore, maintained by prolonged inundation, though they may be maintained by periodic burning. However, as they also include some of the most commercially important thatching grasses, most of these areas (including many of those in wildlife sanctuaries and national parks) are harvested annually and virtually all of them are subject to wide-scale annual (in some areas, twice-annual) burning. Most of this burning is conducted at the beginning of the dry season (i.e. in December or early January), in order to preclude the possibility of later, uncontrolled 'hot' burns, which are far more destructive. As a result, however, the regularly burnt grasslands are also characterized by the relatively uniform growth of a few, fire-resistant species and, hence, a chronic reduction in species' diversity and the quality and carrying-capacity of this habitat for many dependant animal species.

Threats to Survival

The recent and continuing decline in the distribution and numbers of pygmy hogs is directly attributable to the loss and degradation of habitat to human settlements, agricultural encroachment, commercial forestry and flood control schemes; the latter as a result of the disruption of natural successions and the replacements of former grasslands by later stage communities or other developments. In Assam, as elsewhere, most former habitat has been lost to settlements and agriculture following the rapid expansion of the human population. However, this process has been exacerbated by high levels of (mostly illegal) immigration of Bengali, Bangladeshi and Nepali peoples, thereby also producing problems of civil unrest amongst Assamese ethnic groups. These factors have put additional pressure on what little wildlife habitat remains, and have resulted in the loss of at least two known populations of these animals in recent years; i.e. those in Corromore Unclassed State Forest, which was occupied by immigrant settlers from Nepal in 1978/79, and those in Gohpur Reserve Forest which was swamped by illegal immigrants from Bangladesh in 1979/80 (D. K. Lahiri-Choudhury, pers. comm).

In these, as in other parts of north-western Assam, the surviving grasslands are reduced to small, discrete patches within declared reserve boundaries, where they are mostly subject to continued attrition or exploitation through commercial afforestation programmes, over-grazing by domestic herbivores and/or thatch grass harvesting. Virtually all remaining grasslands are therefore burnt every year, either by Forest Department personnel or by herdsmen and thatch collectors from neighboring settlements. This burning is extremely prejudicial to the survival of the hog, through the short-term loss of cover and other resources, and the resulting ecological instability, loss of species' diversity and consequent reduction in the carrying capacity of this habitat for dependant (non-grazing) animals. In drier areas, the interval between the burning (usually in late December or January) and the regrowth of vegetation following early rains (usually in April or May) may be as long as three to four months. During this period, the hogs are either entirely dependent on any habitat left unburnt, mostly by chance or, if burning is particularly severe, are forced to seek cover elsewhere (e.g. on neighboring tea estates). In either event they are liable to be killed by hunters, whose activities are facilitated by the enforced concentration of game in any remaining cover during the post-burning period. In the Barnadi Reserve Forest in 1977, for example, village hunters accounted for at least five (14%) of the total estimated population of about thirty-five pigmy hogs (Oliver, 1979a, 1980).

A combination of these factors has almost certainly resulted in the loss of all of the recently known (i.e. post-1971), small populations of these animals in the reserve forests of north-western Assam. These losses include Khalingdaur Reserve Forest, where pigmy hogs were reported to have become extinct by 1975/1976 following the replacement of some habitat by hardwood plantations and the repeated burning of all of the remaining grasslands by herdsmen. Wide-scale burning in connection with commercial thatch concessions is thought to have accounted for the loss of small populations in Subankhata, Darranga and Rowta Reserve Forest some time between 1978 and 1980. The population in Barnadi was also feared lost following particularly extensive burnings in 1980 and 1981 (Oliver, 1981). However, a recent (1990) visit to this area provided confirmation of subsequent reports that small numbers of these animals survived, following the upgrading of Barnadi from a Reserve Forest to a Wildlife Sanctuary in August 1981, the subsequent cessation of all commercial forestry practices, the eviction of squatters and improved protection (patrolling) against poaching and grazing of domestic herbivores (P. C. Das, pers. comm., N. C. Kalita, pers. comm., Oliver, 1990a).

These losses strongly reinforced the overwhelming importance of the largest and, by the early to mid-1980's, only known surviving population in the Manas Wildlife Sanctuary. Moreover, the deleterious effects of wide-scale annual burning on the tall grasslands in Manas are considered less severe than in the reserve forests, owing to the absence of the associated exploitative practices, the deliberate management policy of early 'patch-burning', and the rapid regrowth of vegetation consequent of condensation and a high water table. Given the relatively large size of the Sanctuary (391 sq km) and contiguous reserve forests, which incorporate several large grasslands, some inter-population

dispersal is possible, and a single catastrophic event, such as a major conflagration, is unlikely to eliminate the entire population of hogs, as has apparently happened elsewhere.

Nonetheless, the survival of this species remains crucially dependant on the future of the Manas Sanctuary itself. Unfortunately, this is far from assured, given the continued civil unrest and other, mostly political, problems relating to the high levels of illegal immigration and a strong separatist movement in Assam. Recent threats to the Sanctuary have included the proposed construction of two dams on the Bhutan side of the Manas River, to supply hydro-electric power, flood control and water for irrigation schemes on the north bank of the Brahmaputra River. This plan was abandoned in 1986, following strong national and international opposition, but in February 1989, an equally serious threat became manifest when armed extremists of the All Bodo Student's Union (ABSU) invaded the Sanctuary and killed several guards, looted and burnt rest houses and other property, and allowed the entry of numerous wildlife and timber poachers. This and subsequent attacks on the Sanctuary staff and property was justified on the basis that the Manas area was part of the homeland of the Bodos, one of the largest ethnic minorities in Assam, but had been taken from them during the British rule. In fact, however, Manas is being used as a refuge by militant extremists who shelter in the Sanctuary following acts of hostility and sabotage elsewhere in the region. At present, most of the core area, particularly the 120 sq km western sector, continues to be controlled by the extremists and therefore remains out of the control of the relevant authorities. The damage perpetrated by poachers and the rebel tribals is not thought likely to have had a major negative impact on the pygmy hog population as yet, but the future of the whole area is now in jeopardy (Deb Roy, unpubl.; Oliver, 1990b).

Conservation Measures Taken

The pygmy hog is included on Schedule 1 of the Indian Wild Life (Protection) Act (Government of India, 1972) under the terms of which it is accorded maximum protection. However, this Act was not ratified by the State of Assam until January 1977, and it has proven entirely ineffective in protecting this species in the absence of any legal protection of its habitat over the majority of its recent known range in the reserve forests of N.W. Assam. In 1981, the Barnadi Reserve Forest was upgraded to a Wildlife Sanctuary for the better protection of the pygmy hog and the hispid hare, and small numbers of these species are now known to survive there despite earlier fears that they were both extinct in the area by that time. The species also survives only in the Manas Wildlife Sanctuary and its buffer reserve forests. However, its habitat remains unprotected in latter areas, where commercial forestry operations pose a continuing threat to its survival. The Manas Sanctuary was one of the first sanctuaries to be designated in (1973) as a Tiger Reserve, and its boundaries were extended to a total area of 2,837 sq km in 1980. In recognition of its international significance, Manas was also one of the first wildlife areas in India to be designated by Unesco (in 1986) as a World Heritage Site. However, it is also included on the IUCN list of the World's Threatened Protected Areas (J. Thorsell, pers. comm.).

The pygmy hog is included on Appendix 1 of the 1973 Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES), so that trade in it or its products between acceding nations is subject to severe restriction, and trade for primarily commercial purposes is prohibited. However, international trade is not considered an issue for this species, or to have materially influenced its present conservation status. The species is listed as 'Endangered' in the IUCN Red List of Threatened Animals (1988), and was included in the first (1984) IUCN/WWF listing of the twelve most threatened animal species (Anon, 1985). It is also included in the current, provisional list of World Heritage Species (S. Edwards, pers. comm.).

Current understanding of the species' recent history, distribution, present status and future management needs are based largely on the field surveys conducted in 1977, 1981 and 1984, referred to above (Oliver 1979a,b, 1980, 1981 and 1984), and on observations are records appertaining to the captive animals on tea estates (Mallinson, 1971, 1977) and in the Manas Sanctuary (Deb Roy, unpubl.). A three-point 'Action Plan for the Pigmy Hog', submitted to the relevant authorities in the Assam States and Indian Central Governments by the IUCN/SSC Pigs and Peccaries Specialist Group, was agreed in full in December 1987 but, owing to the continued high levels of civil unrest in north-western Assam, this has yet to be implemented. A duly modified, and extended version of this Plan is outlined below.

Captive Breeding

Despite the relatively large number (i.e. >40) of pigmy hogs taken into captivity on tea estates in north-west Assam between 1971 and 1976, and the relatively large number of captive births (>45) recorded during this period (Mallinson, 1977), all of this stock has since died out. These losses include small numbers of animals supplied to the Assam State Zoo, Guwahati, and Zurich Zoo, Switzerland (K. C. Patar, pers. comm.; Schmidt *et al.*, 1978; Oliver, 1980; Schmidt, unpubl.). Small numbers of pigmy hogs were also maintained in a compound in the Manas Wildlife Sanctuary in the mid-1980'. Several litters were born to these animals, but no young reared and all of the adults eventually escaped or were released. A further ten individuals (six caught in 1988 and four in 1989) were captured in Manas and placed in a larger (1.25 ha) enclosure in tall grassland in Bansbari Range, Manas, though the subsequent history of these animals, is poorly known owing to the difficulty of observing them in such a (relatively) large, densely vegetated enclosure, difficulty of access during the current crisis, and the fact that the enclosure has been damaged by wild elephants and rhinos on at least two occasions. In any event, there were no pigmy hogs left in this enclosure by late 1991/early 1992 (P. Lahan, pers. comm.).

Additional Remarks

The pygmy hog is thought to be sole host of the pigmy hog sucking louse, *Haematopinus oliveri*, which, owing to the status of its host, is also accorded 'Endangered' categorization in the IUCN Invertebrate Red Data Book (Wells *et al*., 1983).

Any conservation measures designed to protect the habitat of the pygmy hog are certain to benefit a wide variety of other seriously threatened species, including the hispid hare, *Caprolagus hispidus*, and the Bengal florican, *Houbaropsis benghalensis*, both of which species also have their largest surviving populations in the Manas Sanctuary.

As it is by far the smallest suid, the pygmy hog is a potentially extremely useful and valuable genetic resource, with obvious possibilities for use in biomedical research and for the further domestication of one of the man's most important sources of terrestrial animal protein.

Conservation Measures Proposed:
An Action Plan

In line with currently available information on the critical status of this species, and the terms and objectives of India's National Wildlife Action Plan (Government of India, 1983), the following objectives and actions are strongly recommended for immediate implementation. However, it is recognized that the survival of this species is intimately linked with the restoration of the Manas Wildlife Sanctuary by the removal of illegal occupants and the enhanced future protection of this Sanctuary and its buffer reserve forests, and that any such actions are of paramount priority and urgency.

Objectives:

1. To promote whatever actions are necessary to restore the Manas Wildlife Sanctuary and its buffer reserves, and to assist the enhanced future protection of that area.

2. To help to ensure the survival of the pygmy hog into perpetuity by the promotion and implementation of those activities/projects specified in the Action Plan, or such others as may be identified in the future.

3. To facilitate an enhanced understanding and appreciation of this species, its potential importance as a genetic resource and as a model for the enhanced future management of tall grasslands in the north Indian sub-continent.

Priority Projects:

1. Conduct field status surveys of the Barnadi and Manas Wildlife Sanctuaries (the latter to include the adjacent Koklabari, Kahitama, Panbari and Manas Reserve Forests) in order to assess this species' present distribution, status and immediate management requirements in these areas.

2. Conduct field status surveys of selected tall grasslands within the known, or postulated recent range of this species, with a view to the identification and protection of any possibly surviving populations elsewhere, and the assessment of selected areas for the future reintroduction of translocated or captive-bred animals.

   Areas to be investigated should include: Pochu and Mochu Reserve Forests, Goley Game Reserve, Neuri Wildlife Reserve and Khaling Reserve Forest in southern Bhutan; Subankhata and Darranga Reserve Forests, Sonai-Rupa and Nameri Wildlife Sanctuaries in north-western Assam; and Pakkui, Lali, Dibru Saikhowa, D'Ering Memorial and Namdapha Wildlife Sanctuaries in southern Arunachal Pradesh. Selected areas in south-eastern Assam, north-eastern Bangladesh and extreme south-western Nepal may also merit further investigation in this context.

3. Establish a properly structured, captive breeding program.

   This Program should include the following objectives: a) to serve as a safeguard against the (not improbable) early extinction of the species in the wild state; b) to serve as a source of animals for reintroduction to selected, protected sites within its recent known habitat in north-western Assam and elsewhere; c) to serve as a means of obtaining detailed information on the species' life history, reproductive biology and social behaviour, much of which information would be impractical to obtain from studies of wild animals (also see below); and d) to serve as a conservation education, captive breeding and field research training facility. This program should be initiated in Barnadi (if possible with a corollary project in Manas), but should include extensions to other reputable breeding centers in India or elsewhere at the earliest opportunity.

4. Conduct detailed studies of the behaviour and ecology of the pygmy hog, with particular reference to the establishment of management criteria for the enhanced protection of the wild population.

   These studies should be conducted in Manas (with its more extensive range of early successional grasslands and grassland dependent species) and in Barnadi (where field conditions are easier) and should be continued for at least two years, but preferably three to four years. These studies should include related investigations into the general ecology of the tall grasslands the effects of current management policies, particularly dry-seasonal burning, with a view to the development of strategies designed to maintain the integrity of these grasslands and optimal species' diversity.

Manas is ideally suited for this purpose since it supports a variety of different tall grass communities, and representative populations of a larger number of major (including Schedule 1) species of herbivores than any other area in the Indian sub-continent.

Acknowledgements

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Chapter 5.4

The Javan Warty Pig (*Sus verrucosus*)

Raleigh A. Blouch

Status and Action Plan Summary

Both subspecies are status category 4 (vulnerable).

The Javan warty pig is endemic to the islands of Java, Madura, and Bawean in Indonesia. Two subspecies are recognized. These are *S. v. verrucosus* from Java and Madura (though it is reported to be extinct on Madura, following the virtual deforestation of that island), and *S. v. blouchi* from Bawean Island, off N. E. Java. The current status of the latter form, which was described as recently as 1981 (Groves, 1981), is not known, but it is thought to be relatively secure despite its extremely limited range. The nominate form is not uncommon on Java, but the remaining populations are highly fragmented and the species is poorly represented within existing nature reserves. It is widely persecuted as a pest, but some segments of society value it as a game animal and for its meat. Poisoning and uncontrolled hunting are the greatest threats. Habitat loss is not currently a major problem over most of its remaining range, since the species is found on marginal lands with little potential for agriculture, or on land already devoted to teak plantations.

The principal recommendations for the conservation of the nominate Javan population include: 1) the creation of three new nature reserves totaling 32,000 ha, and expansion of two existing reserves to include an additional 20,000 ha of warty pig habitat; 2) gaining control of the harvest by improved regulation of sport and market hunting, and

elimination of the use of poisons; 3) expansion of the current captive breeding program for *S. v. verrucosus*; and 4) investigations into the extent of hybridization with wild *S. scrofa* to determine whether this poses a potential threat to the genetic integrity of *S. verrucosus*. Field surveys are required to determine whether any remnant populations of this subspecies survive on Madura and to assess the present status and future management needs of the Bawean form.

Introduction

The Javan warty pig is endemic to the Indonesian islands of Java, Madura, and Bawean. Little was known about the natural history of this species until, prompted by fears that it may have become extinct in the wild (J. MacKinnon, 1981 and pers. comm; National Research Council, 1983), a thorough survey of its range was conducted during 1982, under the aegis of the W.W.F.- Indonesia Conservation for Development Programme (Blouch *et al*., 1983, Blouch 1988).

Two subspecies are recognized. The nominate form, *S. v. verrucosus*, occurs on Java and on the neighboring large island of Madura, though MacKinnon (1981) reported the species was extinct in the latter area. It is sympatric with *S. scrofa vittatus* on Java. The second subspecies, *S. v. blouchi*, described by Groves in 1981, is confined to Bawean Island in the Java Sea, where its present status is uncertain despite the establishment of a 4,500 ha nature reserve in 1979.

For adult males of both races the most distinctive feature is the presence of three pairs of facial warts - the preorbital, infraorbital and the large mandibular warts. There is considerable individual variation in the size of these, and the females do not exhibit these pronounced features (Groves, 1981; Groves and Grubb, this vol.). The nominate race is larger than the Bawean form, though little comparative data is available, and shows marked sexual dimorphism in body size, viz: mean live weights for adult males being about 108.2 kg (n=5, s.d.= 17.48) and for adult females only about 43.9 kg (n=4, s.d.=5.75) (Hoogerwerf 1970). Javan warty pigs are of some interest to animal breeders because of the potential value as domesticates (National Research Council, 1983). Possible advantages include the small size of the sows, which could make the species appropriate for households or smallholder farms, and the genetic distance of the species from the (ex-*S. scrofa*) domestic pigs, which may make it a useful generator of heterosis in crossbreeds.

Link to Fig. 12: Approximate former and present distribution of the Javan and Bawean warty pigs, *Sus verrucosus* ssp., and the closely allied Vietnamese warty pig, *Sus bucculentus.*

Former and Present Distribution

There is little reliable information on the former distribution of the species within its restricted range. This is partly because most early references to the natural history of the wild pigs of Java did not differentiate between *verrucosus* and *scrofa*, presumably

because of the difficulty of distinguishing these species under field conditions. However, there is no doubt that its range on Java has also been greatly reduced and fragmented during the last century. For example, it is known that it formerly occurred in Udjung Kulon National Park (Hoogerwerf, 1970) where it is no longer present, possibly because of human-induced vegetation changes (Blouch, 1988). The species might also be expected to occur in or around Blambangan Nature Reserve in extreme south-east Java, and in Baluran National Park in the extreme north-east, both of which include substantial amounts of apparently suitable habitat (see later text), though no evidence of its occurrence in either of these areas was obtained during the 1982 survey. Since World War II the increasing human population and resultant habitat fragmentation has also resulted in the elimination of Javan warties in the lowland areas 50 km south-east of Jakarta.

Javan warties are also reported to be extinct on the neighboring large island of Madura following its almost complete deforestation (J. MacKinnon, pers. comm.), though this island was not visited during the 1982 survey and it is possible that a few still exist there.

The subspecies *blouchi* is confined to the small (20,000 ha) island of Bawean, 150 km north of Surabaya in the Java Sea. Formerly, it would have occupied the coastal lowlands, but these areas have now all been converted to the cultivation of rice and other crops. Consequently, the warties are now predominantly concentrated in the teak plantations in the hilly central parts of the island, where most of this habitat is included within the Bawean Island Nature Reserve (Table 7).

In West Java much of the terrain is mountainous and therefore unsuitable for *verrucosus*, though there is a narrow plain about 150 km long on the south coast, which provides habitat for good numbers of the species. The vegetation in this area includes lalang (*Imperata cylindrica*) grasslands and scrubby secondary forest, mixed with dryland agriculture and coconut plantations. The 2,000 ha Leuweung Sancang Nature Reserve in this region is one of the few existing protected areas to contain Javan warty pigs. Two other areas of extensive lalang grasslands with substantial numbers of *verrucosus* are located north of Bandung and east of Ujung Kulon National Park.

South and east of Surabaya the landscape of east Java is dominated by a series of large volcanoes and the *verrucosus* populations are mostly small and confined to the lower slopes. A few are found within the Meru Betiri National Park, but the habitat is predominantly heavily forested and unsuitable for the species.

Habitat, Ecology and Behaviour

Most births of Javan warty pigs occur during the rainy season months of January, February, and March. Litter size ranges from three to nine (Sody, 1941). The largest groups of warty pigs reported in Java consisted of only four to six individuals, suggesting that several sows and their young do not band together, as is the case with the (sympatric)

S. scrofa. Adult male warty pigs are usually solitary except during the mating season (Blouch et al., 1983).

The largest remaining concentration of *S. v. verrucosus* is in the extensive teak plantations between Semarang and Surabaya on both sides of the border between the provinces of Central and East Java. The vegetation is dominated by mixed age teak (*Tectona grandis*) plantations interspersed with lalang grasslands, brush and patches of secondary forest. This apparently provides an optimum habitat for this species, which is common or even abundant in some areas, though declining elsewhere. In contrast, *S. scrofa* is rare or absent throughout much of this part of Java.

Javan warty pigs are everywhere restricted to elevations below about 800 m. The reasons for this are not known, but it might be due to their being unable to tolerate low temperatures. They evidently prefer secondary or disturbed forests, though they are also often found near the coasts in remnant patches of mangrove and swamp forest. They are rare in the few remaining lowland primary forests, and in areas with high human populations where otherwise suitable habitat is fragmented and surrounded by agricultural land. However, they do feed on crops, making nocturnal raids on fields of corn and cassava and, in common with *S. scrofa*, the species is widely persecuted for such depredations (Blouch, 1988).

On Bawean Island, *S. v. blouchi* is found in habitat similar to that of north-western East Java, i.e. teak plantations with scattered patches of secondary growth, lalang openings, and mature forest on the tops of hills. They are also considered a pest by farmers, who sometimes kill them with dogs and spears, though they are never eaten owing to the strict Islamic faith of the islanders.

Threats to Survival

With the elimination of the tiger (*Panthera tigris sondaica*) from Java, and reduction in the number of Asiatic wild dogs (*Cuon alpinus*), the leopard (*P. pardus*) is probably the only large carnivore which regularly preys on wild pigs, though its impact on the remaining populations of these animals is unknown. In any event, human predation and persecution undoubtedly constitutes the greatest threat to this species. Although it is illegal, poisoning is particularly widespread, and stories abound of poisoners killing, for example, 10 to 40 pigs per night or well over one hundred in one week. The largest remaining populations located between Semarang and Surabaya have been drastically reduced by poisoning in some areas. It is also a significant problem immediately west of Semarang, around Nusa Kambangan Nature Reserve, on the border between Central and East Java in the south, throughout the southern coastal plain in West Java, and in the Pembarisan Hills. Much of this poisoning is done for the purpose of selling the meat for human consumption rather than to protect crops.

Uncontrolled hunting poses an additional threat. A hunting license entitles the holder to take five wild pigs of either species per year and imposes other restrictions such as a three-month closed season and a ban on night hunting with spotlights. However, due to

lax enforcement, most of the regulations are ignored even by those who purchase the 600 licenses sold annually in Java. Although there is no way of knowing the number of firearm hunters who do not purchase licenses, it almost certainly exceeds the numbers who do. Illegal hunting is practiced by many police and military personnel as well as by some market hunters. Rural people still hunt wild pigs with dogs and spears, but the use of these more traditional methods, as well as the numbers of pigs, seems to have dwindled in recent years commensurate with the more common use of poison.

For thousands of years the Javan warty pig has coexisted with the more numerous native *S. scrofa*, suggesting that hybridization does not threaten the genetic integrity of the species under normal conditions. Nonetheless, a probable hybrid was identified among 31 specimens examined, indicating that a low level of crossbreeding may now be occurring in the wild (Blouch, 1988; Blouch & Groves, 1990). If so, it is possible that habitat reduction and fragmentation coupled with a reduction in numbers of one species may have resulted in the localized breakdown of the natural isolating mechanisms between the two species. However, there is no information on the reproductive success of the hybrids and, hence, the potential deleterious effects on the *verrucosus* gene pool.

In comparison, habitat loss is thought to pose a relatively minor threat at the present time, since Javan warties tend to occupy either marginal lands with little potential for agriculture or teak plantations, which are unlikely to be converted to other forms of land, use.

Conservation Measures Taken

Little regard has been paid to the conservation of this species to date, except that it is classed as a game animal and a license is required to hunt it. However, due to a lack of enforcement personnel, the hunting laws are largely ignored and only occasional efforts are made to stop poisoning.

An island-wide survey of Java was undertaken in 1982 to determine the distribution and status of *S. v. verrucosus*. This resulted in a number of recommendations for the enhanced future management of this species, though many of these have yet to be implemented. Commensurate with the findings of this survey, and the fact that the only protected area to harbor a sizeable population of Javan warties is the small Leuweung Sancang Nature Reserve (Table 7), the species has been categorized as "Vulnerable" in the IUCN Red List of Threatened Animals since 1986 (IUCN, 1986).

Most of the remaining habitat of the Bawean subspecies, *S. v. blouchi*, is included within the Bawean Island Wildlife Reserve (4,500 ha). This Reserve was created in 1979 with the main objective of conserving the Bawean deer (*Axis kuhlii*), which is endemic to the island (Blouch and Sumaryoto, 1979). However, very little if any additional information on these animals has been obtained over the last ten years, and their present status is not known. Nonetheless, given their restricted habitat and the fact the Island supports a relatively high (>70,000) human population, it would be unrealistic to suppose that they are securely established.

Table 7. Protected areas known to support *Sus verrucosus*.

Protected Area	Size (sq km)	Comments
S. v. verrucosus		
Leuweung Sancang Nature Reserve	20	Both *S. verrucosus* and *S. scrofa* relatively common but, given the relative importance of this Reserve, it should be enlarged to benefit the warties
Nusakambangan Nature Reserve	9.3	Available habitat probably more suitable for *S. scrofa* which also occurs here; the Reserve should be extended northwards to incorporate more *verrucosus* habitat.
Meru Betiri National Park	50	A few *verrucosus* occur in disturbed areas; predominant vegetation is dense forest more suited to *S. scrofa*.
S. v. blouchi		
Bawean Island Nature Reserve	45	Size of remnant pig population unknown, and mostly confined to teak plantations.

Captive Breeding

The largest Javan warty pig breeding colony is maintained at the Surabaya Zoo in East Java where a total of 11 (9ГГ, 2EE) individuals were maintained in 1987. By September 1990, there were at least 17 (? sexes) individuals (including two litters born that year) in Surabaya, and a further 4 (2ГГ2EE) at the Gembiraloka Zoo in Yogjakarta, and one Г at Ragunan Zoo in Jakarta, on loan from Surabaya Zoo (A. Macdonald, pers. comm.). All of these are descendants of about seven animals obtained from the wild in the late 1970's and early 1980's. In addition, in 1982 the Semarang Zoo in Central Java was holding one E unrelated to the Surabaya Zoo stock.

Unfortunately, some of the Surabaya Zoo stock has been offered for sale on the open market since late 1989, thereby compromising the possibility of promoting the development of a properly structured, co-operative breeding program through the placement of surplus, captive-bred animals to other reputable breeding centers under the aegis of breeding loan agreements.

Conservation Measures Proposed:
An Action Plan

It is apparent that the Javan warty pig is not in any immediate danger of extinction and, indeed, it remains fairly common in some areas where it may cause considerable damage

to crops. It is not, therefore, either necessary or practicable to attempt to protect all surviving populations outside the (few) protected areas in which it occurs. However, due to uncontrolled poisoning and hunting pressure, some local populations are in decline and likely to be eliminated, and the overall conservation status of this species must give cause for concern.

The ultimate conservation objective for this species should be to expand the area of Javan warty pig habitat within nature reserves so that several viable populations can be given complete protection, whilst managing other populations as a harvestable resource providing opportunities for recreational hunters whose activities will maintain populations at levels where their depredations on crops are tolerable. This approach will also generate income for local people who provide food, lodging, and guide services to the hunters. These objectives and the priority projects designed to achieve them may be summarized as follows:

Objectives:

1. To extend the existing network of protected areas to provide complete protection to several, selected Javan mainland populations by including their habitat within nature reserves.

2. To conserve as many of the remaining viable populations of Javan warties outside of protected areas as possible by managing them for meat and sport hunting.

3. To develop appropriate management strategies for the enhanced future protection of any possibly surviving populations on Madura and the sole remaining population of the endemic subspecies, *S. v. blouchi*, on Bawean Island.

4. Maintain breeding colonies in zoos to serve as an insurance and as a source of animals for possible future reintroduction attempts (e.g. to Madura) and as material for studies of the biology and potential value of the species as a genetic resource.

Priority Projects:

1. Create three new nature reserves suitable for the conservation of Javan warty pigs.

These are: (1) a 13,000 ha area of rain forest in the Pembarisan Hills lying mostly above 650 m altitude, where good numbers of *verrucosus* coexist with *scrofa* at the lower elevations on the disturbed fringes of the forest; (2) a 16,000 ha area of lowland forest on limestone soil at Teluk Lenggasana on the south coast of East Java; and (3) the consolidation of the proposed Mt. Ringgit and Mt. Beser reserves in East Java, which are presently situated 10 km apart and total only 3,000 ha of disturbed monsoon forest below 500 m altitude, but which would afford potential protection to one of the largest *verrucosus* populations remaining east of Surabaya if made into one larger reserve. Besides supporting viable *verrucosus* populations, all three of these areas have

other important conservation merits and all have been recommended as nature reserves in the National Conservation Plan for Indonesia (FAO, 1982).

2. Extend two of the existing nature reserves to include more Javan warty pig habitat.

These are: 1) The 2,000 ha Leuweung Sancang Nature Reserve, which should be increased by as much as 16,000 ha, thereby also benefiting the resident population of banteng (*Bos javanicus*); and 2) the 930 ha Nusakambangan Nature Reserve, which should be expanded northward to include the 5,000 ha of mangroves and lowland forests known as Segara Anakan.

3. Conduct a field status survey on Madura.

This is necessary to determine whether any remaining populations of *S. v. verrucosus* occur there, with a view to the development of recommendations for their protection and/or the identification of sites for possible future reintroduction.

4. Conduct a field status survey on Bawean.

The present status of *S. v. blouchi* should be assessed, and management recommendations formulated to benefit this subspecies and other endemic taxa.

5. Concentrate law enforcement and public education efforts in most critical areas.

Priority should be given to Bawean and those parts of Java where *S. verrucosus* is the predominant pig species, with a view to the better control of illegal hunting pressure and the elimination of poisoning.

6. Clarify the ecological and genetic relationships between *S. verrucosus* and *S. scrofa*.

Research should be initiated to elucidate these relationships with regard to interspecific competition for resources and the incidence of hybridization.

7. Conduct a survey of market hunting of wild pigs to determine its extent and formulate means of regulating or eliminating this practice

8. Assist development of a captive-breeding program in Indonesia and elsewhere.

All captive individuals should be individually marked and registered in a studbook, and the breeding program developed by means of a properly structured plan for the long term genetic and demographic management of this species, including the early extension of the present stocks in Javan collections to other breeding centers elsewhere. Sales of individuals of this species should be suspended or prohibited.

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Chapter 5.5

The Bearded Pig
(*Sus barbatus*)

Julian O. Caldecott, Raleigh A. Blouch and Alastair A. Macdonald.

Status and Action Plan Summary

Status categories 2-3 - the nominate subspecies from Borneo, *S. b. barbatus*, is still widespread but declining in numbers; the western subspecies from Peninsular Malaysia and Sumatra, *S. b. oi*, and the eastern subspecies from Palawan and neighboring islands, *S. b. ahoenobarbus*, are both rare.

In Borneo, the dipterocarp forests should be deliberately managed for a variety of non-wood as well as wood outputs, which will benefit bearded pigs if wild meat is one of the outputs required. This action requires a fundamental rethinking of forestry management strategy. Conservation areas need to be maintained, and the communal forest system expanded, thereby retaining intact forest areas for the benefit of rural communities and with them, local bearded pig populations. Detailed, long-term investigation of the behaviour of identified pigs is necessary to resolve outstanding questions of social structure and home range use.

In Peninsular or West Malaysia, (northern) Sumatra, Bangka and the Riau Islands, field surveys are needed to correct a lack of information on the distribution and status of *S. b. oi* and the habitats where they can be expected to survive, which is hampering measures to conserve bearded pigs in these regions. Unlike either of the other two subspecies, these animals are everywhere sympatric with *S. scrofa*, which may be competitively advantaged by human induced changes in its environment and whose relative abundance may have a negative influence on local attitudes to the management requirements of the rarer form.

There is similar lack of recent information on the distribution and status of the Philippine endemic, *S. b. ahoenobarbus*, which has by far the most restricted range of the three, currently recognized subspecies. The present status of these animals on Balabac is unknown, but they remain quite widely, if patchily, distributed on the Calamian Islands (Busuanga, Culion and Coron) despite intense hunting pressure. Bearded pigs are also reported to be intensively hunted on Palawan, though precise data is lacking on their range there and any future fieldwork on this island is likely to be seriously compromised by the presence of armed rebels. All of these and other related problems are addressed in

the proposed action plan for this species, which also recognizes the need to resolve the now rather confused systematic relationships between the three (Sundaic) forms of bearded pigs the closely allied wild pigs of the neighboring Wallacian subregion, i.e. the eastern Philippines' '*philippensis*' and '*cebifrons*', and the Sulawesi warty pig, *S. celebensis*.

Introduction

Adult bearded pigs are characterized by their relatively large body size, a degree of sexual dimorphism, an elongated skull, long legs, a 'bearded' jaw (gonial tuft) and sparse body hair (Pfeffer, 1959). In addition, they are well known for their most spectacular collective attribute - lemming-like population eruptions - which have been recorded in different parts of Borneo since early this century (Shelford, 1916). Equally interesting migratory behaviour was described from Malaya in the 1940's and 1950's, but by the 1960's the camphor wood forests whose fruiting seemed to stimulate this behaviour had been felled (Caldecott, 1991). The result was a long period when eruptions and migrations were known to be a feature of the species, but they could not be described in the context of a broad appreciation of the bearded pig's ecology.

Following Groves (1981) and Groves and Grubb (this vol.), three subspecies are currently recognized. The type race, *S. b. barbatus*, is confined to Borneo (Kalimantan, West Malaysia and Brunei), though recent reports indicate that it may also occur on some neighboring islands, including Sibutu and Tawi-Tawi in the Sulu Archipelago, Philippines (Oliver *et al*., Chapter 5.6, this vol.). The closely related race from West Malaysia, Sumatra, Bangka and the Riau Islands, was separated as a distinct subspecies, *S. b. oi*, by Groves (1981), though this was questioned by Mudar (1986), who proposed it should be lumped with the nominate race. In either event, ecological and behavioral, as well as morphometric, similarities suggest that these 'Sundaic' forms are the most closely related. This name refers to Sundaland, the continental shelf, which was exposed at times during the Pleistocene and which thereby, linked Malaya with Sumatra and Borneo and, at its periphery, with Java and Palawan (Whitmore, 1981, 1987, 1988). On Java *S. barbatus* is replaced by *S. verrucosus*, but there is a third subspecies, *S. b. ahoenobarbus*, on Balabac, Palawan and the Calamians Group. Groves (1981) also tentatively recognized two additional subspecies of bearded pigs from the central and easternmost islands of the Philippines (i.e. *S. b. cebifrons* and *S. b. philippensis*, respectively), but recently acquired evidence suggests that these forms should be treated as separate, though closely allied, species (Grubb and Groves, this vol.; Oliver *et al.*, *op cit*.).

Link to Fig. 13: Approximate former and present distribution of the bearded pig, *Sus barbatus* ssp.

Former and Present Distribution

The bearded pig occurs in archipelagic South-east Asia, extending from the large landmasses of the Sunda shelf (Peninsular Malaya, Sumatra and Borneo) to Palawan and

neighboring islands in the west Philippines. In Malaya and Sumatra, it is sympatric (though not necessarily syntopic) with the Eurasian wild boar, *S. scrofa*. The archeological evidence suggests that the bearded pig was fairly plentiful and widespread in the Malayan Peninsula about 1500 to 2000 years ago (Gibson-Hill, 1950).

Herds of *S. b. oi* have been seen in the vicinity of the Taman Negara National Park in central north-east Malaya as recently as 1981 (Johns, 1983), and this extensive forest block presumably represents an important refuge for the subspecies. On the other hand, annual movements of bearded pig populations in Malaya appear to have been associated with the regular fruiting of camphor wood forests, which once occupied several thousands of square kilometers in the south- east and north-east of the Peninsula.

Formerly, bearded pigs of this subspecies were also found in northern (Medan), central (Indragiri) and southern (Lampung) Sumatra (Groves, 1981). However, a field survey of the larger mammals revealed that they had all but disappeared from the southern quarter of the island, where they are now reported to survive only in the Lebong Hitam forest across the straits from Bangka Island (Blouch, 1984). Not coincidentally, deforestation in Sumatra during the past 30 years has been heaviest in the south, and the relatively small amount of remaining forest there is now highly fragmented. In central Sumatra bearded pigs were nowhere abundant in 1984, although local people in several areas reported occasional large traveling herds (Blouch, unpubl.). There is no recent information on the status of these animals in the northern end of the island, north-west of Medan. Recent information on their status on Bangka Island and in the Riau Archipelago (Bintang Island), where they are known to have occurred (Groves, 1981), is also lacking.

Archaeological studies in Sarawak indicate the human hunting of bearded pigs was undertaken since before the Palaeolithic (Medway, 1958, 1977). This (type) subspecies remains widely distributed in Borneo and is still relatively abundant in some areas. It also occurs on some offshore islands, including Karimata (off west Kalimantan), where it was recently reported to be common (Bekti *et al.*, 1991). *S. b. barbatus* is not, therefore, particularly threatened at the present time. However, the continued ability of the bearded pig to provide an abundant source of meat to the tribal inhabitants of the interior is now threatened by deforestation and selective logging. Since bearded pig productivity is so dependent on ecological events (see below), this can be regarded as only one among many consequences of a broader abuse of the Bornean forest estate by the timber industry.

From reports obtained recently (W. Oliver pers. comm.; Oliver *et al.*, Chapter 5.6, this vol.), it appears that bearded pigs periodically cross the strait between the north-easternmost tip of Borneo (Sabah) to the Sibutu and Tawi-Tawi, the southernmost islands of the Sulu Archipelago, in south-west Philippines. This implies genetic continuity between these locations and also another (though non-endemic) pig taxon to the Philippines' list. However, it is not known if there is any correlation between the (as yet poorly documented) incidences of pigs crossing this strait and the periodic eruptions and migrations of these animals on the Bornean mainland (see below).

The third subspecies, *S. b. ahoenobarbus*, is endemic to the Philippines, where it is confined to Balabac, Palawan and the Calamian Islands (Groves, 1981; Rabor, 1986), which collectively comprise the 'Palawan Faunal Region' (Heaney, 1986), the westernmost edge of the Sunda Shelf. There is relatively little information on the status of these animals on Balabac, though it is reported to survive in most still-forested areas on Palawan (McGowan, 1987) and on the three principal islands, Busuanga, Culion and Coron, in the Calamian Group (Oliver, 1992; Oliver and Villamor, 1993).

Habitat, Ecology and Behavior

The natural vegetation in all areas where bearded pigs are found is dominated by tropical evergreen rainforest, but within this broad category the animals utilize a wide variety of habitat types, ranging from beaches to upper montane cloud forests. The carrying capacity for bearded pigs no doubt varies greatly from habitat to habitat within the rainforest, depending on soil, drainage, elevation and floristic and phytochemical composition of the vegetation. Population density is also radically variable over time, so it is hard to determine consistent differences between habitats in this respect.

Bearded pigs consume roots, fungi, invertebrates in soil and rotting wood, small vertebrates, turtle eggs, carrion, and items from at least 50 genera and 29 families of plants. Fruit supply is believed to have particular influence in determining growth rate, fat deposition and reproduction, with the oil-rich seeds of members of the tree families Fagaceae (oaks and chestnuts) and Dipterocarpaceae (dipterocarps) being especially important in this regard. Of these, the oaks are significant because of their relatively continuous or regular fruiting behaviour, and also because they can come to dominate submontane habitats. The dipterocarps are often dominant in lowland and hill forests, and strongly influence food availability for terrestrial seed-eaters by characteristically synchronized flowering and mast-fruiting behaviour (Caldecott, 1988; Pfeffer, 1959; Pfeffer and Caldecott, 1986; Davies and Payne, 1982; Janzen, 1974; Jessup *et al.*, 1982; Leighton and Leighton, 1983).

Large-scale population movements by bearded pigs have often been reported in Malaya (Allen, 1948; Kempe, 1948; Hislop, 1949, 1952, 1955) and Borneo (Shelford, 1916; Banks, 1931, 1949; Banks in Hislop, 1955; Pfeffer, 1959; Davies and Payne, 1982; Caldecott and Caldecott, 1985; Caldecott, 1988a, 1991). Pigs are described as moving consistently in one direction, in scattered or condensed herds, over a broad or narrow front, and over a period of several days, weeks or months. The animals are variously described as being in good, poor or very poor physical condition, sometimes accompanied by piglets and sometimes not, and regularly swimming across rivers, sometimes coastal bays and even out to sea. In some cases, the population is said to retrace its route later, or to follow a circular course to return whence it originally came. The distances traveled appear to vary greatly. Pfeffer (1959) described annual, apparently unidirectional, population movements in Kalimantan involving distances of 250-650 km, while Davies and Payne (1982) refer to annual reversible movements over tens of kilometers in Sabah. The approximate population tracks given by Caldecott (1988a) suggest rates of travel of 8-22 km/month sustained over at least 4-8 months as part of

larger cyclical movements in interior Sarawak. Some reports indicate that such population migrations begin or end in particular locations where abundant food may be found. Thus, Davies and Payne (1982) linked movements to seasonally-fruiting *Dinochloa* bamboo groves, while Caldecott (unpubl.) reinterpreted historical accounts so as to link Malayan bearded pig movements with predictable fruiting in camphor wood (*Dryobalanops aromatica*) forests. Caldecott (1988a) also described what appeared to be regular use of fruiting montane oak (*Lithocarpus*) forests in the upper Baram area of Sarawak.

In Sumatra bearded pigs also exhibit large scale population movements, but reports are anecdotal and often contradictory. Groups of up to 300 individuals are said to embark on long migrations, arriving at a given location at irregular intervals, sometimes as often as once a year but more frequently once every two to four years. In the highlands these movements do not seem to have any relation to the seasons, but in the lowlands the pigs tend to move out of the inundated forests to higher ground in the rainy season and back again in the dry season (Blouch, 1984). The relationship between these movements and the cycles of mast production has not been investigated.

The primary ecological adaptation of the western races of bearded pigs, to the pursuit of fruiting peaks within the large-scale phenological mosaic of dipterocarp forests, may not be a feature of the Philippine subspecies, since 'eruptions' and 'migrations' of the kind seen in Borneo and Malaya have not been reported there. However, bearded pig populations exhibit a range of different states, which can be summarized as follows:

- Dispersed, static populations exploiting small, dispersed, unpredictable and discontinuous 'background' food sources. Low breeding and growth rates possible. Local movements only. (E.g.: typical mixed dipterocarp forest in Borneo between generalized fruiting episodes).

- Small to medium populations exploiting concentrated, predictable and continuous 'target' food sources. High breeding and growth rates possible. Local movements only. (E.g.: *Koompassia-Burseraceae* forest in Malaya).

- Small to medium populations, with members aggregating to exploit large, dispersed, unpredictable food sources. Breeding and birth rates depend on success of matching movements to fruiting within a dynamic phenological mosaic. Short to medium-range movements. (E.g.: typical mixed dipterocarp forest in Borneo between generalized fruiting episodes.

- Small to large populations moving regularly to exploit concentrated, predictable and discontinuous target food sources. Breeding and growth linked to activity of food sources. Short-range to long-range movements. Size of population varies from year to year depending on background food supply. (E.g.: *Dinochloa* association in Sabah, or *Dryobalanops aromatica* association in Malaya).

- Large and expanding population exploiting an exceptional supply of background food available over a period sufficient for several litters to be raised to sexual maturity. High breeding and growth rates characteristic. Long range movements. (E.g.: interior of Sarawak in 1954, 1959, 1983 and 1987).

- Very large and collapsing population having exceeded background food supply. Low breeding and high death rates. Increasingly desperate long-range movements. (E.g.: starving herds reported from Malaya and Borneo).

The basic social structure is that of the major social unit being the mother family, a female and her litter. These units often join up, and much larger aggregations are formed occasionally, with scores or even hundreds of pigs traveling together. Fully adult males seldom associate with the natal groups. Age at first pregnancy presumably varies in the wild from about 10-20 months. In any one area, the rut coincides with synchronized flowering in the forest, with the timing being centered on the transition between late flowering and early fruit formation. Falling petals therefore offer a potential visual cue. A certain nutritional status may have to have been attained by females before they become responsive to whatever stimulus acts to trigger mating. Pregnant females had a median fatness index (finger-widths of fat depth at the shoulder) of 1.5, while rutting males scored zero by this measure (n = 19, 32).

Gestation length is not known but is estimated at 90-120 days, based on the interval between rut and the ensuing birth-peak. Birth occurs within a nest, which is constructed of vegetation by the mother, and which is occupied by her and the new piglets for a week or so. Data from hunter interviews indicated that the median number of piglets accompanying an adult female (n = 53) was 7, which was the same as the median number of fetuses counted in dead females (n = 8). Abbot in Davies (1962) reported a slightly higher median of 9 fetuses per female (n = 5). Litter size is very variable in part because of the influence of female size: small mothers typically have 3-4 piglets in a litter, while large ones have 10-12. Elsewhere, the range in litter size has been given as 3-11 piglets (National Research Council, 1983).

Fat reserves in the mother are used up quickly during lactation, and females accompanied by small piglets are almost invariably thin or very thin. Those with large piglets are fatter, and have presumably gained weight after weaning. This fattening process seems to depend on what fruit is available, with dipterocarp seeds and acorns having most impact. If these are abundant, it seems likely that two litters can be raised by a female within a year.

Threats to Survival

The unsustainable logging of dipterocarps in Bornean forests will change the underlying ecology of the island, probably in such a way as to prevent bearded pigs from exhibiting in future the mass population eruptions and movements of the kind observed during the 1950's and 1980's. These phenomena are no longer seen in areas where extensive logging has already occurred. The Sundaic bearded pig may be said to be consummately adapted

to life in almost limitless dipterocarp forests. It is possible that the demise and fragmentation of Borneo's forests will allow wholesale invasion of the island by *S. scrofa*, which could then displace S. b. barbatus from much of its former range. The same may be said for Malaya where several thousands of square kilometers of camphor wood forest have now been virtually destroyed, and the integrity of forest cover throughout the Peninsula is so disrupted that long-distance movement by forest-dwelling mammals is no longer possible in many areas.

Meanwhile, a more sedentary population of bearded pigs, apparently associated with continuously-fruiting, *Koompassia-Burseraceae* forests in western Malaya, is probably endangered by hunting and habitat destruction. The habitat changes experienced by the Peninsula since the Second World War have almost certainly favored *S. scrofa* over *S. barbatus*, and the latter species is believed to be in serious jeopardy as a result. The same can also be said of Sumatra, where habitat disturbance has been at least as extensive as in Malaya and where a comparison between the current distribution of bearded pigs and that of the remaining native forest supports the contention that the species cannot long survive the reduction and fragmentation of these habitats. The same situation probably applies to Bangka and the Riau Archipelago where habitat disturbance has been at least as extensive as in Sumatra.

Wildlife protection measures are so limited, and hunting so rife, that there is increasing concern about the status of all wild pig populations in the Philippines. McGowan (1987) concluded that the future prospects for largest population of *S. b. ahoenobarbus* on Palawan were poor if the species were limited to relatively undisturbed lowland forest. Palawan still supports the highest percentage (59%) of forest cover of any of the larger islands in the Philippines, although almost all of the island's forests are subject to logging operations, despite their low commercial value (Quinnell and Bamford, 1988). Palawan is being rapidly deforested for timber extraction and agricultural expansion. The construction of logging roads has also facilitated access to formerly remote areas, which, together with the depressed economy and relative high price of meat, has exacerbated hunting pressure and the increased use of such (non-traditional) hunting methods as pig bombs (McGowan, 1987). There is no information on the current status of these animals on Balabac, but a recent (February 1992) survey has revealed that they remain patchily distributed on each of the three principal islands of Busuanga, Culion and Coron in the Calamian Group (W. Oliver pers. comm.; Oliver and Villamor, 1993).

Conservation Action Taken

As far as is known, little or no action has been taken with the specific intention of conserving these animals anywhere within their range. In Sumatra and Peninsular Malaysia this is at least partly due to predominantly Moslem populations, which consider all pigs to be unclean and pay little attention to them. In addition, the distinction between *S. scrofa* and *S. barbatus* is seldom appreciated, and the relative abundance of the former has probably tended to obscure any declines in the populations of the latter.

In Peninsular Malaysia, the species survives in the Taman Negara National Park (4,343 sq. km), the only protected area that is likely to be large enough to support a viable population. In Sumatra, bearded pigs are known to occur in the large Kerinci-Seblat National Park (14,000 sq. km.) and in Berbak Game Reserve (175,000 ha), and they are likely to survive in some other protected areas, though surveys are needed to confirm this.

As previously stated, the Bornean *S. b. barbatus* remains widely distributed and it occurs in numerous protected areas in Kalimantan, Sarawak, Sabah and Brunei. In direct contrast, it remains uncertain whether the eastern subspecies, *S. b. ahoenobarbus*, even occurs in the only existing protected area within the core area of its range on Palawan, i.e. the relatively tiny St. Paul's Subterranean River National Park (3,590 ha) (Cox, 1988), though a small population (c. 150 individuals; J. Gapuz pers. comm. to W. Oliver) is protected in the Calauit Island Game Preserve and Wildlife Sanctuary (3,400 ha), off N. Busuanga in the Calamian Islands.

Captive Breeding

Bearded pigs have been exhibited only rarely in captivity, and few captive births have been recorded. In recent years, a trio of *S. b. oi* was kept in the Singapore Zoological Gardens, but these have since died without breeding. During the population eruption of l983, many villagers in Sarawak obtained *S. b. barbatus* piglets by catching them from boats while they were swimming across rivers with their families. The main feature reported was how difficult it was to prevent the escape of these piglets, since they were easily able to climb out of pens designed to hold domestic pigs. A majority of the captives therefore escaped within a few days. A small numbers of *S. b. ahoenobarbus* are maintained in small zoos and private collections in the Philippines, though no attempts have yet been made to start a properly structured breeding program with any of these animals.

Conservation Measures Proposed: An Action Plan

Given the relatively wide, but highly fragmented distribution of this species in four countries, the varying conservation status of the currently recognized subspecies and various conservation problems confronted, any Action Plan for the species as a whole must address an array of socio-economic and ecological issues, as well as the more immediate research and management priorities, where these are known. In Borneo, for example, overall conservation priorities should be directed towards the deliberate management of dipterocarp forests for a variety of non-wood outputs (including game meat species, of which the bearded pig is probably the most important) as well as for wood production, rather than the promulgation of activities designed to benefit the wild pigs in particular.

The situation for the western subspecies, *S. b. oi*, in Sumatra and Peninsular Malaysia, and the eastern subspecies, *S. b. ahoenobarbus*, in the Palawan region, are more problematic than in Borneo. Both of these subspecies are already far less numerous than

S. b. barbatus and their habitats are greatly reduced and increasingly fragmented. S. b. ahoenobarbus is probably the most sedentary of the three, but it also has by far the smallest range. In common with the Bornean race, it is also intensively hunted throughout its restricted distribution. By comparison, *S. b. oi* is not an important resource to local people (except perhaps to a few scattered aboriginal tribals) owing to the local predominance of Islam in Sumatra and Peninsular Malaysia, and there is therefore little perceived economic incentive to conserve it. However, this subspecies also differs from ahoenobarbus and barbatus in that it is naturally sympatric with wild *S. scrofa*, which is probably competitively advantaged by human-induced changes in the environment.

Nonetheless, the available information on these rarer forms is insufficient to enable intelligent recommendations at the present time, or even to identify the most important populations with a view to the development of management plans for their enhanced future protection. The foremost priorities for these taxa must, therefore, be directed towards field surveys and other basic research to determine, amongst other things, where they still occur, how far they move and why, which habitats are most critical, and whether or not they are able to survive in logged over forests.

The principal objectives and priority projects for this species can therefore be summarized as follows:

Objectives:

1. To initiate, or otherwise promote, further field status surveys and other studies on topics relevant to the future management needs of these animals.

2. To promote the enhanced future protection of the most threatened subspecies/populations by increasing the number and size of existing reserves, and/or the effectiveness of protective measures, in those key areas where the protected areas network is inadequate to ensure the survival of representative taxa/populations.

3. To design and implement particular, practical conservation management initiatives, including captive breeding, directed towards the most threatened forms, etc.

4. The promotion of conservation management policies designed to ensure the sustainable utilisation of wood and non-wood products, which would be of both direct and indirect benefit to game meat species, including the wild pigs.

Priority Projects:

1. Conduct field status surveys on Balabac, Palawan and associated smaller islands.

   These surveys should be designed to complete the distribution and status survey recently initiated in the Calamian Islands, in order to determine the nature and magnitude of threats to the smallest subspecies, *S. b. ahoenobarbus*, which also has by

far the most restricted range. These surveys should also be conducted with a view to the development of recommendations for the enhanced future protection of selected populations and, if necessary, the formulation of management strategies to enable the continued harvesting of these animals in non-protected areas on a sustainable basis. Particular priority should be given to the survey of Balabac, where any remnant populations are likely to be seriously threatened. This is not to understate the importance of main stronghold for this taxon on Palawan, where surveys are also urgently required, though field investigations are likely to be precluded by the presence of insurgents in some areas.

2. Field status surveys in selected parts of West (Peninsular) Malaysia, (northern) Sumatra, Bangka and the Riau Islands.

   These surveys are required to determine the distribution and status of the western subspecies, *S. b. oi*, and the habitats in which they may be expected to survive in competition with the sympatric, *S. scrofa*. Further research on basic biological questions relevant to the future management of this subspecies should also be supported, particularly those relating to its habitat requirements, population movements, response to commercial logging activities, etc.

3. Assist the development of deliberate management policies in the remaining dipterocarp forests of Borneo for a variety of non-wood (e.g. game meat, of which *S. barbatus* is a predominate source) as well as wood outputs.

   This is proposed as one feature of an 'Extended Variable Management System' for these forests (Caldecott, 1988b). Placing Bornean forestry on a sustainable basis, however, would demand fundamental reforestation at unprecedented cost to local economies. Failing a forestry investment program sufficiently intense to achieve an adequate rate of change, priorities for bearded pigs in Borneo revolve around maintaining protection in certain conservation areas, and expanding the communal forest system whereby intact forest areas are retained for the benefit of rural communities and, with them, local bearded pig populations.

4. Promote detailed, long-term investigations of the behaviour of known individual pigs in circumscribed study areas.

   Such studies are necessary to resolve outstanding questions of social structure and home range use and are of direct relevance to the development of any management plans intended to ensure the maintenance of viable populations of this species over the longer-term and, hopefully, the perpetuation of their phenomenal population cycles and associated migratory behaviour.

5. Assist development of local conservation-education and applied research initiatives in selected, priority areas.

The historical, and in some places continued, significance of these pigs as a basic economic and cultural resource to many ethnic groups, and their potential value as classic 'indicator' species for forest management policy, is widely unappreciated or even countered by religious prejudice. These factors should be addressed by the production and distribution of conservation-education materials and the dissemination of information to relevant decision and policy making bodies. This process would be greatly facilitated by the promotion of more localized research into aspects of the biology, ecology and human utilisation of these animals, particularly in those areas where the species (for whatever reason) remains poorly known and/or where sympatry with S. scrofa occurs.

6. Promote development of properly structured captive breeding programmes for the rarest subspecies, *S. b. ahoenobarbus* and *S. b. oi*.

Although captive breeding is not thought likely to materially influence the survival prospects of these taxa in the near future, it may well constitute an important contribution over the longer-term, as well as providing a potentially invaluable resource for further research into various aspects of the species' biology and behaviour.

Acknowledgements

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Chapter 5.6

The Philippine Warty Pigs (*Sus philippensis and S. cebifrons*)

William L. R. Oliver, C. Roger Cox and Colin P. Groves.

Status and Action Plan Summary

Status categories 3 & 5 - the (east) Philippine warty pig, *S. philippensis*, is rare and the (west-central) Visayan Islands' warty pig, *S. cebifrons*, is endangered.

Recent taxonomic reviews have revealed that there are 3 species and (at least) 2 subspecies of wild pigs in the Philippines, of which 2 species and 1 subspecies are endemic. This is a larger number of endemic suid taxa than any other country, with the

exception of Indonesia. Unfortunately, however, the generally extreme levels of deforestation on most islands on which they occur, coupled with intense hunting pressure, inadequate legal protection and the poor enforcement of existing legislation even within most protected areas, have resulted in the systematic decline of all Philippine populations of these animals.

These factors are especially apparent in the (west) Visayan region, where the endemic warty pig, *S. cebifrons*, is already extinct or close to extinction on five of the seven islands (Masbate, Guimaras, Cebu, Sequijor and Bohol) in which it is known or believed to have occurred, and now survives only in a few small, isolated areas on Negros and Panay, where all remaining populations are still hunted intensively. By comparison, S. philippensis remains relatively widely distributed in most still-forested areas on the larger islands of Luzon, Mindoro, Samar, Leyte and Mindanao, where it occurs in all of the principal national parks. It probably also still occurs on a number of the smaller islands within the Luzon and Mindanao Faunal Regions.

At present, wild pigs are unprotected outside designated reserves and national parks and there are no effectively protected areas within the limited, and extremely fragmented, remaining range of *S. cebifrons*. Immediate action is required to address this situation and to establish a properly structured captive breeding programme as a safeguard against its possible early extinction in the wild state. In view of the essentially negative attitudes of local people to wild pigs, a conservation education programme is proposed, and more basic research on various aspects of the distribution, status, biology and management of some of these animals should be actively promoted. Some priority is also given to the acquisition of specimen materials from selected locations in order to elucidate the systematic relationships of the principal insular populations of philippensis, which are more variable than is indicated by their present (monotypic) assignation, and to facilitate a definitive reassessment of the affinities of the eastern Philippine species with the other Wallacian (*S. celebensis*) and Sundaic (*S. barbatus*) forms.

Introduction

The wild pigs of the Philippines have generally been attributed to two, more widely distributed species, the bearded pig, *Sus barbatus*, and the Sulawesi warty pig, *S. celebensis*. Thus the wild pigs of the west Philippine islands of Balabac, Palawan and the Calamian Group, which form part of the Sunda Shelf, are most closely related to the bearded pigs of Borneo, Sumatra and the Malayan Peninsular, whilst those of the central (Visayas Islands) and eastern (Luzon, Mindanao and associated islands) Philippines, which form part of the Wallacian Region, were lumped with the Sulawesi pig (Sanborn, 1952).

In a major review of the genus Sus, Groves (1981) confirmed the close relatedness of the west Philippine pigs with *S. barbatus*, but reaffirmed their separation as an (endemic) subspecies, i.e. *S. b. ahoenobarbus* (see earlier text). However, Groves also argued that the affinity of the central and eastern Philippine pigs with *S. celebensis* was purely superficial, and that these populations were also more closely allied to S. barbatus. This

view was later endorsed by Mudar (1986), who also concurred with Groves' conclusions that the central (Cebu and Negros) and eastern (Luzon, Mindoro, Mindanao and Jolo) Philippines populations were not only distinct from those of the western Philippines but were also distinct from each other. These regional populations were therefore (provisionally) reassigned as two separate subspecies of *S. barbatus*, i.e. *S. b. cebifrons* and S. b. philippensis, respectively. Even so, it was stressed that these were tentative assignations owing to the few museum specimens studied (particularly from the Visayas Region, where only two skulls were available for examination from Cebu, only one from Negros and none from the other Visayan islands of Guimaras, Panay and Masbate), and the complete absence of any comparative cytogenetic data, precluded a definitive assessment of the systematic relationships of these populations.

To a large extent this situation still obtains, though the recent acquisition of a series of skulls and mandibles from Negros (*cebifrons*) and Samar (*philippensis*), together with the first photographs revealing the external characters of Visayan animals, has revealed that the central and eastern Philippine pigs are sufficiently different from *barbatus* and from each other to warrant separation as distinct species; i.e. *S. cebifrons and S. philippensis*, respectively (Groves, 1991; Oliver, 1991, 1992). A description of these small (*S. cebifrons*) to medium (*S. philippensis*) sized pigs is provided by Groves and Grubb (this vol.), who treat both species as monotypic but acknowledge that *S. philippensis* appears to be regionally variable in some characters and may ultimately prove polytypic.

The recognition of (at least) 3 taxa of wild pigs, also means that the Philippines has a larger number of endemic suids than other country with the exception of Indonesia, which has (at least) 5 species and 8 subspecies, of which 3 species and 5 subspecies are endemic. The inclusion of pigs from Jolo in the Sulu Archipelago with *S. (b.) philippensis* (Groves, 1981) is also of interest in this context, since it implies the westward colonisation of these islands by wild pigs from Mindanao, rather than eastwards from the Bornean mainland (Sabah). There is no doubt that 'typical' bearded pigs (*S. barbatus* ssp.) also occur in the south-westernmost islands (Sibutu and Tawitawi) of the Sulu chain. There are numerous, apparently reliable, accounts of wild pigs crossing the channel between Sabah and Sibutu, where they have sometimes been killed by fisherman. An officer in the Philippine navy reported seeing some of these animals whilst on a tour of duty in c. 1970, and a large number of swimming animals are reputed to have been used for target practice by a U.S. Navy battleship, which encountered them whilst on patrol (R. Hilado, pers. comm.). It therefore seems likely that a fourth (non-endemic) taxon of wild pig, the Bornean S. b. barbatus, should be added to the Philippine list, and that the Sulu Archipelago has been colonised by different populations/taxa of these animals from the south-west (Sabah) as well as the north-east (Mindanao) (Fig. 14).

Link to Fig. 14: Presumed former and present known distribution of wild pigs in the Philippines.

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Former and Present Distribution and Conservation Status

Wild pigs are known or reported from all of the larger, and many of the smaller, offshore islands in the Philippines. As previously indicated, their distribution may be divided into three broad regions, i.e.: 'Palawan' (including Balabac and the Calamians Group); the 'Visayas Islands' (comprising Negros, Cebu, Masbate, Panay and Guimaras, but not Samar, Leyte and Biliran - see below) and the larger, eastern islands of Luzon, Mindoro and Mindanao. Wild pigs are known to occur (or to have occurred until recently) on all of these islands and many of the smaller, offshore islands and island groups (e.g. the Sulu Archipelago; see Table 8).

Table 8. Present known distribution and status of wild pigs (*Sus* spp.) in the Philippines.

Taxon	Status Category	Distribution
S. b. ahoenobarbus (endemic ssp.)	4: Rare and declining	Balabac*, Palawan and Calamians (Busuanga, Culion and Coron Is.).
S. b. barbatus (non-endemic ssp.)	2: Locally rare but widespread in Borneo	Sulu Archipelago* (Sibutu and Tawitawi only ?).
S. cebifrons (endemic sp.)	5-7:Endangered to Extinct	Panay, Guimaras (extinct), Negros, Cebu (extinct) and Masbate*.
S. philippensis (endemic sp.)	3: Rare and declining	Luzon, Catanduanes, Samar, Biliran, Leyte, Mindanao, Jolo* and ? other islands*.
Sus spp/ssp. ?	3-6: Rare to Extinct	Mindoro (rare), Sibuyan (rare), Bohol (critical), Sequijor (extinct).

Key: * = no recent data.

As indicated in Table 8, recent data on the wild pig populations on many islands, particularly the smaller islands, is lacking and their present status can only be inferred from the extent of remaining forest over their known ranges. Thus, *S. b. ahoenobarbus* is probably the most threatened subspecies of 'typical' (or Sundaic) bearded pig (see Caldecott et al., this vol.) and is 'presumed' to be at greater risk than S. philippensis, because it has a relatively smaller range and because the smaller, insular populations on the (now mostly deforested) islands of Balabac and the Calamians are most unlikely to remain securely established. This subspecies is thought to be still relatively widely distributed on Palawan, where it may even be locally common in some areas, but it is intensively hunted (McGowan, 1987 and pers. comm.) and the surviving forests on

Palawan are being rapidly depleted by uncontrolled logging and agricultural encroachment (Quinnell and Balmford, 1988).

By comparison, *S. philippensis* has almost certainly been extirpated over a greater proportion of its former range than *S. b. ahoenobarbus*, but this range is also considerably larger and includes some still (relatively) extensive tracts of forest on the larger islands of Luzon, Samar, Leyte and Mindanao. On all of these islands the species is reported to remain quite widely distributed wherever significant amounts of forest remain. Far less forest remains on Biliran where, by 1985 (see below), the species was reported to declined to the point that viable populations were unlikely to survive for much longer. The species is also reported from Jolo and it is presumed to occur, or to have occurred formerly, on Basilan and on some of the other smaller islands in the Mindanao and Luzon faunal regions, but recent information from these areas is lacking. Wild pigs are reported to be survive on Sibuyan (S. Goodman, pers. comm.) and to be locally common in some still-forested areas of Mindoro (Rabor, 1986; Cox, unpubl.), though the identity of these animals are not yet known (Table 8).

The distribution and status of wild pigs on Samar, Leyte and Biliran were investigated during a field survey in the central Philippines in 1985. This was primarily intended to assess the status and future management needs of *S. cebifrons* and the Philippine spotted deer (*Cervus alfredi*), which were assumed to occur on these islands (Cox, 1985, 1987a). However, although all of these islands are included within the Visayas (geopolitical) Region, they are actually a northward extension of the 'Mindanao Faunal Region', as defined by Heaney (1986) on the basis of the 120 m bathymetric line (Fig. 14). Thus, although Cox's survey revealed that Samar and (to a lesser extent) Leyte continued to support the largest populations of wild pigs in the 'Visayan Islands', these populations are undoubtedly *S. philippensis* (as Groves has confirmed - see above), rather than *S. (b.) cebifrons*, as was assumed at the time (Oliver *et al*., 1991; Oliver, 1992).

The recognition that *S. cebifrons* is confined to the (west) Visayan Islands of Cebu, Negros, Guimaras, Panay and Masbate, profoundly influences any assessment of its conservation status. This taxon is undoubtedly more gravely threatened than previously supposed, or indicated by its current 'Vulnerable' designation in the IUCN Red list of Threatened Animals (IUCN, 1990). As it is, the species is certainly 'Endangered' according to the terms of these status categories. The reasons for this are based on the revelation that wild pigs are now extinct on Guimaras, Cebu and Sequijor; all of islands which have been virtually deforested (Cox, 1975, 1987a; D. Kho, pers. comm.). A similar situation obtains on Masbate, though this island was not visited during the 1985 survey (see below), and on Bohol, where the last remaining population of wild pigs in the Rajaha Sikatuna National Park is said to be close to extinction (A. Alcala, pers. comm.; D. Kho, pers. comm.). However, it is not known whether the Bohol pigs are allied to *S. cebifrons* or *S. philippensis*, since this island is closest to Cebu but it forms part of the Mindanao Faunal Region. In either event, potentially viable populations of *S. cebifrons* are now confined to the western mountains of Panay, where their numbers are certainly declining, and to scattered fragments of surviving forest on Negros. This range is essentially identical to that of the critically threatened Philippine spotted deer (*Cervus alfredi*) and, in common with the latter species, all of the few surviving pig populations are subject to

intense hunting pressure and the continued attrition and fragmentation of their remaining habitat.

Habitat, Ecology and Behavior

The natural vegetation of the Philippines consists mostly of lowland and montane rainforests, along the eastern side of the archipelago, which are replaced by monsoon forests on the western side. The latter include deciduous dipterocarp forests at elevations below 800 m and, in the central highlands of Luzon and Mindoro, extensive tracts of tropical pine forest. To varying extents, all of these formations have been reduced or degraded by agricultural developments, logging and mining, and large areas of cleared land have been replaced by tall grasslands, which are maintained by burning.

Wild pigs are reported to occur in all of these habitats, and may even benefit by the creation of secondary associations in disturbed areas and the proximity of cultivated foodstuffs. Catibog-Sinha (1978, 1981), who has undertaken the only ecological studies of these animals to date, argued that the wanton destruction of forests has compelled wild pigs to forage in neighbouring agricultural lots, though their depredations of crops are probably not confined solely to periods of food scarcity.

In the absence of any detailed studies on the behavioural biology of these species, the available information is sketchy and anecdotal. Pig hunters interviewed during the 1985 survey, reported that wild pigs (*S. cebifrons*) are usually found in groups of 4 or 5 individuals, but that groups of up to a dozen individuals were seen occasionally. Solitary males were also reported, but it was said that these were encountered only very rarely. These hunters also stated that the average number of piglets per litter was three or four, and that these were usually seen in the dry season (i.e. January to March in the western Visayas). Rabor (1986) has recorded that wild pigs (*S. philippensis*) on Luzon usually travel singly, in pairs or in groups of between seven and twelve individuals, and that these larger groups are generally composed of a boar, several sows and younger animals. The sows are reputed to give birth in well-protected sites, such as between the buttresses of giant dipterocarps, and that litter size is usually 5 to 8. However, it is not known whether these reports reflect real differences between the social behaviour and reproductive potential of the two species or a relatively higher adult and infant mortality rate in the Visayas. No discernable seasonal population movements amongst either species has been reported.

Threats to Survival

The principal threats to the fauna of the Philippines are the burgeoning human population (now numbering about 67 million people) and continued deforestation. At least 94% of the total land area of approximately 300,000 sq. km was originally covered by tropical forests. However, by 1988, satellite imagery had revealed that only about 21% natural forest cover remained. These problems are compounded by the depressed state of the economy, continued political unrest, and the generally low priority accorded to

environmental protection issues. Worse still is the lack of any effective protected areas system in the country. In 1986, it was estimated that only 0.7% of the country's land area was designated for protection and a mere 0.3% more had been proposed (MacKinnon and MacKinnon, 1986). Current estimates are unlikely to have improved to any significant extent and, indeed, it has certainly worsened in some places. Many of the existing reserves exist only on paper, whilst others are either too small to be viable or are already deforested. At least two thirds of the national parks contain illegal settlements and/or have been partly logged, park boundaries are seldom properly demarcated, law enforcement is mostly lacking, staff are too few in numbers, poorly trained and remunerated, and hunting is rife.

As far the wild pigs are concerned these problems are not only exacerbated by intense hunting pressure throughout their ranges, but also by the generally negative attitudes of most local people towards these animals. Both species are most frequently encountered when they are hunted in the forest fragments or when they emerge from the shelter of those fragments to forage in neighbouring cultivation areas or 'kaingins'. In some areas farmers build bamboo fences to protect their crops or even go to the trouble of surrounding whole clearings with sharpened staves planted obliquely outwards to prevent the entry of wild pigs (Rabor, 1977). Nonetheless, the damage caused to agricultural smallholdings can be severe. As a result, no special conservation measures have been introduced to protect these animals which, far from being protected, are generally regarded as pests and, hence, a legitimate target for hunting activities. In the 1960's, the government officials distributed poison to farmers on Sibutu to destroy wild pigs (R. Hilado, pers. comm.), and even some officers from the (former) Bureau of Forest Development (BFD) have suggested that wild pigs should be hunted down and killed wherever possible (Cox, 1987a).

The close proximity of outlying human settlements to most of the remaining forest fragments also poses a potentially severe risk of disease transmission and/or genetic contamination to wild pig populations through increased likelihood of their contact with free-ranging domesticates. Experimental evidence for the fertility of hybrid *S. scrofa x S. barbatus* young has been cited by Mohr (1960), and hybrids from a domestic (ex-*S. scrofa*) sow and an *S. philippensis* boar (reputedly of Mindanaon origin) have been reared in a private collection in the Philippines. Several reports of wild hybrids being caught by local hunters on Negros have been received in recent years and a hybrid piglet (presumably a *S. cebifrons* x domestic cross) captured in the vicinity of Basay, S. E. Negros in 1992, is currently maintained at Silliman University, Dumaguete City. Clearly, any such hybridizations pose a serious threat to the genetic integrity of this population.

Conservation Action Taken

Much of the information on the current distribution, status and future management priorities for *S. cebifrons* are based on the 1985 field survey (Cox, 1985, 1987a), which resulted in its inclusion in the IUCN Red List of Threatened Animals (IUCN, 1986). One of the foremost recommendations arising from this survey was the creation of the proposed Panay Mountains National Park (40,000 ha), to protect the largest remaining

population of spotted deer, but which probably also supports the single most important population of this species. A faunal survey and the drafting of a preliminary management plan for this Park have been undertaken (Cox, 1987b), and other activities relating to the development of the Philippine Spotted Deer Conservation Programme (Oliver *et al.*, 1991) have facilitated the acquisition of additional data on the conservation status, systematic relationships and future priorities for research and management of these animals.

On Negros, wild pigs are known to occur on Mt. Silay and the Mangdalangan Mts. (collectively comprising the Northern Negros Forest Reserve, c. 45.000 ha) and Mt. Canlaon National Park (24,600 ha) in the north, and in scattered forest fragments in the south, including the environs of Mt. Talinis/Mt. Guinsayawan/Lake Balinsasayao (c. 30,000 ha), near Dumaguete City. However, in all of these areas wild pigs are subject to intense hunting pressure as well as the continued attrition of their remaining habitat through illegal logging activities. However, precise data on the extent of these threats is lacking owing to the remoteness of most of these areas and/or the presence of NPA rebels; both of which factors effectively negate their regulation or control.

S. philippensis is known or likely to occur in all of the larger national parks (Table 9) and possibly certain other designated protected areas within its range, though some of these areas exist on paper alone. Indeed, at least three national parks - Bulabog-Putian (854 ha) in Iloilo Province (Panay), and Sudlon (696 ha) and Central Cebu (11,893 ha) (both in Cebu) - which were formerly known to support remnant populations of *S. cebifrons*, have been virtually deforested (Catibog-Sinha, 1978; Cox, 1985).

Table 9. Existing and proposed national parks known or presumed to support wild pigs.

Species/Area	Size (ha)	Location	Comments
S. cebifrons			
Mt. Canlaon N. P.	24,557	Negros	Mostly relatively intact montane rainforest, but now isolated; wild pigs present but hunted.
Panay Mts N.P. on	c. 40,000	Panay	Proposed to protect last area of remaining forest this island; probably supports single largest remaining pig population, but hunting is widespread.
Central Cebu N.P.	11,894	Cebu	Virtually deforested, heavily encroached; wild pigs extinct.
Sus sp./ssp. ?			
Rajaha Sikatuna N.P.	9,000	Bohol	Wild pigs reported to be close to extinction.
Mt. Iglit-Baco N.P.	75,445	Mindoro	Formerly mostly montane rain forest, but now

			largely disturbed or degraded; wild pigs common in some places.
S. philippensis			
Mt. Data N.P.		Luzon	Mostly pine forest; no recent information on pigs.
Bataan N.P.	23,853	Luzon	Monsoon forest; pigs (and hunting pressure) reported.
Quezon N.P.	535	Luzon	Remnant tract of lowland rain forest; pigs reported in 1978, but no recent information.
Mt. Isarog N.P.	10,112	Luzon	Wild pigs (and hunting pressure) reported in 1978; no recent information.
Leyte Mts.N.P.	c. 42,000	Leyte	Mostly montane and semi-evergreen forest, though some parts threatened by encroachment; probably still supports a good pig population.
Mt. Apo N.P.	72,184	Mindanao	Formerly montane and lowland rain forest, but most of latter lost to encroachment; wild pigs still present.
Mt. Malindang N.P.	50,000	Mindanao	As Mt. Apo (above).

Captive Breeding

Small numbers of native wild pigs are maintained in several zoos and private collections in the Philippines. However, most of these animals are maintained as single individuals or small groups of animals of mixed origin, and no attempts have made as yet to start breeding programmes for any of the threatened, endemic forms in this country.

Additional Remarks

Recent data from ornithological surveys in Mt. Pulog in the Sierra Madre, indicate that the rooting activity of wild pigs may be of particular importance to certain ground feeding birds, such as the Koch's pitta (*Pitta kochi*), a poorly known threatened species endemic to Luzon. During these surveys, this pitta was observed only in the vicinity of such excavations, where it apparently forages on the invertebrates uncovered by the pigs (A. Jensen, pers. comm.).

Conservation Measures Proposed:
An Action Plan

Nowhere in the Philippines is environmental degradation quite so acute, and need for immediate conservation action quite so pressing, as in the West Visayas, or 'Negros Faunal Region'. This area is one of the most important centers of endemicity in the country but, even by Philippine standards, it has suffered a disproportionate extent of

denudation, and the few remaining forests are chronically under-represented within the existing, and seriously inadequate, protected areas network. For all of these reasons, *S. cebifrons* emerges as one of a host of endangered endemics, and one the most threatened of all suids. The overwhelming priority for this species and, indeed, the terrestrial biota of this entire region, must be the early declaration, and effective future protection, of the (proposed) Panay Mountains National Park. The forests of western Panay are not only the sole surviving area of forest on this island, they are the single largest tract anywhere in the West Visayas and, hence, one of the most important tracts anywhere in the country. It is to be hoped, therefore, that this area and other important sites in the West Visayas (such as Mt. Canlaon National Park and the Northern Negros Forest Reserve in Negros Occidental and the area around Mt. Talinis/Mt. Guinsayawan/Lake Balinsasayao in Negros Oriental), will be upgraded within the context of the current review of priority sites for inclusion in the new Philippine 'Integrated Protected Areas System (IPAS)' which is being conducted by the Department Of Environment and Natural Resources (DENR).

In addition there is a need to address a number of outstanding questions about the distribution, biology and systematic relationships of these animals, and the generally negative attitudes of local people with respect to their future management needs. The principal objectives and priority projects for these species may be summarized as follows:

Objectives:

1. To promote and assist the enhanced future protection of the most threatened species/populations by increasing the number and size of existing reserves, and/or the effectiveness of protective measures, in those key areas where the protected areas network is inadequate to ensure the survival of the most threatened forms.

2. To promote further applied research on topics relevant to an improved understanding of the biology, systematics and future management requirements of the various Philippine endemic pigs, with a view to the enhanced protection of representative populations of all recognized taxa.

3. To design and implement such other practical conservation initiatives - including captive breeding, personnel training and public education programmes - as may be necessary to enhance the survival prospects of the most threatened taxa and a better understanding and appreciation of these animals at a local level.

4. To promote the development of conservation management policies directed towards the sustainable utilisation of wildlife resources in non-protected areas and/or where these are not in conflict with the overall survival prospects of threatened, endemic forms.

Priority Projects:

1. Promote and otherwise assist current proposals to develop effectively protected areas in the west Visayas, particularly the Panay Mountains National Park (west Panay), the Northern Negros Forest Reserve and Mt. Canlaon (north Negros) and the environs of Mt. Talinis and Lake Balinsasayao (south-east Negros).

   All of these areas are known to support remnant populations of numerous critically threatened species endemic to the (West) Visayan faunal region, including the last known populations of *S. cebifrons* and *C. alfredi*.

2. Conduct field status surveys in selected locations and promote development of management plans for the enhanced future protection of other known, or possibly surviving, populations of *S. cebifrons*, in other critical sites in the West Visayas.

   Data on the present status and/or the identity of the local wild pigs are required from:

   - Masbate: this island was not visited during the 1985 survey, though it may still support remnant populations of S. cebifrons and other threatened Visayan endemics. The adjacent, smaller island of Ticao should also be investigated in this context.

   - Bohol: small numbers of wild pigs are reported to survive on this island, which has been almost entirely deforested. However, it is not known whether these are *S. cebifrons* or *S. philippensis*, so taxonomic material (such as skulls or other hunting trophies) should also be obtained from this island.

   - Sibuyan: wild pigs are known to survive on this island, but it is not known whether these are *S. cebifrons* or *S. philippensis* as no museum specimens have ever been obtained for study.

   - Negros: additional and updated status data is required from several locations on this island *where S. cebifrons* has been reported to survive; including Mt. Silay, Mangdalangan Mts., Mt. Canloan, Mt. Talinis, Mt. Guinsayawan, Lake Balinsasayao and areas due east of Hinoba-an, which are of critical importance to the future survival prospects of this and other endemic taxa.

3. Develop a properly structured, cooperative breeding program for *S. cebifrons*, as a safeguard against its possible early extinction in the wild state.

   In the first instance, at least, any such breeding program should be established at a recognized academic institution or conservation foundation on Negros or Panay, in

order to facilitate the acquisition of the founder stock and promote local interest and research into the conservation and biology of these animals.

4. Promote and assist development of local conservation-education projects, including media coverage and the production and distribution of leaflets, posters and other materials.

   The importance of the Philippines as a center of endemicity for wild pigs is almost entirely unknown to the relevant authorities, let alone the general public, and local attitudes to these animals are generally negative owing to occasional damage caused to crops planted in or close to forested areas. Recent experience has shown that teachers and members of the higher socio-economic groups (including landowners, local politicians, and the military and police forces, who include both decision-makers and many recreational hunters) are mostly unaware of the conservation significance of native wildlife species or the importance of protecting remaining forests, but are often receptive to suggestions appertaining to the patrimony of the country and the need to protect species unique to the region.

5. Conduct field status surveys in other, selected locations in the Philippines, which may support important populations of wild pigs and/or those whose taxonomic affinities have yet to be assessed.

   These include Mindoro, Sibuyan, Bohol, Basilan and some other islands in the Sulu Archipelago. These surveys should be designed to determine the distribution, status, nature of threats and possible future management needs of any pigs that may occur there, and serve to obtain additional skin, cranial or other (soft) tissue specimens as may facilitate studies to determine the systematic relationships of these animals.

6. Encourage and support field studies on topics relevant to the future management of these species.

   Very little field research has been conducted on any of the Philippines pigs, and such information as is available is therefore largely anecdotal. Comparative studies of their social and reproductive behaviour, ecology and habitat requirements, population dynamics, response to hunting pressure and commercial logging activities, etc., are all required.

7. Promote useful, comparative research on all captive wild pigs and the development of cooperative breeding projects between institutions/private individuals maintaining these animals.

At the present time there are small numbers of various other native wild pigs being maintained in city zoos, research institutions and private collections. Most of these animals are kept in non-breeding situations or in small mixed groups. Efforts should therefore be made to encourage the exchanges of specimens to promote breeding success and prevent inter-specific or inter-population hybridizations. These animals represent a potentially useful resource for research and training, and comparative studies of their behaviour and biology should be encouraged. Some priority should also be given to the collection of blood samples and other soft tissues for seriological and cytogenetic analyses. These could be collected relatively easily from captive animals, and could be expected to elucidate some outstanding questions about their genetic diversity and systematic relationships. For example, there are evident morphological differences between the wild pigs of the Luzon and Mindanao Faunal Regions, which need to be investigated in respect of the current (possibly unsatisfactory) assignment of both populations to the same monotypic taxon (*S. philippensis*). Similarly, the proposed separation of '*philippensis*' and '*cebifrons*' is almost entirely based on morphometric (osteological) and zoogeographic criteria, and the phylogenetic relationships between these taxa, and their distance from *S. barbatus* and *S. celebensis*, merit further investigation.

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Chapter 5.7

The Sulawesi Warty Pig (*Sus celebensis*)

Alastair A. Macdonald.

Status and Action Plan Summary

Status category 2 (locally abundant, but with a restricted distribution).

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

Whilst continued habitat destruction, hunting pressure and genetic contamination through contact with *S. scrofa* domesticates represent potentially serious threats to this species, it cannot be regarded as seriously threatened throughout its range at the present time. For this reason, recommendations for future action are primarily directed towards elucidating outstanding questions about: a) the systematic status and future management needs of

populations in certain specified areas within its original range and in locations to which it can only have been introduced by human agency; and b) promoting applied research on various aspects of its biology, its socio-economic significance to village and island societies and its potential importance as a genetic resource for further domestication.

Introduction

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

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

Link to Fig. 15: Approximate distribution of native and introduced (including domestic and feral) populations of the Sulawesi warty pig, *Sus celebensis.*

Former and Present Distribution

Available evidence suggests that the species formerly occurred throughout Sulawesi, as well as on the neighboring islands of Selayar, Buton, Muna, Peleng, Lembeh and the Togian Islands. MacKinnon (1981) reported that the species remained extremely abundant throughout north, central and south-eastern Sulawesi, despite hunting pressure and agricultural development, but that it was extinct or greatly reduced in numbers in south-west Sulawesi, and on nearby Selayar, following the virtual deforestation of these areas.

Wild pigs referred to as feral *S. celebensis* by Groves (1981), are known from Halmahera, Flores, Timor, Lendu and Simeulue and Nias islands, and domesticated animals of *S. celebensis* derivation are reported from the islands of Roti and Sawu (Groves, 1983; Bell, 1987). The present working hypothesis is that the species was transported by man to the Mollucas and along the Lesser Sunda chain of islands either as a domesticate or as a barely modified wild form which was released to be hunted whenever required for eating. In the Mollucas, and possibly elsewhere in this region, these introduced *celebensis* are

thought to have hybridized with other introduced pigs of *S. scrofa* derivation, and apparent hybrids between these species are now reported to survive on a number of islands in this region, including Salawatti, Great Kei Island, Dobu, Seram, Ambon, Bacan, Ternate, Morotai and New Guinea (Groves 1981, 1983; Oliver and Brisbin, this vol.).

Habitat, Ecology and Behavior

Sulawesi warty pigs are reported to occur in a wide variety of habitats, ranging from rainforest and swamp, to open grasslands and agricultural areas, and at all altitudes up to moss forest (>2,500 m) (MacKinnon, 1981). They usually live in groups, but the social composition of these groups is not known (Macdonald, 1991). They forage during the day, this activity being concentrated in the early morning and evening. Although roots, fallen fruit, leaves and young shoots constitute the bulk of their diet, invertebrates, small vertebrates and carrion are also eaten (National Research Council, 1983).

The pregnant sow reported from south Sulawesi by Sody (1941) was probably mated in February. Birth can occur at any time throughout the year but sows usually have their young in April or May (National Research Council, 1983). Gestation length is not known for certain, and the suggestion that it may lie between 16 and 20 weeks should be treated with the caution implied by Sody (1941). Farrowing sows give birth in nests made of grasses, leaves, branches and twigs, piled over a shallow excavation of approximately 2 m in length. Litter size ranges from 2-8 (National research Council, 1983), but a recent study in North Sulawesi found 6 pregnant sows killed by hunters to be carrying only 1-3 fetuses with a mean of only 2.17 fetuses per pregnancy (Budiarso *et al*., 1991). The young are striped along the length of their bodies but lose these markings as they get older (Appelman, 1955; National Research Council, 1983; and pers. obs.).

Threats to Survival

S. celebensis is evidently highly adaptable, and is thought to remain abundant through much of its former range, despite changing land use and hunting pressure. Apart from man, it has few if any important predators on Sulawesi and its offshore islands.

Whilst it is not, therefore, considered threatened over much of its range at the present time, wide scale deforestation for timber and conversion of land for agriculture, coupled with human population expansion and immigration, have resulted in a marked contraction of its range in some places. In addition, resources are insufficient to enforce controls on hunting, and there are reports that subsistence and/or organized commercial hunting is continuing even within designated reserves and national parks (Smiet, 1982; Blouch, 1990). In north Sulawesi, the Minahasa people consider wild pig meat to be superior to domestic pork, and are willing to pay 20% to 50% more for it. Reports obtained during brief surveys of three village markets in north-east Sulawesi, suggest that butchers in each market handled from 2 to 20 wild pigs per week, buying them live from commercial hunters and slaughtering them when needed (Blouch, 1990). Budiarso *et al.* (1991)

recorded 2,317 pigs harvested in four regions of North Sulawesi during 12 months in 1990 and 1991. Although they found the fetal sex ratio to be approximately 1:1, the male to female ration of 1:1.7 in harvested pigs suggests that the females are more susceptible to these commercial hunting operations, which may make heavily exploited populations especially vulnerable to extirpation.

The expansion of human settlements also brings an increased threat of genetic contamination and/or disease to the wild pig populations through the importation of 'improved' (ex-*S. scrofa*) domesticates, and the carriage of these animals from coastal communities to villages in the interior.

Conservation Measures Taken

Sulawesi warty pigs are known or are likely to occur in all of the principal national parks, nature and game reserves on Sulawesi, including Lore Lindu (2,310 sq km), Dumoga-Bone (3,000 sq km), Morowali (2,250 sq km) and many other smaller sites. Within all of these areas the species is technically fully protected by law, though it is certainly still hunted in some of these areas (Setyodirwiryo, 1959).

There are few recent data on the distribution and numbers of *S. celebensis* on Sulawesi and neighboring islands. However, preliminary surveys conducted in 1991 in various locations north and south-west of Kendari and within the Lore-Lindu, Dumoga-Bone and Morowali National Parks, indicate that the species is still plentiful in these areas. However, the socio-economic importance of these animals to local people, as well details of their distribution and relative abundance in each of these areas and elsewhere in Sulawesi will require further study.

Captive Breeding

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

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

Additional Remarks

S. celebensis is somewhat variable in size and other characters, a circumstance, which led Groves (1981) to treat the species as monotypic, and to reject a number of previously recognized subspecies. However, Groves also drew attention to the existence of three skulls from Latimojong Mountains in South Sulawesi, which may represent a distinct form. These skull are of relatively small size for this region, i.e. there being evidence of a north (smallest) to south (largest) cline in body size on Sulawesi (which also extends to the offshore island populations - see also Groves and Grubb, this vol.).

Sulawesi and associated islands comprise the larger (southern) section of the Wallacian sub-region, which also includes the eastern Philippines. Sanborn (1952) included the wild pigs of the eastern Philippines with *S. celebensis*. This treatment was followed by various authors (e.g. Sinha, 1982; and Catibog-Sinha, 1985), but strongly refuted by Groves (1981) and Groves and Grubb (this vol.) who demonstrated that these animals were more closely related to the (Sundaic) *S. barbatus*. This view is followed here, though the close resemblance of at least some of the Philippine pigs (especially those from Luzon; to *S. celebensis* suggests that further investigation of their affinities is warranted.

Conservation Measures Proposed: An Action Plan

S. celebensis is of particular interest in that it is the only pig species, apart from *S. scrofa*, which has been domesticated and quite widely transported by human agency outside its original range. The available evidence indicates that it is still maintained as a domesticate in some areas, but its commercial importance and future potential as a genetic resource are virtually unknown. Detailed studies of its ecology, behaviour, physiology and regional genetic variation have yet to be undertaken, and although its apparently large population size suggests it is not seriously threatened at present, the small amount of available data is mostly anecdotal. This lack of substantive data is presumably due to the relative remoteness of Sulawesi and its offshore islands, which have only recently become more accessible. The increasing interest in the renewable resources of this region should include studies of these animals, which have long been of great economic importance to the local people.

Objectives

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

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

3. To investigate its regional genetic variation with particular reference to the identification (and, if necessary, the protection) of any possibly distinct forms, its

affinities to other Asian warty pigs and the origins and relationships of surviving domestic and feral populations.

Priority Projects:

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

Although detailed, island-wide surveys would be impractical and possibly unjustified on the basis of the present known status of this species, there is a need to assess, or reassess, its conservation and taxonomic status in certain locations, such as the Latimojong Mountains and elsewhere in south Sulawesi, and on Selayar and other offshore islands where the species is known to have occurred. In north Sulawesi, the extent of market hunting and its effects on the wild populations needs to be determined with a view to ensuring that the species is managed on a sustained yield basis.

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

Efforts should be made to establish the present status, human utilisation and affinities of the various introduced wild (i.e. unmodified), feral or domestic *S. celebensis* populations in the Mollucas, Lesser Sunda Islands and the west Sumatran islands of Simeulue and Nias (Oliver and Brisbin, this vol.). These studies are of considerable anthropological interest, and can be expected to throw light on the origins and affinities of these animals (and hence also the people who introduced them), as well as the history and process of animal domestication. In addition, some of these pig population are likely to be of some potential genetic importance for the production of improved breeds, and efforts may need to be made to preserve some pure-bred stocks (e.g. from genetic contamination by hybridization with more modern domesticates of *S. scrofa* origin).

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

Very little is known about the natural history of *S. celebensis*, despite its evident importance as a basic economic resource to a number of island and village societies. No detailed studies of its behavioral ecology, diet, reproductive biology, parasites and diseases have ever been published. Such studies should also investigate hunting pressures and practices, and the relative densities of these animals in intact and degraded habitats, with a view to assessing the impact of logging and other sources of disturbance on their populations.

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

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

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The Babirusa
(*Babyrousa babyrussa*)

Alastair A. Macdonald

Status and Action Plan Summary

Status categories 4 - 5 (vulnerable or endangered), according to subspecies.

The babirusa is known only from Sulawesi (*B. b. celebensis*), some of the Togian Islands (*B. b. togeanensis*), the Sula Islands and Buru (*B. b. babyrussa*). Two extinct forms, one fossil and one recent (*B. b. bolabatuensis*), have been found in South Sulawesi. The species is therefore presumed to have been more widely distributed on Sulawesi in earlier times, but by the middle of the last century they were reported to occur only in the east and north-east parts of the island and to have disappeared from the whole of the south-western peninsula. Currently, babirusa are known only from the northern peninsula, central and south-eastern parts of the Sulawesi mainland, and from three of the larger Togian Islands Archipelago. Reports obtained in 1990 indicate that babirusa also survive on Buru and two of the Sula islands, Mangole and Taliabu, but that they may now be extinct on Sulabesi (formerly Sanana). However, there is no doubt but that babirusa are seriously threatened over most of their remaining range by deforestation and hunting pressure; the latter being particularly intense in parts of northern Sulawesi where there is commercial trade in the meat of these animals (Blouch, 1990; Budiarso *et al*., 1991).

Much of the available information on the natural history and biology of this species is anecdotal or derived from the study of captive specimens. Distribution and status surveys in all parts of its range are required as a matter of high priority, with a view to the development of management plans for its enhanced future protection and the establishment of additional reserves in key areas, such as Buru, Mangole and the Togians. The possibility of relic populations of *B. b. bolabatuensis* surviving in remote locations in south Sulawesi should be investigated, and the taxonomic relationships of the central and south-eastern Sulawesi populations, which are unknown at present, need to be assessed. The first longer-term field study of the species' behaviour and ecology has been initiated recently in northern Sulawesi, and such studies should be continued and extended to other parts of the species' range in the near future. Particular emphasis should be placed on obtaining a proper understanding of its habitat preferences, population sizes and densities in different habitats, and the nature and extent of factors, such as hunting pressure, deforestation and agricultural encroachment, which are negatively influencing the distribution and numbers of surviving populations. Although there are large numbers of *B. b. celebensis* being maintained and bred in zoological collections at present, the captive population is extremely inbred. Priority should therefore be given to the acquisition of additional, wild-caught founders of this subspecies, and to the development

of properly structured breeding programmes for the more threatened Togian subspecies, *B. b. togeanensis*, and, especially, the golden or hairy subspecies, *B. b. babyrussa*.

Introduction

B. babyrussa is the sole living representative of the subfamily Babyrousinae, and is generally considered to be in an isolated position with regard to the other living suids. Being endemic to Sulawesi, it also has a very limited geographical distribution. This island has long been isolated by water from mainland Asia, the strait never having been narrower than about 25 miles during Pleistocene times. Since the fossil record is confined to Pleistocene material from Sulawesi and from Buru, the hypothesis has been put forward that Babyrousa has developed since Oligocene times along a separate evolutionary line (Thenius, 1970; Groves and Grubb, this vol.). This concept is fully supported by chromosome data; although the babirusa has a diploid chromosome number of 38, as in most other suids, five pairs of babirusa autosomes (Nos. 6,12,14,15 and 17) have no direct equivalents in Sus species (Bosma, 1980; Bosma and de Haan, 1981; Bosma *et al.*,1991).

In any event, there is no doubt that the babirusa is one of the world's most bizarre mammals, and is certainly one of the most extraordinary suids. Amongst its many peculiarities are that the upper canines of the male emerge vertically from the maxillary alveoli, penetrate through the skin of the nose and then curve posteriorly over the front of the face towards the forehead; a unique feature in mammals. The mandibular canines of the male also grow over the front of the face. The peculiar appearance of the adult male (the canines of the female are either absent or markedly reduced) has led local people to liken its appearance to deer (i.e. '*babi*' = pig and '*rusa*' = deer) and, on some islands, to confer mythical properties to it. The function of these tusks remains unknown. They are quite brittle, and therefore easily broken, and they are rarely used in combat between males (see below).

Subspecific Taxonomy

Following Groves (1980) and Groves and Grubb (this vol.), three extant subspecies are currently recognized. However, it is possible that some central or southern Sulawesi populations are of a fourth subspecies, *B. bolabatuensis* (Hooijer, 1950), which is known only from Tolian deposits collected from caves and rock shelters in south-western Sulawesi. The (three) living forms are described as follows:

1. *B. b. babyrussa* (Linnaeus, 1758), the 'hairy' or 'golden' babirusa is known only from the islands of Buru and Taliabu, Sulabesi (where it is now extinct) and, probably, Mangole in the Sula Islands. This is the smallest subspecies, and is otherwise characterized by its long and thick body hair, which is colored white, creamy gold, black or gold with a black rump. The upper canines of the males are usually short and slender, with the alveolus forwardly rotated, so that lower canine crosses the upper in lateral view.

2. *B. b. togeanensis* (Sody, 1949), the Togian Islands' babirusa is, as its name suggests, confined to the Togian Archipelago, between the northern peninsula and central Sulawesi. This is the largest subspecies. It is also characterized by the possession of body hair, though this is less long and dense than in the nominate form. The pelage of the upper parts is also darker than that of the under parts and fawn, brown or black in color. The upper canines of the males are usually short, slender and somewhat rotated forward, and always converge.

3. *B. b. celebensis* (Deninger, 1910) is certainly known only from the northern peninsula and the north-eastern part of mainland Sulawesi, including the offshore island of Lembeh. This is the only subspecies to be maintained in captivity at the present time and is therefore the most familiar. The adult male body size is fairly large (though smaller than that of the preceding subspecies), ranging from 60 and 100 kg. The female is approximately 30% smaller. It is usually considered to be naked, though in reality its body hair is merely short (0.5-1.0 cm), sparse and dark brown in color over gray skin. The upper canines of the males are generally long and thick, and the alveoli vertically implanted, so that upper canine emerges vertically and is not crossed by the lower canine, converging in almost all cases (Groves, 1980).

Link to Fig. 16: Approximate known range of native and introduced populations of babirusa, *Babyrousa babyrussa* ssp.

Former and Present Distribution

The species appears to have been more widely distributed over the island of Sulawesi in former times than it is now. Two extinct forms, a Pleistocene fossil (*B. b. beruensis*) and one Holocene subfossil *(B. b. bolabatuensis*), described from remains found in caves and rock shelters on the east side of the south-west peninsula (Sarasin & Sarasin, 1905; Dammerman, 1939; Hooijer, 1948, 1950), also indicate that babirusa were the principal large prey species of prehistoric man in some localities in the island (Franssen, 1949; Heekeren, 1949). By the middle of the last century the species was reported to survive in the east and north-east parts of Sulawesi but to have vanished from the whole of the south-western peninsula (Temminck, 1849; Sarasin & Sarasin, 1905), and by the 1930's it was said to be: "being squeezed slowly into the hinterland of Sulawesi" (Heynsius-Viruly and Heurn, 1935).

Babirusa are now definitely known only from the northern peninsula (*B. b. celebensis*), and central and south-eastern Sulawesi, though various recent reports indicate that populations also occur at intervals along the length of the south-western peninsula (H. B. Hasanuddin, J. Clark and A. Kyari, pers. comm.). However, the taxonomic status of the central and the southern Sulawesi populations is not known, i.e. these may represent the otherwise believed extinct form *B. b. bolabatuensis*. The subspecies *B. b. togeanensis* is known only from the Togean islands of Batudaka, Togian and Talatakoh, where Selmier (1983) estimated that the total population was in the region 500 - 1000 individuals in

1978. The nominate subspecies, *B. b. babyrussa*, is now known only from Buru and from the Sula islands of Mangoli and Taliabu. It also occurred on Sulabesi (formerly Sanana), the only other large island in the Sula Group, but this population is now thought to be extinct (A. Sol and M. Patry, pers. comm.).

Habitat, Ecology and Behavior

The babirusa inhabits tropical rain forest on the banks of rivers and ponds abounding in water plants. Whereas in the past the animal has tended to occur in low lying areas near coasts, recent anecdotal and survey reports indicate that it is now confined mostly to the interior, on higher and less accessible ground.

In common with most of the other suids, babirusa are omnivorous. The species' intestinal tract is similar to that of the domestic and wild pig (*Sus scrofa*) in many ways (Flower, 1872; Mitchell, 1905, 1916; Langer, 1973, 1988), although its enlarged stomach diverticulum has led to the spurious suggestion that this may be involved in rumination. However, all the available evidence shows that this is not the case (Macdonald, 1991). Whether the diverticulum is actually a food storage chamber or an enlarged 'acid bath' is now being investigated, along with other studies of the species' digestive physiology. Except in mud and swampy ground, babirusa do not exhibit the rooting behaviour typical of other suids, but this is associated with its lack of a rostral bone in the nose. From observations of both wild and captive individuals they are known to consume a wide variety of leaf, root, fruit and animal material, though detailed studies of their diet in the wild still need to be carried out. Their jaws and teeth are reported to be strong enough to crack very hard nuts with ease (Peters, 1985), and adult babirusa have been observed to catch and eat small mammals. In captivity, adults of both sexes will also sometimes attack and cannibalize infants born to other individuals.

The available information suggests that babirusa are social, with groups or troops of up to eight individuals having been observed in rainforest, especially around water, communal wallowing areas and salt licks (Valentijn, 1726; Desmarest, 1820; Selmier, 1983; Macdonald *et al.,* 1989; Patry and Capois, 1989; M. Patry, pers. comm.). No detailed accounts of group structure have been published, though field studies currently underway in Sulawesi are expected to shed light on this, and whether the species is territorial (M. Patry and L. Clayton, pers. comm.). Recent video film of wild animals has shown that they may associate with the sympatric warty pigs (Sus celebensis) and that, contrary to Jennison (1927), they are active during daylight hours (Selmier, 1983; Patry and Capois, 1989).

Nests built in the wild are reported to be similar to those of the other wild pigs (Deninger, 1910). Babirusa shelter from the rain under bitten off branches of leaves, though nests have also been found in volcanic rock caves (Selmier, 1978). Sleeping nests tend to have little or no padding on the ground, being essentially 'babirusa-sized depressions', and all babirusa flushed out of such nests were solitary (Selmier, 1983). Nests built by sows for farrowing are up to 3 m long and 25 cm deep, and are layered with branches torn from trees and bushes (Guillemard, 1886; Selmier, 1978).

Captive babirusa may become sexually mature as early as five to ten months of age (National Research Council, 1983), and have lived as long as 24 years (Mohr, 1960). However, it is likely that the age of sexual maturity in the wild is influenced by the level of nutrition and that animals are unlikely to breed until they are more than one year old. Estrus cycle lengths of between 28 and 42 days have been recorded, and captive females generally re-cycle within 3 months post-partum (Chaudhuri et al., 1990; P. Vercammen and P. Immens, pers. comm.). Estrus lasts 2-3 days, and the female is not receptive to males at other times (Macdonald, Leus and Vercammen, unpubl. data). Gestation length is usually 155-158 days, though up to 171 days has been reported (Heinroth, 1908; Reinhard and Frädrich, 1983; Bowles, 1986; Vercammen, 1991). The normal litter size is one or two, but a low incidence of triplet births has been recorded both in captivity and in the wild, and four fetuses have been reported in utero in a wild female (Patry, 1990). Although the gestation is six weeks longer than that of S. scrofa (+ 114 days), neonate babirusa are smaller in size and seem to be no more developed as a consequence of the longer time spent in the uterus. The young are uniformly brown in color, rather than striped, as in all other wild suids with the exception of the warthog, *Phacochoerus* spp.

In captivity, sows produce young at all times of the year (Plasa, 1990), and may produce two litters within a 12-month period. However, since it seems likely that diet or other seasonal factors would normally influence inter-birth intervals, wild litters may be produced less frequently. Females, which are normally quite docile in captivity, become exceedingly aggressive to their keepers and other babirusa from shortly before parturition to about two weeks after the young are born (Dittoe, 1945; Reinhard and Frädrich, 1983; Peters, 1985; Anggawijaya *et al.*, 1985).

Threats to Survival

Adult babirusa have few, if any, natural predators, though pythons (*Python reticulatus* and *P. molurus*) and Sulawesi civet (*Macrogalidea musschenbroeckii*) may predate younger animals (Whitten *et al.*, 1987). Indeed, given the small litter size, babirusa appear unadapted to a high rate of predation; a consideration evidently supported by MacKinnon (1979) who suggested that, having evolved in a more or less predator-free environment, babirusa were especially vulnerable to hunting pressure. However, hunting by humans with nets, spears and dogs has undoubtedly been an important factor since prehistoric times (Guillemard, 1886; Franssen, 1949) and that continued, hunting pressure now constitutes an increasingly important threat to the remaining populations of these animals in some areas (Blouch, 1990; Budiarso *et al.*, 1991; L. Clayton, pers. comm.; M. Patry, pers. comm.). The market hunting practiced by the Christian community in north Sulawesi is concentrated on the warty pig, *S. celebensis*, but some babirusa are also taken. Budiarso *et al.* (1991) counted 295 babirusa among 2,612 wild suids they recorded in a survey of hunters and markets in four areas of North Sulawesi. This relatively small proportion (11.3%) of the total wild pig harvest is caused, at least in part, because babirusa reportedly now live further from human habitations than the warty pigs. Additionally, they fetch no more in the market place, giving hunters little incentive to go after them (Blouch, 1990 and pers. comm.). Nonetheless, babirusa skulls are openly

sold in tourist areas south of the Lore Lindu National Park and in large department stores in Jakarta.

In recent years large-scale commercial logging operations have also posed a major and increasingly serious threat to this species (Smiet, 1982). The loss and degradation of habitat has already resulted in the dramatic diminution in the known range of this species and the recent extirpation of some populations, e.g. in parts of north Sulawesi and on Sulabesi (Selmeir, 1978; Clayton, in prep.; M. Patry, pers. comm.). Babirusa are one of the first animals to become locally extinct after logging or land opening, which not only deprives them of their moist forest habitat but may also increase their exposure to hunting pressure by immigrant settlers and their dogs (Whitten *et al.*, 1987).

Little is known about the susceptibility of this species to natural or introduced diseases (Munro *et al.*, 1990), though many babirusa on the Togian islands reportedly died during an epidemic skin disease in the early 1970's (Selmier, 1983). The increased likelihood of babirusa in formerly remote and inaccessible areas being exposed to virulent (insect- or livestock-borne) diseases to which they have no natural resistance may, therefore, pose a potentially serious threat to this species, as it does to some other threatened suids (Oliver *et al.*, Chapter 5.2, this vol.).

Conservation Measures Taken

The babirusa was accorded full protection under Indonesian law in 1931, and the legislation relating to babirusa and nature conservation in general in Indonesia was summarized by Dammerman (1950) and by Setyodirwiryo (1959). Since 1978 *B. babyrussa* has been categorized as 'vulnerable' in the IUCN Red Data Book (IUCN, 1978), and listed as 'endangered' by the United States Department of the Interior since 1980 (USDI, 1980). The species has also been included on Appendix I of CITES since 1982, although international trade in this species is not thought to be have been an important issue in recent times.

To date, approximately 12,000 sq km of land on Sulawesi has been formally declared as wildlife protection areas, and a further 20,000 sq km within the distribution of this species have been proposed as wildlife reserves of one form or another, but await formal gazetting. Populations of mainland babirusa occur in a number of these national parks, nature reserves, hunting reserves and protected forests in Sulawesi (Table 10), some of which areas have been designated specifically for their protection. However, babirusa are patchily distributed and/or still subject to hunting pressure in many of these areas (e.g. Dumoga-Bone). Efforts are being made by the parks service to educate local people and to control animal poaching and timber cutting within the existing protected areas, but chronic lack of financial resources, pressure from an expanding human population and insufficient up-to-date information seem to combine with other factors to make much of the protective legislation ineffective at a local level (Blouch, 1990; Clayton, in prep.). In some cases, the amount of suitable habitat remaining within these areas is also considerably less than the designated size of the reserves (Basjarudin, 1971; Olivier & Watling, 1977; Wind, 1984; MacKinnon and MacKinnon, 1986). As yet there are no

national parks or other wildlife reserves within the range of or *B. b. babyrussa*, though relatively large areas have been designated for protection in north-central Taliabu (700 sq km) and west Buru (1,450 sq km), but these have yet to be formally gazetted. Similarly, there are as yet no wildlife reserves in the Togian Islands, though the whole archipelago has been proposed for future protection.

Table 10. Existing and proposed national parks and other protected areas known to contain babirusa populations.

Location/name	Existing area (sq km)	Proposed area (sq km)
Sulawesi		
Dumoga-Bone National Park	3,000	
Lore Lindu National Park	2,300	
Bulusaraung Nature Reserve	57	
Gunung Ambang Nature Reserve	86	
Lasolo-Sampara Nature Reserve		450
Pegunungan Peruhumpenai Nature Reserve	900	
Tangkoko-Dua Saudara Nature Reserve	89	
Buton Utara Game Reserve	820	
Gunung Manembo-Nembo Game Reserve	65	
Lambu Sango Game Reserve		200
Pegunungan Morowali/Pelantak Game Reserve		5,000
Rangkong Game Reserve		590
Rawa Opa Game Reserve		1,500
Tanjung Peropa Game Reserve	380	
Gunung Watumoha Hunting Reserve	500	
Danau Towuti Recreation Park	650	
Gunung Lompobatang Protected Forest	200	
Pegunungan Latimojong Protected Forest	580	
Sula Islands		
Taliabu Nature Reserve		700
Buru		
Gunung Kelapa Muda Game Reserve		1,450
Togian Islands		All Islands

Captive Breeding

Babirusa have been maintained and bred in captivity at intervals since the early 19th Century, and perhaps for much longer. Quoy and Gaimard (1830), for example, recorded that the Rajahs of Celebes often kept and raised babirusa to present them as diplomatic gifts. In 1820, the first pair of animals to arrive in Europe was maintained at the Menagerie du Jardin des Plantes in Paris, where a male piglet was produced in March 1821 (Boitard, 1851). During the ensuing 150 years the small captive zoo population fluctuated in number but never exceeded 20 individuals. These included three *B. b. babyrussa* - 2 from the Sula Is. and 1 from Buru - being maintained at Amsterdam Zoo from 1915 to 1925 (Mohr, 1960). However, as a result of the extremely successful breeding of this species at Surabaya Zoo, Java, since the early 1970's, there has been a dramatic increase in the captive population which, by the end of 1989, stood at 68 (36 males, 29 females + 3 unsexed) in four Indonesian zoos, 50 (25 males, 25 females) in eleven European collections and 13 (7 males, 6 females) in 3 zoos in the U. S. (Plasa, 1990). The latter author states that these animals were derived from 13 (7 males, 6 females) wild-caught founders, though this is almost certainly incorrect. Unpublished Indonesian sources describe the stock as descended from a wild-caught pair obtained in 1968 (Matur, 1989), while other reports suggest that this stock is entirely derived from 4 (2 males, 2 females) of 5 wild-caught individuals from the vicinity of Poso, north-central Sulawesi, acquired by Surabaya Zoo in 1975 (S. Soebakir, pers. comm. to W. Oliver). There is also a possibility of a contribution to the world zoo population from 11 animals said to have been brought from Sulawesi to Jakarta in 1977.

In any event the present stock is highly, perhaps chronically, in-bred. In addition, there is increasing concern about the difficulties relating to the useful dispersal of surplus stock in some collections, particularly in Surabaya, which was maintaining 49 babirusa (37% of the total captive population) on 31.12.89. Fortunately, these animals are evidently able to live amicably in large groups, though overcrowding has resulted in high levels of infant mortality and, hence, a greatly reduced rate of recruitment (pers. obs.; Plaza, 1990).

Additional Remarks

The babirusa is considered by the Indonesian authorities and a proportion of the general public to be species of particular patrimonial interest and especially worthy of protection. Evidence for this is found in various unpublished reports in Indonesia, which have suggested that it is second only to the rhinos as most the important wild mammal in the country, and in observations that it has potential as a 'flagship species' for conservation interests. The babirusa has been selected as the emblem of the Lore Lindu National Park, and the species is frequently referred to in staff training and conservation materials produced by the PPA (Forestry Department) and PHPA (Forestry and Nature Conservation Department). In recent years, it has also been increasingly featured in children's text and coloring books in Indonesia.

Conservation Measures Proposed
An Action Plan

The bizarre appearance of this species, coupled with its high degree of taxonomic uniqueness, has attracted comment in the scientific community for 500 years, and it has been a treasured resource to local people for much longer. Recent and current research is rapidly adding to our understanding of its biology (Macdonald, 1991), though basic information on many aspects of its ecology and behaviour is still lacking. The species' shyness and the relative remoteness of its distribution has limited earlier academic studies, but anthropological research has indicated that there is also an extensive local knowledge of these animals which is almost entirely unreported. Its potential importance as a classic indicator of forest disturbance has also been recognized only very recently and this factor, together with need for recent and more detailed information about its present distribution, threats to its survival, and various aspects of its biology, must be reflected in the structure and priorities of any future management and research initiatives.

Objectives

1. To determine the present distribution and relative population sizes of the species throughout its known range.

2. To assist the establishment of a network of protected areas to safeguard the survival of representative populations of all subspecies of babirusa and, where necessary, promote the establishment of captive populations of these subspecies as a safeguard to their survival.

3. To promote further research into the systematics, biology, conservation status and future management needs of the species in order to better ensure its long-term survival.

4. To promote interest and awareness amongst local people and visitors of the need to conserve this unique natural resource.

Priority Projects

1. Conduct field status surveys in selected priority areas, including the Togian Is., the Sula Islands and Buru, with a view to the development of management recommendations/plans for the enhanced protection of two or more representative populations of the least known, but potentially most threatened subspecies, *B. b. togeanensis* and *B. b. babyrussa*, respectively.

2. Assist the relevant governmental authorities in their efforts to establish national parks in the Togian Islands, the Sula Islands (Taliabu and Mangole) and Buru, and such other of those islands where the animals occur and should be better protected in future.

3. Conduct surveys in selected areas of central, southern and south-eastern Sulawesi to assess the distribution, conservation and taxonomic status of relic populations of animals, which may represent extant examples of *B. b. bolabatuensis* (Hooijer, 1950).

4. Assess and implement options for the development of properly structured captive breeding programmes for the most threatened subspecies, *B. b. babyrussa* and *B. b. togeanensis*.

5. Promote efforts to introduce fresh blood-stock from the wild into the captive population of *B. b. celebensis*, assist the useful placement of surplus, captive-bred stock in Indonesian collections (including the possibility of reintroducing some of these animals), and promote development of integrated, in-country management and conservation-education projects with the support of the international zoo community and other relevant bodies.

6. Investigate subsistence hunting methods and levels of utilisation of this species throughout its range, in order to determine its cultural and economic importance to local people and to enhance future monitoring and regulation.

7. Investigate current methods and levels of commercial trade (intra- and inter-island) in the flesh and other products of these animals within Indonesia, with a view to the enhanced future monitoring, regulation and/or prohibition of this trade.

8. Investigate the species' ecology in representative habitats, its habitat preferences, and the reasons for its apparent inability to survive in disturbed areas.

9. Conduct further research into the social and reproductive behaviour and physiology of the babirusa, with particular reference to group size and composition, and factors relating to age of puberty, reproductive cycles and litter size.

10. Investigate the species' natural diet and its digestive physiology, with a view to an understanding of its dietary requirements, the function of the gastric diverticulum and the animal's ability to digest cellulose and other fibrous material.

Acknowledgements

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Chapter 5.9

Origins of Domestication and the Pig Culture

William L. R. Oliver, Colin P. Groves, C. Roger Cox and Raleigh A. Blouch

Abstract and Action Plan Summary

The long and close association between people and pigs has crossed many biogeographic and ethnic boundaries. It is an association which, on archaeozoological evidence, dates back at least 40,000 years, and one which has involved the independent domestication of at least two species of *Sus*, and the carriage of these animals, or their domestic and hybrid derivatives, to all continental land masses and a great many oceanic islands. The resulting diversity of native and introduced forms has produced patterns of distribution and interrelationships of great confusion. Some of these forms are of potential importance in terms of genetic resources for the further domestication of one of man's major sources of animal protein, and some are of considerable anthropological interest in terms of the ethnic origins and the cultural integrity of various surviving tribal societies. However, many formerly important cultural and economic relationships between people and their pigs are breaking down as other economic options become available or religious prejudice fosters change in values. Nonetheless, pigs are still among the most important of all domestic animals, particularly in Asia where the annual consumption of pork exceeds that of all other domestic species put together.

The priority recommendations for future research on these topics include assessing the systematic affinities of selected feral and domestic pig populations, their current conservation status, and their continuing cultural and economic importance to local people, particularly those aboriginal (or early immigrant) groups with whom they may share a common geographic origin. The presently perceived priorities for this research are all in S. E. Asia, most notably the Andaman and Nicobar Islands, the Lesser Sunda Islands, the Moluccas and the Mentawi and associated islands off west Sumatra. Assistance should also be provided for the development and implementation of management recommendations for the preservation of representative populations of: a) any seriously threatened endemic wild pigs; and b) ancient domestic or feral populations of known or potential genetic importance, or of demonstrable economic or cultural importance to local people.

Introduction

There has been a long and close association between people and pigs. It is an association which has crossed many biogeographic and ethnic boundaries and, in some South-east Asian tribal societies, has even acquired a ritualised symbolism of great cultural importance. It is an association which positively facilitated the early expansion of settling peoples, and enormously extended the range of the few, variously derived pigs which they carried with them. It is an association which is essentially, but seldom simply, exploitative, and one which is complicated by considerations of relevance to many different disciplinary standpoints. The pigs, perhaps more than any other animal, are a great many things to a great many people.

The confounding of human attitudes towards pigs is as apparent in the developed countries as in the less developed countries. Either way, they are as much a reflection of changing lifestyles as of opposing or ambivalent interests. Wild pigs which were formerly highly valued as a source of food are later regarded as pests requiring constant control for their depredations on crops, pasture, other livestock and native wildlife species. However, their otherwise desirable eradication, even if practical, may be vigorously opposed by subsistence or recreational hunters or the profitable interests of game meat industries. Equally, the continued demand for wild pork products may have strongly positive benefits in controlling the numbers of introduced pigs, whilst having a strongly negative impact on the distribution and numbers of some of the native wild pigs, which continue to represent a primary source of meat for some surviving hunting cultures.

Other factors may be involved. The recent decline of the endemic bearded pigs (*Sus. b. barbatus*) in those parts of Borneo which have been extensively deforested by logging companies, led MacKinnon (1981a) to refer to the extreme bitterness of the Segama villagers in Sabah who were thereby deprived of a resource on which they have been heavily dependent for hundreds of years. In the Andaman Islands (Bay of Bengal), a dwarf feral pig is one of the staple dietary items of the aboriginal negritos, but these animals have been drastically reduced in numbers, partly through widescale destruction of the Andaman forests and partly by over-hunting by more recent immigrant groups from the Indian sub-continent who compete directly with the negritos for this and other resources (Oliver & Brisbin, this vol.).

The Andaman Negritos have in some ways amongst the simplified cultures of all surviving hunter-gatherers. Their origins, and those of the pigs their ancestors presumably carried with them, are obscure, but their dependence on these animals dates back at least 2,000 years to judge from their subfossil remains in the earliest midden deposits found to date (P. Dutta, pers. comm.). Now, however, the future of these people, not to mention their pigs, is one of the most pressing of many conservation issues appertaining to these islands. Two of the four recognised groups, the Onges and the Andamanese, are now so reduced in numbers that their future survival is in doubt. Some of the few remaining Onges now keep domestic pigs, whereas the other tribes, the Jarawa and the Sentinelese, have always resisted contact with outsiders and are still dependent on

the feral pigs as a basic resource. H. Abdulali (pers. comm.) has therefore suggested that the decline of these animals should be viewed as a matter of the greatest concern as..."their possible elimination would hasten that of the people too". However, while the evident decline of the negrito groups is linked to factors resulting in a corresponding decline in the feral pig population, it might be more realistic to suppose that the survival of these pigs will ultimately depend on the outside recognition and enforcement of the territorial prerogative and cultural integrity of the aboriginal peoples.

The Origins of Domestication

The origins of human exploitation of pigs can be traced to the midden deposits of some of the earliest hunting cultures. In caves in southern Sulawesi, the midden remains of the Sulawesian warty pig *(S. celebensis)*, followed by those of the babirusa (*Babyrousa babyrussa*), are again more numerous than any other species (MacKinnon, 1981b). Human remains c. 40,000 years B.P. found in the Niah Caves in Sarawak were associated with large numbers of pig bones and teeth. The bearded pig (*S. barbatus*) was the most commonly eaten large mammal (Cranbrook, 1979). Today, these pigs are still the most widely consumed wild animal in this part of Borneo, providing approximately 32,000 tonnes of carcass meat a year which is sufficient to supply nearly half the total annual protein requirement for Sarawak's 1.4. million human population (Caldecott and Hyaoi, 1985).

The importance of the pig as a primary source of animal protein naturally resulted in its early domestication, and it is now amongst the most abundant and widely distributed of all domestic animals. There is evidence that local wild pigs were independently domesticated in Europe, in Asia Minor, the Far East (including Japan) and in various parts of South-east Asia (Zeuner, 1963; Herre, 1969; Eusebio, 1980; Ma, 1980; Groves, 1981). The remains of early domestic pigs are sometimes associated with those of wild pigs which were still hunted, and differences between clinal variants of the wild pigs have been related to differences between the early domesticates of these regions. In Europe and the Near East, in places as scattered as Jarmo in north-eastern Iraq, Jericho in Jordan, and several sites in southern Greece, the earliest records of domestic pigs date back to the first appearance of permanent settlements in c. 8,500 years B.P. (Clutton-Brock, 1987). It has often been assumed that these remains represent the earliest evidence of the domestication of these animals, but it is possible that their ancestry is older in the Far East and in South-east Asia. White and Allen (1980), for example, cited the evidence of 'fossilised' pig wallows to suggest that pigs had been domesticated in the Far East as early as 11,000 years B.P., though other interpretations (such as the planting of water-loving root crops) have been placed on the origin of similar wallows in the 9,000 B.P. deposits in the Wahgi Valley, New Guinea (J. Golson, pers. comm.). Similar doubts have also been placed on Solheim's (1972) suggestion that pigs were first domesticated in Thailand as early as 12,000 years B.P., and the remains of these animals in the earliest midden deposits in New Guinea (c. 10,000 years B.P.) refer to individual teeth which are easily trodden down into deeper layers (M.-J. Mountain, pers. comm.).

Whatever the antiquity of such remains, there is no doubt that pigs were independently domesticated in different parts of the world. In New Guinea, for instance, the so-called *'Sus papuensis'* - are almost certainly a hybrid swarm of *S. scrofa vittatus x S. celebensis* derivation, which were introduced by human agency (Groves, 1981). It is not yet clear whether the antecedents of these animals were carried as a hybrid form or whether they have hybridised on New Guinea following the early, separate introductions of domestic or feral derivatives of each of these species. However, the former hypothesis is actually more likely, since there are other populations of hybrid feral pigs in the Moluccas which are practically indistinguishable from the New Guinea pigs, as well as apparently pure-bred derivatives of each of these species on some other islands in this Group, and in the Lesser Sunda chain of islands.

The origins and systematic affinities of some of these introduced pig populations are also of potential anthropological interest in terms of tracing the origins and ethnic relationships of the various tribal groups whose ancestors often carried pigs with them. Such considerations are less esoteric than they might appear in view of our greatly improved understanding of the distribution and interrelationships of the genus *Sus* in South-east Asia. A case in point is the recent hypothesis, based on linguistic comparisons, that the ethnically aberrant tribal peoples inhabiting the islands of Simeulue and Nias off western Sumatra, were most closely related to the Buginese or other southern Sulawesi groups (W. Foley, pers. comm.). The evidence for this has been strongly reinforced by Groves' (1981) revelation that the equally 'out-of-place' feral pigs on these islands were of *S. celebensis* stock (Groves, 1981).

The 'Pig Cultures'

Whilst it is often necessary to rely on archaeozoological evidence to interpret the history of domestication, its development and cultural implications may be more clearly assessed from the relationships between these animals and some of the surviving tribal cultures. In many parts of South-east Asia, various kinds of wild pigs are still among the most important sources of animal protein. In parts of Borneo, for instance, *S. barbatus* remains relatively abundant and may be seasonally present in thousands. These pigs are simply hunted by hill tribals who do not practise domestication, although an introduced *S. scrofa* domesticate is one of the most commonly kept animals in some of the settled coastal communities. Nonetheless, Banks (1931) reported that the nomadic Punan occasionally kept tame bearded pigs which they had caught as orphans while hunting. This habit of raising wild piglets can also be seen on Buru and Seram amongst settled communities who do not keep truly domesticated pigs but who frequently hunt the introduced *celebensis* and *scrofa x celebensis* pigs (respectively) with bows and spears. On Siberut, a similarly introduced, and barely modified *scrofa* pig runs feral, but is regularly fed and lured into cage traps whenever required for eating. In New Guinea and the Nicobar Islands, domesticated pigs are kept and fed, although feral pigs are still hunted and are prized for their meat.

As a primary economic resource, pigs, whether wild or domestic, have sometimes acquired a ritualistic symbolism of great cultural importance in many tribal societies. On

Bawean and Buru, the skulls of wild pigs are revered as trophies and they are hung from longhouses in Siberut. Omens are read from their intestines and strict rules govern who eats which part of each pig. Such aspects of the culture are also reminiscent of human cannibalism, with the general recognition that the human flesh is most like that of the pig (MacKinnon, 1981b). In Borneo, the flesh and other parts of the pig are of great importance in many traditional customs, and are often linked with lore and ceremony of great antiquity (Medway, 1973). Pig jaws are displayed as hunting trophies - symbols of the prowess of the hunter and a tally of the number of pigs killed - and are often buried with the owner on his death. On the island of Seram they are buried before the start of each new period of hunting, which may be prompted by the death of one of the dogs or the breakage of a bow or spear. The prominent display of pig jaws is also believed to deter pilferers, and even to deflect evil spirits which are reputed to be afraid of pigs.

The importance of the pig is also reflected in the traditional customs of peoples who practise domestication. In the Nicobar Islands, Mathur (1967) has described how pigs: ...."occupy an exalted place in the sentiments of the people, who feel very much when any pig is even slightly injured". The Nicobarese dearly love their pigs, and even compose songs in their praise. Nevertheless, the eating of pork is essential on all festive occasions and during convalescence. Pigs are regarded as symbols of wealth and status, and are given or imposed as fines in the settlement of disputes. The Nicobarese also hunt feral pigs, which are not only considered prize trophies, but they are used for the traditional practice of 'pig-fighting'. The latter is both a sport and a test of valour in which a tethered (and usually mildly intoxicated) wild pig is supposed to be grasped by its ears.

The dog, as well as the pig, is closely interwoven with the culture of some of the Pacific Islanders, since both have been the most important suppliers of meat for thousands of years. Orphaned piglets, like puppies, are sometimes nursed by the women, and may attain the status of pets. They are raised with great care and given or exchanged as gifts or as bride price. In Vannatu (formerly, New Hebrides), Baker (1929) recorded that pigs were the standard currency of the people and that a man's wealth, and hence his status, could be measured by the number of pigs that he owned or could extort from others through his ability to pretend he possessed magical powers. Harris (1977) described how the Marang people in the Western Highlands of Papua New Guinea raise pigs as members of their families, and that the men put a higher value on their pigs than on their wives. Pigs are often kept more for the purposes of ceremonial rituals and for trade than as a source of food. However, they are also sacrificed to the ancestors and eaten on all-important occasions (Harris, 1977). About every twelve years each Marang clan also holds a year-long festival or 'kaiko', which includes a massive slaughter of pigs followed by several months of fighting with neighboring tribes. After a number of cycles of battles and feasting, in which the pigs are sacrificed to placate the ancestors and succor the warriors, the supply of adult pigs dries up and fighting ceases for several years, until a new herd of pigs is reared for the next kaiko (Rappaport, 1968).

Pigs also play a crucial role in the ceremonial exchange systems between neighboring clans in New Guinea. An outstanding example of this is the 'tee' of the Tombena-Enga people, which Feil (1987) described as: "..perhaps the most elaborate and highly

developed system in terms of the number of distinct communities involved and their interlocking dependence, in its geographical extent, and its organizational rules and requirements". With adjoining groups, more than 200,000 people may be involved in the Enga tee which, as Feil suggested, might be more appropriately referred to as the 'mena (or 'pig') tee', because it gives pigs the highest, almost sole, exchange value. Thus, pigs are needed for virtually every presentation in the Enga tee: to obtain wives, to compensate enemies and allies, and to achieve personal power and prestige (Feil, 1976). People do not eat all their own pigs in the Highlands of New Guinea because: .."by giving pigs to other men links between men are created and structures of social organization evolve" (Rubel & Rosman, 1978).

The pig culture is deep-rooted and is as strongly developed amongst the Proto-Malays and Malays as it is among Papuans and Melanesian peoples (MacKinnon, 1981b). However, as Clutton-Brock (1981) has pointed out: "The pig, more than any other animal, has also been subject to the whims of human taste and religious scruple." The recent spread of Islam has now weakened the pig-culture in many areas to the point where wild pigs are actively persecuted as agricultural pests rather than being esteemed, even revered, as a basic resource. In Java, where the human population is now predominantly Muslim, the native warty pig *S. v. verrucosus* and the sympatric Indonesian wild boar or banded pig *S. s. vittatus* are shot or poisoned as vermin, and captive animals in zoological gardens have sometimes been spat at or stoned by the visiting public. On Sumba, Sumbawa and Flores, feral pigs originally introduced as domesticates or released for hunting are now poisoned as vermin, although their meat may soon form the basis for a canning industry for export to Japan. In 1954, a coastal Muslim community in Borneo even declared war on a hill tribe who had 'polluted' their water supply with the blood of bearded pigs they had killed upstream (J. MacKinnon, pers. comm.). Tension between the Muslims and groups of differing religious persuasion in Borneo led McNeely and Wachtel (1988) to suggest that these animals separate the people of this island more effectively than any artificial boundary. Such changing attitudes, however, are as much a reflection of changing lifestyles as an expression of religious prejudice. As earlier hunting cultures are transformed to an economy based largely on agriculture, the value of wild pigs as a resource is likely to be offset by their depredations on the crops of the subsistence farmer. Contrarily, the adaptability and prolificacy of the pigs, particularly domestic pigs, is certain to ensure their continued economic importance as one of the principal sources of animal protein. This is especially true in Asia where, for example, the annual consumption of pork exceeds 20 million tonnes per year, an amount greater than the total consumption of all other domesticated species put together (FAO, 1985).

Ancient Domesticates as a Future Resource?

In many areas, wild pigs - particularly feral pigs - interbreed regularly with domestic pigs. Indeed, in places such as the Nicobar Islands (Mathur, 1967) and the New Guinea Highlands (Rappaport, 1968), the genetic continuity of wild and domestic pigs is positively encouraged by the castration of domestic boars to promote their docility. In these circumstances, domestic sows are necessarily mated by wild boars. However, this

can be a two-way process, with free-ranging domesticates interbreeding with wild animals and they, or their progeny becoming naturalized - often to the detriment of the genetic integrity of the wild population (Oliver *et al.*, this vol.) through the introduction of domestic genes. Conversely, the introduction of wild genes into a (often highly in-bred) domestic population can be highly beneficial in terms of local adaptive characters or increased heterosis. In any event, the enormous array of native and introduced, wild and domestic pigs, often of ancient lineage and of widely varying derivation, also represent a potentially invaluable genetic resource, as yet barely explored, for the further domestication of these animals.

This situation is exemplified by the recent revelation that *S. celebensis* is a localized progenitor of some present-day domestic and feral forms (Groves, 1981). This has obvious implications for our better understanding of the genetic resources available for the possible improvement of domestic breeds, and it clearly refutes the widespread assumption that all modern domesticates are derived from the Eurasian wild pig, *S. scrofa*. The recent separation of the wild pigs of the eastern Philippines from *S. celebensis* to either *S. barbatus philippensis* (Groves, 1981) or *S. philippensis* (Groves & Grubb, this vol.) is also relevant in this context, since it may add yet another species to the list of wild progenitors in view of Eusebio's (1980) belief that the ancient breeds of Philippine's pigs were independently derived from the domestication of native forms. Similarly, the suggestion of Swinhoe (1870), recently endorsed by Ma (1980) that the Taiwanese ancient breeds are derived from local wild pigs (*S. s. taivanus*), offers further presumptive evidence for an even wider genetic base amongst regional domesticates and ferals than has been generally appreciated. It is therefore necessary to return to Zeuner's (1963) assertion that domestic - or, rather, artificially modified - pigs are descended from several species, as opposed to the regionally variable species *S. scrofa* (Epstein, 1971; Clutton-Brock, 1981). Leastways, this is appears to be true among Asiatic domesticates, though most archaeozoologists hold the view that European domestic pigs are wholly descended from *S. scrofa*, albeit that these were crossed with oriental breeds of this species in the late 18th Century (J. Clutton-Brock, pers. comm.).

Unfortunately, many of the potentially most valuable aboriginal or ancient Asiatic breeds, or their descendant ferals, are either no longer maintained or are otherwise threatened by genetic swamping, over-hunting or habitat destruction. As far as is known, for instance, the aforementioned Philippine and Taiwanese native breeds are unrepresented as feral populations, and both have become increasingly scarce as domesticates as a result of their widespread replacement by 'improved' (mostly ex-Chinese) breeds. Although some of the variously derived celebensis pigs are still found in all states ranging from domestic through hybrid-domestic and hybrid-feral, to feral and simply introduced (i.e. unmodified) populations, some of the most interesting populations are certainly threatened. The Simeulue pig, for example, which had been previously considered a valid subspecies of *S. scrofa* or even a separate species, *'S. mimus'*, was felt to be so distinct that special efforts might be justified to protect the remaining wild population (MacKinnon, 1981b; Oliver and Brisbin, this vol.). In the light of Groves' findings, however, it is most unlikely that this would merit high objective priority in conservation terms, even though these pigs obviously remain as distinct in real terms as they were

before clarification of their taxonomic status. Essentially the same situation may obtain with respect to the Andaman pigs, where the recent acceptance of their feral status has considerably weakened attempts to promote their effective conservation. However, these pigs remain technically fully protected under the terms of their Schedule 1 listing in the Indian Wildlife (Protection) Act, 1972; albeit that their inclusion was based on the hitherto mistaken belief that they were a truly endemic wild form (M. K. Ranjitsinh, pers. comm.).

Research and Conservation Measures Proposed:
An Action Plan

Objectives:

1. To promote more pure and applied research on the importance of pigs, both culturally and economically, to indigenous people, particularly in developing countries.

2. To conduct field surveys in selected, critical areas, known or likely to be of greatest interest to determining the origins/centers of dispersal of ancient domesticates, and their present status and utilisation by local people.

3. To examine existing hypotheses about the origins and interrelationships of native and introduced pigs, both wild and domestic, with particular reference to cytogenetic comparisons, mitochondrial DNA sequencing and the potential importance of these animals as genetic resources.

4. To develop and assist implementation of management plans to ensure the future survival and genetic integrity of representative populations of the most distinct and/or scientifically (including anthropologically) most interesting and important native (wild or domestic) pig populations.

Priority Projects:

1. Assess current status, distribution and (where possible) the interrelationships between wild pigs and aboriginal people of the Andaman Islands, with particular reference to the threats posed to these animals and the enhanced future protection of representative populations on each of the main islands.

2. Assess distribution and genetic diversity of the wild and domestic pigs on the Nicobar Islands, with particular reference to their cultural and economic importance to the various local tribal peoples, and the identification of any possibly surviving aboriginal stock.

3. Conduct surveys of wild and domestic pigs in the Moluccas and associated islands, with a view to assessing the systematic relationships of these animals, the level and

nature of their utilisation by local people, and their possible origins and role as an early center of wild pig domestication and dispersal.

4. Conduct surveys of wild and domestic pigs in the Lesser Sunda Islands, the Mentawi Islands, Nias and Simeulue, with a view to re-assessing the systematic affinities of these animals and their significance in terms of the known or possible origins of the various ethnic groups inhabiting these islands, the present status of any ancient feral and domestic pig populations and the nature and level of their utilisation by local people.

5. Test existing hypotheses about native domestic breeds being derived from local wild pigs in the Philippines, Taiwan, India and other selected locations, assess present status of these animals and, if necessary, assist development and implementation of recommendations for their preservation as ancient native breeds.

6. Conduct archival research of records of early European maritime explorers and traders to trace accounts of any trade in wild and domesticate pigs, particularly between Europe and S. E. Asia from Spanish, Portuguese, Venetian and Dutch sources during the 14th - 16th Centuries.

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Chapter 5.10

Introduced and Feral Pigs: Problems, Policy and Priorities

William L. R. Oliver and I. Lehr Brisbin.

Policy and Action Plan Summary

Wild pigs or their domestic and feral derivatives have been widely distributed by man as a source of food, and naturalized populations have become established, often in large numbers, on all continents except Antarctica and on a great many oceanic islands. The overwhelming majority of naturalized populations are regional variants or derivatives of the Eurasian wild pig, *Sus scrofa*, although the Sulawesi warty pig, *S. celebensis*, has also been domesticated and introduced in some areas. The resulting diversity of native, naturalized, domestic and hybrid forms has produced patterns of distribution and interrelationships of great taxonomic confusion, particularly in the Indonesian and Papuan Archipelagos. The origins of some of these populations are obscure, though many are associated with the earliest phases of human expansion, exploration and colonization. Some are certainly thousands of years old, but the majority are much more recent and are of little immediate scientific and anthropogenic interest.

However, almost all of these naturalized populations are of relevance to conservation interests. There are a variety of reasons for this, some of which are ambivalent. For example, the babirusa, *Babyrousa b. babyrussa* is frequently cited as one of the main target species for conservation interest in Buru and the Sula Islands, where they have apparently been introduced. Moreover, these populations may represent an otherwise extinct form from southern Sulawesi. On the other hand, the similarly introduced

bushpigs, *Potamochoerus larvatus* ssp., of Madagascar and Mayotte, are also genetically isolated and distinct from their mainland conspecifics, but these animals are generally regarded as environmental pests. Many of the variously derived forms of *Sus* are of potential importance as genetic resources, with possibilities for the further domestication of one of the most important sources of animal protein. Many of the most ancient forms are also of considerable anthropological interest in terms of the ethnic origins and cultural integrity of some surviving tribal societies, whose antecedents may have originally introduced these animals. In those hunting societies, which do not practice domestication, wild pigs often represent a basic economic resource, whereas many other naturalized populations are of only marginal economic importance, except to recreational or commercial game meat interests. However, given their evident adaptability, their widely eclectic omnivorous diet and the fact that they have a higher reproductive rate than any other ungulates, naturalized pigs generally have a profound and invariably negative impact on the ecosystems to which they been introduced. They disrupt natural successional sequences, out-compete or predate native species, and they are frequently implicated in the extinction and endangerment of endemic plants and animals - particularly on oceanic islands. In many areas they also cause serious damage to agriculture, pasture and forestry, and they can act as reservoirs for various pathogenic organisms transmissible to humans and other livestock.

For these reasons, it is recognized that, with a few notable exceptions, naturalized pigs, whether of unmodified wild type or of variously derived feral or hybrid forms, should be treated as exotic pests and strictly controlled or eradicated as appropriate. Nonetheless, it is also felt that a small number of these naturalized populations are of sufficient scientific importance to merit conservation attention. In each case, these populations are: 1) threatened throughout their known range; 2) of relatively ancient origin (i.e. introduced at least several hundred years ago); 3) likely to have been genetically isolated for most or all of the period since their original introduction; and 4) have genetic characters of potential importance for further domestication and/or are of particular socio-economic significance to surviving tribal societies. Consequently, it is also suggested these few introduced populations should be conserved in-situ, unless it is subsequently revealed that their continued existence is in clear conflict with the survival or ecological integrity of other threatened (endemic) taxa or communities.

The single highest conservation priority amongst these few populations is the Buru and Sulu Islands' babirusa (*B. b. babyrussa*), although the (mostly) ancient domestic and feral pigs of *S. celebensis* origin on Simeulue and certain other Indonesian islands, and the feral pigs of *S. scrofa* derivation on the Andamans and some of the Nicobar Islands, are also of particular genetic and anthropogenic significance, and merit special efforts to conserve them - preferably in-*situ*. The more recent, but nonetheless distinct, dwarf pigs of Ossabaw Island, S. E. USA, are also of some genetic importance and should be conserved by means compatible with the ecological integrity of this island - if necessary, ex-*situ*.

Introduction

Interactions with people from earliest times to the present day have significantly altered the genetic, distributional and ecological characteristics of many of the world's pig populations. These interactions have produced two forms of non-native, free-living or 'naturalized' pig populations, which have successfully colonized many different habitats on all continents except Antarctica, and many oceanic islands. These naturalized forms include both 'introduced' populations, which are defined herein as essentially unmodified wild forms which have simply been transported and re-established in a free-ranging state outside of their original range, and 'feral' populations whose genetic structure has been altered through a process of domestication, before being re-established in a free-ranging state. Amongst the suiformes, two species of peccaries (*Tayassu* spp.), the babirusa (*Babyrousa babyrussa*), a warthog (*Phacochoerus africanus*), and the bushpig (*Potamochoerus larvatus*) are all represented by free-ranging 'introduced' populations, but only two species, the Eurasian wild pig (*Sus scrofa*) and the Sulawesi warty pig (*S. celebensis*) have been truly domesticated and are represented by both 'introduced' and 'feral' forms (Fig. 17).

Unfortunately, however, it is not always possible to distinguish between those naturalized populations which are introduced and those which are truly feral, or even between native and naturalized populations in some cases. Often the evidence is purely circumstantial, e.g. whether or not self-introduction is considered to be physically possible and/or whether there are any other large mammals in the same locality. In the Andaman Islands, for example, an aberrant dwarf wild pig, *S. s. andamanensis*, was long thought to be endemic, whilst the locally abundant spotted deer (*Cervus axis*) and a variety of other animals were recognized as exotics since their later introduction had been documented. In fact, the taxon '*andamanensis*' is technically invalid as these pigs are now known to be feral (Oliver, 1984a), though their remains date back to the earliest midden deposits of the original negrito settlers, by whom they were presumably introduced. Moreover, it has recently been shown that there are actually two quite distinct, and apparently stable, feral pig morphotypes in the Andamans, i.e. long-snouted and short-snouted forms (Abdulali, 1962). However they both remain poorly known and their derivation is far from certain. Similarly, in Corsica and Sardinia, wild pigs (*S. s. meridionalis*) and wild cats (*Felis sylvestris* ssp.) have simply been introduced, whilst the wild mouflon (*'Ovis musimon'*) are feral, albeit as barely-modified relics of a species not long under domestication (Groves, 1989).

The otherwise problematical presence of bushpigs, *P. larvatus*, on Mayote (Comoro Islands) and Madagascar, and babirusa, *B. b. babyrussa*, on Buru and the Sula Islands, are also most easily explained in terms of human introductions (Ansell, 1971; Grubb, this vol., section 4.1; Groves and Grubb, this vol., section 5.1). This has sometimes been refuted on the basis that there is also no evidence to suggest that either species has ever been domesticated, although this argument is rather weak in view of the quite widespread introduction of unmodified wild pigs elsewhere (see later text; Fig. 17). Moreover, there are a number of accounts of tame bushpigs (Simoons, 1953; Epstein, 1971) and babirusa (Groves, 1980) being kept as pets by local people, and Dammerman (1929) has even

described how local rulers in Sulawesi formerly kept and bred babirusa for use as diplomatic gifts.

Taxonomy and Distribution of Naturalized Pigs

Nowhere are the various native, introduced, feral, domestic and hybrid pig populations more diverse or of more ancient origin than in the biogeographic area known to botanists as Malesia. The pigs of the Indonesian and Papuan archipelagos in particular, include an astonishing array of forms, whose taxonomic and anthropogenic affinities are only now being unraveled. In perhaps the most extreme case, Groves (1981) provided convincing evidence that the second species of *Sus* to be described, *'S. papuensis'* of New Guinea, was not only a feral population but that it was almost certainly a hybrid of two independently domesticated species, *S. scrofa* and *S. celebensis*, which were introduced to New Guinea, either separately or as a hybrid stock. Similar hybrids also occur as ferals in the Moluccas, the most likely source of origin of the New Guinea pigs, and from where both *S. scrofa*- and *S. celebensis*-type pigs are found in feral states on other islands in this group. Similarly, the so-called *'S. timorensis'* of Timor and *'S. mimus'* of Simeulue Island (off N. W. Sumatra) are both highly modified introduced forms of *S. celebensis*, whereas *'S. andamanensis'* and *'S. nicobaricus'* of the nearby Andaman and Nicobar Islands (Bay of Bengal) are both highly modified forms of *S. scrofa*.

The origins of many of these naturalized pig populations are associated with the earliest phases of human expansion and dispersal. As settling peoples spread from South-east Asia into Melanesia, and thence into Polynesia, they carried pigs with them. Pigs were introduced to New Guinea at least 6,000 years ago (White, 1972; but also see Oliver *et al.*, this vol., Section 5.9) and human settlers and their pigs reached Fiji by 1,300 years B.C. and had spread into most of Polynesia by about 1,000 B.C.. By 1,000 A.D. pigs had been introduced throughout much of Oceania, including the Hawaiian Islands.

Elsewhere, the introduction of pigs can often be traced back to the first European navigators and the colonial settlers who followed them. Christopher Columbus introduced pigs into the West Indies in 1493, and Spanish settlers brought the first pigs to Florida in 1539 (Belden and Frankenberger, 1977). By the end of the 16th Century, Spanish colonial settlements were well established in Mexico, parts of Central America and the West Indies, Peru and Chile, and the Portuguese had founded settlements in Brazil. The widespread practice of allowing domestic pigs to range freely, inevitably led to the early establishment of feral populations, and their descendants are now found in at least sixteen U.S. states and in most Central and South American countries. In Argentina and in the U.S., some of these feral populations have interbred with the descendants of Eurasian wild pigs, S. s. scrofa, which escaped from game ranches where they had been introduced for hunting in the early 1900's (Mayer and Brisbin, 1991). In parts of their range in the Americas, the naturalized pigs are 'sympatric' with the native peccaries, *Tayassu tajacu* and *T. pecari*, which have also been introduced to Cuba for hunting purposes (Figs 1, 2 and 17).

The European expansion into the Indian, Pacific and Southern Oceans also contributed greatly to the spread of these animals. Pigs carried for food or for trade were marooned on oceanic islands for the benefit of later voyagers. The Portuguese navigator, Pero Mascarenhas, released "hogs, goats and fowls" on Mauritius in 1512, although this island was not actually colonized until 1683 (Hachisuka, 1953). De Surville carried the first pigs to New Zealand in 1769 (Clarke and Dzieciolowski, 1991), and a boar and two sows were released by Captain Cook at Queen Charlotte Sound, South Island in 1773. These rapidly increased in numbers, and the New Zealand population was supplemented by later additions, e.g. by Governor King of New South Wales who presented ten pigs to the Maoris at the Bay of Plenty, North Island, in 1793 (Hutton and Drummond, 1904). Pigs had evidently been introduced to Australia by that time, probably on a number of occasions dating from the founding of the first European settlement at Sydney in 1788, though there is some evidence of their earlier introduction into the Cape York Peninsular, via the Torres Strait, by aboriginal traders from the Western Province of Papua New Guinea (Baldwin, 1983). In any event, feral pigs are now widely distributed in all states, including Tasmania, although populations are concentrated in the wetter areas of the Northern Territory and throughout the eastern states of Queensland and New South Wales (Tisdell, 1982).

From the late 18th century to the early 20th century, pigs were also introduced into many other locations in the Pacific and Southern Oceans. Lever (1985) listed such populations as occurring, at intervals, throughout the western Pacific and as far east as the Galapagos Islands, Ecuador, and the Juan Fernandez Isles, Chile. Pigs were first introduced into Tristan da Cunha some time before 1810 and onto numerous other widely separate locations in the South Atlantic Ocean, including the Falkland Islands (where they have since died out or have been eradicated) and in the French Antarctic Territories of Amsterdam Island, Ile Saint Paul and (the later named) Ile aux Cochon in the Crozet Islands in the south Indian Ocean. In quoting the narratives of 19th century seal hunters, Ross (1847) reported that in 1840 'Pig Island' was: "so overrun with these animals that you can hardly land for them"; and that: ..."in less than six years they had increased in an almost incredible manner, although great numbers are killed every year by the sealers, not only for their present subsistence, but salted down for supplies on their voyages to and from the Cape". In fact, these animals had evidently been introduced many years before 1834 (as implied by Ross) as they were recorded as being "very numerous and very ferocious", by Goodridge (1834) who was shipwrecked on the Crozet Islands in 1820. The subsequent history of this population, which has since disappeared, is unknown, although Gressit (1970) suggested that they may have been deliberately exterminated by later visitors on account of their ferocity.

Most if not all of these pigs were of *S. scrofa*-type and the human-induced expansion in the range of this species, and its domestic and feral derivatives, has resulted in its becoming the most abundant and widely distributed of all large mammals. The only major areas where these animals do not occur are the northern United States and Canada, the polar regions and most of continental Africa south of the Sahara. Their failure to become established as a naturalized form in the former areas can be attributed to extreme

seasonal climatic conditions, although the evidence is less clear in sub-Saharan Africa, particularly since domestic pigs of *scrofa*-type are widely distributed there (Epstein, 1971). However, this region broadly equates with the distribution of the bushpigs, *Potamochoerus* spp, which are the analogues of *Sus* in this region. It is possible that *Sus* is competitively disadvantaged in this situation and/or poorly adapted to local conditions, though both introduced and feral populations of *scrofa*-type pigs have become established in parts of Sudan and the Republic of South Africa (Botha, 1989; Lever, 1985). The unfortunate recent introduction of European wild pigs, *S. s. scrofa*, and a variety of other animals (including both species of *Tayassu peccaries*), into the Wonga-Wongue Presidential Hunting Reserve in Gabon is of relevance in this context, as these animals are not only reported to be surviving but to have hybridized with native river hogs, *P. porcus* (Nicoll and Langrand, 1986). A similar cross between a male bushpig, *P. larvatus*, and an escaped domestic sow is also cited by Skinner and Smithers (1990), though it is not known if these hybrids are fertile.

Habitat, Ecology and Behavior

The importance of wild pigs as a basic resource lies as much with their remarkable adaptability as to the fact that they are one of the most prolific suppliers of meat for human consumption. They are clearly tolerant of regional climatic conditions ranging from sub-Antarctic to tropical and, given their highly omnivorous diet, they are also able to exploit a wide array of available habitats. In Jamaica, feral pigs presently survive in conditions ranging from xeric scrub-forest, salt marsh and mangrove woodland at sea-level to wet montane forest at elevations exceeding 2,000 m; these habitats also representing local climatic extremes in terms of average seasonal temperatures and annual rainfall (Oliver, 1984b).

S. scrofa-type pigs are also able to reproduce at a much higher rate than any other ungulates. They generally attain sexual maturity at age six months to one year, and they are relatively long-lived. Under favorable conditions, domestic and feral sows are polyestrous and often produce two litters of up to eight or more young per year. Dzieciolowski *et al.* (1992) recorded a mean litter size of only 6.2 amongst feral pigs in New Zealand, but have noted a third pregnancy within 12 months and that captive feral sows were capable of producing 3 litters in a 14 month period. Hunting pressure and infant mortality are the most critical factors in determining population growth, though Wood and Barrett (1979) estimated that (unless controlled) the feral pig population in the U.S. could be expected to increase by a factor of 33% per annum, even with a 90% mortality of young pigs, given a conservative average of two litters of five young each per year. Tisdell (1982) felt that this would be an underestimate if applied to Australia, and suggested that the feral pig population could be expected to increase by up to 60% per annum given the comparative remoteness of some areas and the general absence of effective predators apart from man. Either way, these rates are considerably in excess of that normally attained by native S. scrofa, which is generally limited to a single breeding season, whereas its descendant ferals often breed year-round in more equable climes.

In these circumstances, their potential for successful colonization is obviously phenomenal. Wild pigs first introduced into New Zealand in 1769, had become so well established soon after the turn of the century that they were considered a scourge by sheep farmers. By the 1860's, they had ..."accumulated in such vast numbers in uninhabited valleys that experienced pig hunters took out contracts for their suppression" (Hutton and Drummond, 1904). In the United States, it has been estimated that the total number of wild pigs was between 0.5 and 1 million animals in Texas alone (Jackson, 1964), and these animals (including introduced Eurasian wild pigs and their hybrid derivatives) now range over sixteen states (Mayer and Brisbin, 1991). These are harvested in some states where they have game status. In Florida, for example, an estimated 77,500 animals were taken in the 1976-77 hunting season, whilst 32,100 were taken in California during the same period (Wood and Barrett, 1979). In New South Wales, Tisdell (1982) has estimated that amateur hunters account for at least 150,000 feral pigs per annum, and that the kill rate for Australia as a whole is in the region of 0.5 million pigs per annum. Even so, this is probably only a fraction of the potential sustainable harvest of the Australian feral population, which has been estimated at between 5 and 10 million animals. A substantial international trade in the meat of animals killed in New South Wales and south-west Queensland has been therefore been developed to meet shortfalls in the gourmet demands for wild pork in Japan. In 1984, for example, this trade resulted in the export to Japan of more than 2 million kg of Australian feral pig meat, with a value at the point of export of AU$10 million (Takahashi and Tisdell, 1989).

The widespread introduction and naturalization of these animals has had a generally disruptive and negative impact on agriculture, forestry and, particularly, native wildlife. This has been especially true on oceanic islands with a high rate of endemism and where specialized forms have evolved in the absence of major predators and competitors. The degradation and extinction of faunal and floral elements in these fragile communities has often been attributed to direct or indirect destruction by pigs and diverse other exotic species (see below). Their impact on the ecology of continental habitats and native species is frequently less overt, at least in terms of attributable extinctions, but may nonetheless be significant and is invariably deleterious.

In the United States, feral pigs are regarded as livestock or game species by different agencies and interests, but the undoubted consensus of opinion is that they are a nuisance if not a major environmental pest. The U.S. Forest Service, for example, regards feral pigs as undesirable because they destroy pine seedlings and compete with native species for the mast crop. They also damage ditch lines, riverbanks, forest roads and recreation areas, and they can be dangerous to the public (Belden and Frankenberger, 1977). Similar biological and economic considerations have led the U.S. Fish and Wildlife Service to treat feral pigs as exotic pests and to carry out active control programs on many federal lands (Mayer and Brisbin, 1991). This agency has further identified pig damage to include: disruption of natural plant communities and successional sequences; damage to agricultural crops planted for wildfowl; predation upon various small vertebrates and the eggs and young of ground-nesting birds; and damage to fencing and water control structures (Thompson, 1977; Springer, 1977).

In temperate climates, feral pig diets vary seasonally, with the pattern described by Wood and Roark (1980) being typical of studied populations: fruits and mast, primarily acorns, being the most common food items in the autumn and winter, with new grasses becoming predominant in the diet in the spring and roots, tubers, various herbs and foliage becoming the most important foods during the summer months. In warmer and less seasonal climates, diets probably include a combination of all of these foodstuffs on a year-round basis, according to local availability. Nonetheless, their ability to eat practically anything not only results in direct competition with a wide variety of native wildlife species, but is also reflected in their being effective, if opportunistic, predators. Stomach content analyses of feral pigs in the U.S. have yielded remains of various birds, rodents, rabbits, fawns, piglets, terrapins, snakes, frogs, salamanders, small fish and a large number of invertebrates. The extent to which larger-bodied species are predated or eaten as carrion is not clear, although feral pigs have been observed feeding on the carcasses of adult deer, fawns, cattle and other pigs. On Auckland Island, off New Zealand, feral pigs are known to scavenge dead penguins, sea lions and even beached whales (C. Clarke, pers. comm.). In Argentina, feral pigs have even been reported to attack and kill newborn cattle (R. Lourival, pers. comm.), whilst in Australia these animals are now well known for their depredations on flocks of lambing ewes and bounties are paid for their control. Pavlov and Hone (1982), for instance, observed lambs to be killed in 10 of 42 observed chases, and that one individually identifiable boar was seen to kill five lambs during one lambing season.

As indicated in the latter example, such behavior tends to be confined to a few offending individuals in the population, and the consumption of vertebrate prey may be a relatively rare event in most feral pigs whose diet, under normal conditions, consists mostly of plant material in all seasons (Springer, 1977). Wood and Barrett (1979) also felt that wild pigs were essentially opportunistic predators, but that they could still pose a serious threat to some animal populations, particularly in concentrated nesting areas. Thus Merton (1977) records that feral pigs were so destructive to nesting seabirds on biologically important islands in New Zealand that they had to be eradicated by poisoning and hunting with trained dog packs. On Mona Island, Puerto Rico, Wiewandt (1977) found that predation by feral pigs of the nests of the threatened ground iguana (*Cyclura stejnegeri*) averaged 25% per annum, but rose to 100% in excessively dry years. Predation by feral pigs is also regarded as one of the principal threats to the nesting sites of various threatened species in the Galapagos Islands, including dark-rumped petrels (*Pherodrama phaeopygia*), green turtles (Chelonia mydas) and giant tortoises (*Geochelone elephantopus* ssp.). These pigs are also known to predate young giant tortoises (up to a weight of 25 lbs = 11.3 kg.), which has delayed restocking programs until hatchlings have achieved a good size (MacFarland and Reeder, 1975). Similarly, predation by introduced bushpigs, *P. larvatus*, is regarded by Juvik *et al.* (1981) as the primary threat to the endangered Malagasy tortoise, *G. yniphora*, and current plans to protect the most important remaining population site of this species in N. W. Madagascar will have to include measures to exclude these pigs (L. Durrell, pers. comm.). In the Mascarene Islands, feral pigs, together with a host of other introduced species, are implicated in the direct and widespread extinction and endangerment of most of the endemic avifauna, some of the herpetofauna, and have facilitated the spread of various exotic plants, such as guava

(*Psidium* spp.) and brambles (*Rubus* spp.), which are transforming the little remaining native vegetation (C. Jones and W. Owadally, pers. comm.).

Position Statements on Introduced and Feral Pigs

In view of the essentially negative impact of almost all naturalized pig populations on their environments, the Pigs and Peccaries Specialist Group considers that:

1. *Wild pigs or peccaries of any species or subspecies (or their domestic or feral derivatives) should never be deliberately released to range freely outside their known, recent and original distribution, and that all possible efforts should be made to prevent the accidental naturalization of domestic or wild populations of these animals.*

The only, presently conceivable, exception to this might be in the event that such an 'introduction' was considered essential to the future survival prospects of a wild species or subspecies that was extinct or seriously threatened throughout its original known range; and: a) neither of the preferred alternatives of 'reintroduction' or 'translocation' were possible or practicable, and b) available information was sufficient to indicate that the any such introduction would not prejudice the survival prospects any other threatened organisms/communities which were native to the proposed introduction site.

2. *That all existing naturalized populations should be regarded as exotic pests which should be controlled, reduced in numbers or eradicated wherever possible and appropriate; unless and excepting those (genetically isolated and threatened) populations which are considered to be of sufficient importance to warrant their continued in-situ conservation based on one or more of the following criteria:*

   a. *Representation of otherwise extinct or endangered taxa – i.e. the population(s) is/are known (or considered likely) to represent the sole or otherwise critically important remnant(s) of a scientifically valid wild taxon which is endangered or extinct throughout its original known range.*

   b. *Anthropogenic or socio-economic significance – i.e. the population(s) has/have particular religious or other cultural significance to local people and/or represent an essential basic economic (subsistence, rather than commercial or recreational) resource.*

   c. *Unique genetic importance – i.e. the population(s) is/are known (or considered likely) to possess a unique genetic trait or traits of potential resource value for future husbandry or other legitimate scientific purposes. Evidence should exist to indicate that any such population has had an extended history of existence in the naturalized state (usually at least several hundreds of years), during which time it may be expected to have become adapted to local environmental conditions and*

should have been essentially free from genetic contamination through hybridization with other native, naturalized or domesticated forms.

It is also suggested that any threatened naturalized populations which fulfill criteria A) and/or B) (above) should be conserved in-situ, unless it is demonstrated that their continued presence is in conflict with other threatened, native taxa and communities; whereas naturalized populations which only fulfill criterion C) (above) should be conserved in-situ only if it can be demonstrated that their continued presence is not in conflict with other native taxa and communities.

Threats to the Survival of Selected Priority Populations

In accordance with the criteria and priorities stated above, the following introduced or feral populations are known to be threatened and are considered to be of sufficient importance to merit particular conservation attention:

1. The Buru and Sula Islands' babirusa, *Babyrousa babyrussa babyrussa*.

   Status category: 5 (endangered). As previously stated, these animals, which are otherwise known as the 'golden' or 'hairy' babirusa on account of their unusually long (<5 cm) yellowish pelage, are known only from Buru and the Sula Islands of Taliabu and Mangole (Fig. 16). The available, if mostly circumstantial, evidence suggests that these populations were introduced, possibly from southern Sulawesi where the species is now extinct (Groves, 1980). Very little is known of their status on either Taliabu or Mangole, although recent reports and remains have confirmed their continued existence on these islands. If babirusa ever occurred on the only other large island in the Sula group, Sulabesi, they are now almost certainly extinct as this island has been virtually deforested. Their present status on Buru is also poorly known. Reports obtained in 1990 indicated that this population had declined in recent years, but that there were still 'reasonable' numbers in some parts of the island. A large area in the west of the island has been designated for protection, but logging in the north and the resettlement of immigrant people from Java in the east, are putting severe pressure on remaining habitat in these areas (also see Macdonald, this vol., section 5.8).

2. The Andaman and Nicobar Islands' feral pigs, 'ex-*Sus scrofa*'.

   Status categories: Andaman Islands: 5 (endangered); Nicobar Islands ? (indeterminate). The wild pigs of the Andaman and Nicobar Islands comprise a small series of genetically isolated populations which, in terms of their diminutive size (35-40 kg) and various other diagnostic characters, are distinct from all other regional populations of S. scrofa derivation. The Andaman pigs have also diverged into at least two distinct morphotypes, i.e. 'long-snouted' and 'short-snouted' forms, which both occur on Little Andaman Island, though it is not known whether these are genetically dimorphic or sympatric. Unfortunately, however, it is doubtful if many of the original Nicobar Islands' populations still exist as pure-bred forms following importations of modern domesticates and the genetic continuity of the domestic and feral populations

in the principal inhabited islands, where domestic sows are often mated to wild boars (Mathur, 1967). However, these populations are of extreme importance to the cultures and economies of these people (Mathur, 1967; Oliver, 1984a; Oliver *et al.*, this vol., section 5.9), and it is possible that remnant, purebred populations of ancestral type survive on some of the smaller, uninhabited islands (R. Whitaker, pers. comm.).

Both the Andaman and Nicobar populations were generally assumed to be endemic, and they are accorded full legal protection by their Schedule 1 categorization under the terms of the Indian Wild Life (Protection) Act, 1972. In fact, both are certainly feral, though midden deposits in the Andamans indicate that they were introduced at least 2,000 years ago (P. Dutta, pers. comm.). During this period these pigs have evidently evolved as an integral component of these biologically important, but now seriously threatened insular ecosystems, which also include some of the most isolated tribal societies in the world. These are the Jarawa, Sentenilese and the (nearly extinct) Andamanese and Onges negritos, whose hunting cultures are linked intimately with the wild pigs, which are a primary food resource and may also have ritual and religious significance. Unfortunately, the negritos and their wild pigs are now seriously threatened by increased contacts with more recent immigrant groups, and high levels of deforestation from logging, agricultural encroachment and other developments (Whitaker, 1988). In addition, the wild pigs are subject to increasing pressure from immigrant poachers who use more efficient hunting techniques, including firearms, snares and dogs, as compared to the indigenous negritos with whom they are in direct competition for these diminishing resources. Recent proposals to promote the interests of the negritos have included suggested gifts of domestic pigs (Tewari, 1984), which could pose a further serious threat to the wild pigs through genetic contamination and/or disease (Oliver, 1984a,b).

3. Simeulue Island and other selected 'ex-*Sus celebensis*' ferals.

The revelation by Groves (1981) that the dwarf feral pigs of Simeulue Island (N. W. Sumatra), the so-called *'Sus mimus'*, are a highly modified form of *S. celebensis*, also provided clues to the origins of the island's human inhabitants, whose language is most closely related to Buginese or other south Sulawesi dialects. Shortly before the publication of Groves' review, MacKinnon (1981) reported that the Simeulue pigs were threatened, and urged that their taxonomic status be clarified with a view to the establishment of a suitable reserve in the event that they were found to be a distinct species. Although this is not the case, the Simeulue pigs are still of considerable scientific, especially anthropogenic, interest and they are of undoubted socio-economic importance to the present-day Simeuluese, whose forefathers were presumably responsible for their introduction. Therefore, despite their feral status, these pigs have been cited as one of the reasons for the creation of the proposed Pulau Simeulue Game Reserve (26,750 ha), which will also protect an endemic subspecies of macaque (*Macaca fascicularis fuscus*), and an important endemic avifauna and entomofauna (WCMC, 1991).

Other populations of wild pigs referred to as feral (and/or domestic) *S. celebensis* are known from the neighbouring island of Nias, and from Halmahera and Buru (Moluccas), and Flores, Timor, Lendu, Roti and Sawa (Lesser Sunda Islands (Groves, 1981; MacKinnon, 1981; Macdonald, this vol., section 5.7; Fig. 15). However, available data is insufficient to assess the present and possible future management needs of most these populations, or their socio-economic significance to local people.

4. Ossabaw Island feral pigs, 'ex-S. scrofa'.

Unlike all of the aforementioned examples, the dwarf feral pigs of Ossabaw Island, S. E. USA, are of far more recent origin (i.e. <400 years) and they are of little or no ethnic or socio-economic significance. However, in view of their genetic isolation (Smith *et al.*, 1980) and their accessibility for detailed study, they are of considerable interest to basic and applied research in a number of fields, including reproductive biology, biochemistry and endocrinology, as has been detailed elsewhere (Brisbin, 1989; Mayer and Brisbin, 1991; Miller and Hedrick, 1991).

However, Ossabaw Island is now part of the State of Georgia's 'Heritage Trust Program', and the continued existence of these animals as a free-ranging population must be contingent on their numbers being managed to ensure that they do not pose a threat to any of the island's native ecosystems and species, especially the nesting sites of loggerhead turtles (*Caretta caretta*). Present control measures should therefore be intensified with a view to the removal of these animals from all ecologically sensitive areas or to some other location. Currently (1991), between 50-100 captive Ossabaw pigs are held by private owners and public institutions in the U.S., though this stock is derived from only 14 founders (Mayer and Brisbin, 1991), and a studbook is maintained by the American Minor Breed Conservancy (Heise and Christman, 1989).

With the exception of the Ossabaw Island pigs, all of these populations are threatened by habitat destruction and, to varying degrees, by increased hunting pressure and/or hybridization and disease contagion from more recently imported domesticates. Available information suggests that they are each of sufficient biological or anthropological importance to warrant special efforts being made to protect representative populations in-situ and, indeed, that the existence of some of these populations has often been cited as a reason for the establishment of protected areas within their respective ranges, but that existing or proposed reserves within these ranges are inadequate, or inadequately protected, at the present time. By comparison, the Ossabaw pig is not threatened at present, but its future is uncertain unless the population is confined or managed to minimize its impact on the ecology of this island.

Within the context of this review, it is clear that the Buru and Sula Islands' *B. b. babyrussa*, merits particular concern in that it is not only recognized as a distinct taxon, but that available data indicate that it also represents an otherwise extinct form of a globally threatened species of considerable interest and conservation concern. All of the other, currently prioritized forms are of relatively ancient derivation and now exist as

pure-bred feral and/or domestic populations which, by virtue of their small body size and various other characters, are of potential importance as genetic resources for the further domestication of one of man's most important sources of animal protein. All of the S. E. Asian populations of Sus are also of particular socio-economic importance to surviving tribal societies. These considerations involve a range of issues of relevance to a wide variety of scientific disciplines, including anthropology and archaeozoology, biogeography, animal genetics and husbandry, and conservation biology, as well as basic and applied research interests in the physiological and biomedical sciences. However, further research is required on almost all of these topics before the resource potential and future management needs of these populations can be properly assessed and appropriate conservation measures implemented.

Conservation Measures Proposed:
An Action Plan for Selected Populations

As previously emphasized, the overwhelming majority of naturalized populations of pigs should be regarded as exotic pests, which should be managed on a 'damage limitation' basis and strictly controlled, reduced in numbers or eradicated, wherever possible or appropriate. Those (few) selected populations described above (or others not yet identified which may meet the criteria suggested herein) should therefore be regarded as exceptions which prove this rule. Conservation measures directed towards these few populations should, where possible, take into account any cultural and economic requirements of legitimate ethnic groups, and these populations should continue to be managed in-situ, providing their continued presence is not in conflict with the survival prospects of other threatened and native species or natural communities. In the latter event, the protection of threatened native species and communities should take precedence over those of threatened naturalized populations which should, if possible, be relocated to less sensitive environments and/or managed as captive populations. In accordance with these criteria the following actions are recommended for the aforementioned selected populations:

Priority Projects:

1. Buru and Sula Islands' babirusa, *B. b. babyrussa*.

Field surveys of Buru, Taliabu and Sulabesi (Sula Islands) are required, perhaps as a matter of some urgency, in order to determine the current distribution and conservation status of this taxon, and to explore options and possible locations for longer-term field studies. Data on hunting and other threats, such as logging and agricultural encroachment, should be collected and analyzed with a view to an assessment of their magnitude and the development of recommendations for the enhanced protection of representative populations on each island. Strong support should be given for the early establishment of the proposed reserves on Buru and Taliabu, and the possibility of establishing a similar reserve on Mangole should be investigated. The neighbouring island of Sulabesi should be visited to ascertain whether any babirusa survive there.

The possibility of setting-up a properly structured captive-breeding program should be investigated, given that the available data suggest that this is the most threatened subspecies of babirusa, as well as the least known and most distinct morphologically. (Also see Macdonald this vol., Section 5.8).

2. Andaman and Nicobar Islands' wild pigs.

High priority should be given to a joint zoological - anthropological survey of all islands known to support populations of wild pigs, with a view to: a) ascertaining their present (and, where possible, recent) distribution and status; b) the nature and relative degree of threats to their survival; c) conducting interviews with hunters and tribal leaders concerning hunting methods, numbers of animals killed, their economic importance, traditional beliefs and cultural practices associated with wild (and/or domestic) pigs, and collection of anecdotal data on the biology and ecology of the wild pigs; d) collection of hard and soft tissue specimens from hunter-killed animals for analyses of their regional genetic variation and systematic affinities, and e) the development of longer-term studies of the ecology and behavior of these animals in selected (comparative) locations and, especially, their importance to the culture and economies of the various tribal groups of these islands. Recommendations for the enhanced future protection of representative populations of wild pigs, based on these findings, should be given high priority, but any such recommendations must take the legitimate rights and needs of the original human inhabitants into account, as well as the possible negative impact of these pigs upon other threatened endemic species.

3. Simeulue Island pig and other feral *S. celebensis*.

Field studies and surveys are required on Simeulue, Nias and other selected locations, especially in the Moluccas (e.g. Halmahera) and the Lesser Sunda Islands (e.g. Timor, Flores, Lendu, Roti and Savor), in order to clarify the distribution, status and systematic affinities of the various domestic and feral populations of S. celebensis origin in these areas. Particular emphasis should also be placed on anthropological components of these surveys, which should include investigations of possible relationships between the ethnic origins of local tribal groups and the distribution patterns amongst wild pigs of varying derivation, the socio-economic importance of these animals to these people, and their cultural traditions with respect to the hunting and husbanding of pigs and other livestock. These pigs are also of interest in genetic resource terms, and the introduction of 'improved' breeds should be actively discouraged in all areas where purebred, ancient domestic or feral populations survive. Support should be given for the early establishment of protected areas within the ranges of these forms, but management plans should also address the possibility that feral pigs may need to be actively managed to control population numbers in well-protected sites and/or remove these animals from ecologically sensitive areas.

4. Ossabaw Island feral pig.

Although this population is of sufficient importance to merit efforts being made to conserve it, it should not be allowed to range freely in any areas where its presence may impact negatively on the island's native ecosystems and species. Further research is required on the impact of these pigs on these communities, but they should certainly be excluded from all ecologically sensitive areas. This could be achieved by setting up fenced exclusion zones or confining a reduced population of pigs in a least-sensitive area. Unfortunately, Ossabaw pigs are also known to carry pseudorabies and vessicular stomatitis, which may negate the possibility of translocating a wild (sub)population to the mainland and/or acquiring additional founders for the existing captive population. Current studies of the epidemiology of vessicular stomatitis on the Island, and the testing of procedures for the use of a vaccine to reduce the prevalence of pseudorabies in these animals should therefore be continued.

Acknowledgements

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<div align="center">Chapter 5.11</div>

Review of Priorities for Conservation Action and Future Research on South and Southeast Asian Suids.

Raleigh A. Blouch and William L. R. Oliver

Introduction

Suid conservation in South and Southeast Asia is especially complex because all seven species of *Sus* plus the three subspecies of *Babyrousa* are found here coexisting and interacting with a wide array of human cultures. The various attitudes of these local people towards wild pigs strongly influence the success of conservation programs. At one extreme, some villagers despise wild pigs as unclean animals to be shunned, or as agricultural pests competing with them for food; whereas other cultures regard wild pigs as invaluable sources of protein or as prized hunting trophies. Some such situations cause problems for suid conservation, but others provide opportunities for biologists to devise sustained yield management strategies designed to benefit local people while conserving the wildlife.

Although it is often unwise to generalize about such a diverse group of taxa over such a large region as South and Southeast Asia, it is safe to say that the creation and proper management of protected areas is vital to the long term survival of many of these animals. The continued survival of some of the less adaptable species is directly related to the broader issue of conservation of habitats, particularly tropical rain forests and tall grasslands. Indeed, for species such as the pigmy hog complete protection both inside and outside of national parks and wildlife reserves is the only management option open at present.

On the other hand, some taxa of wild pigs are adaptable and productive enough to support a level of hunting, and in these cases there is a need to find out what those levels are for each population and ensure that they are not exceeded. Currently, such basic biological information as distribution, numbers, mortality rates and fecundity is lacking for almost all populations. Clearly, ecological research and estimation of current annual rates of harvest are needed for many populations in order to devise effective management strategies. Trained wildlife personnel to formulate and enforce the required regulations are also a priority.

Whilst certain research and management recommendations pertaining to selected native and introduced populations of *Sus scrofa* elsewhere are identified in preceding chapters 5.2 and 5.10, this review is confined to South and Southeast Asia because the overwhelming majority of relevant taxa and all currently perceived conservation action priorities are concentrated in these regions.

Objectives

1. To assess the distribution, status and management requirements of populations which may be at risk due to habitat destruction or over-exploitation.

2. To create and expand protected areas to include greater numbers of those taxa which have restricted ranges or low populations.

3. To implement management policies designed to conserve taxa at risk existing outside protected areas. These would include modification of land use practices to conserve vital habitats, and promotion of public awareness of the need for suid conservation in particular and nature conservation in general.

4. To develop sustained yield management systems for those populations which can support harvesting. This would require initial monitoring, and eventual regulation or elimination, of market hunting.

5. To promote captive breeding of threatened taxa, as an insurance against possible extinction, for research and public educational purposes, and as a potential source of animals for reintroduction to the wild.

6. To encourage ecological, behavioral, and genetic studies with a view to increasing our understanding of the biology and interspecific relationships of the wild suids.

Conservation Action Priorities

A. Conserve Taxa at Risk

Those suid taxa which have been included in status categories 4 (vulnerable), 5 (endangered) or 6 (critically endangered) must receive priority for conservation action. In addition, one species and two subspecies currently classified as status category 3 (rare), and one species and several insular feral populations categorized as 'indeterminate', are deserving of attention because so little is known of their current status. Based on the information now available the taxa most at risk are:

- *Sus salvanius*   -   status category 6

- *S. cebifrons*   -   status category 5

- *Babyrousa babyrussa*   -   status categories 4 and 5, according to ssp.

- *S. scrofa riukiuanus*   -   status categories 4 and 5, according to population

- *S. verrucosus*   -   status category 4 (both subspecies)

- *S. barbatus oi*　　　　-　　　　　status category 3

- *S. b. ahoenobarbus*　　　　-　　　　　　status category 3

- *S. philippensis*　　　　-　　　　　status category 3

- *S. bucculentus*　　　　-　　　　　Indeterminate (extinct ?)

- *S. scrofa* (ancient feral pigs　　-　　　　　Indeterminate.
of the Andaman and Nicobar Islands)

Actions needed to improve the conservation status of these taxa are summarized below :

1. Conduct field surveys to determine the present distribution, status and threats to the survival of *S. salvanius*, *S. cebifrons*, *B. b. togeanensis*, *B. b. babyrussa*, *S. s. riukiuanus*, *S. v. blouchi*, the Madura population of *S. v. verrucosus*, *S. b. ahoenobarbus* and *S. b. oi*. Recommend and (where possible) assist the implementation of immediate management actions for populations identified as being important for the survival of their representative taxa. The ancient feral pig populations of the Andaman and Nicobar Islands are also considered to merit high priority in this context.

2. Promote and otherwise assist current proposals to create or expand effectively protected areas containing existing populations (or areas suitable for the reintroduction) of *S. salvanius*, *S. cebifrons*, *S. s. riukiuanus*, *S. verrucosus*, *S. barbatus*, *S. philippensis* and *B. babyrussa* (see 'action plan' recommendations for these taxa in preceding chapters 5.2 to 5.8 for details of these areas).

3. Establish properly structured captive breeding programs for *S. salvanius*, *S. cebifrons, S. s. riukiuanus*, *S. v. verrucosus* and *S. v. blouchi*, *B. b. babyrussa* and *B. b. togeanensis*, through the acquisition of sufficient (>12) wild-caught founders, and the long-term, collaborative management of these animals, preferably under common ownership, through the participation of several, actively cooperating institutions.

4. Promote and assist development of local conservation education projects to increase awareness of the need for nature conservation in general and the conservation of particular taxa, especially *B. babyrussa*, *S. cebifrons*, *S. s. riukiuanus*, *S. verrucosus*, *S. barbatus*, *S. philippensis* and the *S. scrofa* feral populations of the Andaman and Nicobar islands.

5. Increase law enforcement efforts with a view to eliminating the (currently) intense hunting pressure on the few remaining populations of *S. cebifrons*, the poisoning of *S. verrucosus*, the continued payment of government bounties for the killing of *S. s.*

riukiuanus, and commercial trade in the meat of the latter animals and of *B. babyrussa*.

6. Investigate the possible continued existence of *S. bucculentus* (known from only two skulls collected in southern Vietnam in the 1890's) and assist development of management plans for the future protection of any surviving populations.

B. Encourage the Rational Management of Healthy Suid Populations

For healthy suid populations which are at no immediate risk of extirpation, hunting on a sustained yield basis is a viable management option. There are several benefits to be derived from such hunting if it is properly controlled:

1. It provides an inexpensive source of protein to local people.

2. It allows villagers to exercise some control over crop-raiding pigs.

3. It provides income for local people from sport hunters who spend money on guides, food and lodging.

4. As a valuable non-timber forest product, wild pigs can be an incentive to conserve forests, rather than convert them.

5. It provides recreational opportunities for city dwellers, land owners and decision-makers, many of whom are sport hunters.

Although wild pigs of virtually all taxa are subject to varying degrees of hunting pressure, the overwhelming majority of wildlife management authorities lack adequate personnel, training or equipment to monitor and regulate the harvests properly. This is not a major problem in those areas where suid populations remain relatively abundant at current levels of exploitation, but excessive hunting pressure is a definite threat to the existence of some taxa and should be eliminated or much more rigorously controlled. A goal of local wildlife authorities should be to determine which suid populations fall into the latter category and to impose and enforce scientifically based hunting regulations.

The taxa having at least some populations with potential to be managed for a sustainable harvest *include S. scrofa*, *S. barbatus*, *S. verrucosus*, *S. philippensis*, *S. celebensis* and most, if not all introduced and feral populations of *S. scrofa* and/or *S. celebensis* origin. Most of these taxa/populations are currently under pressure from subsistence, sport and/or market hunting. Subsistence hunters rely on wild pig meat as an important part of their diet and these are usually the most numerous class of hunter. Sport hunting is mostly quite limited, but market hunting is also common in some areas and poses a potentially serious and growing threat to some populations.

Although each situation is different and demands its own management approach, priority actions for the development of management programs for non-threatened suids may be summarized as follows:

1. Initial surveys must be conducted to identify pig populations which are subject to significant hunting pressure and are which will require management to ensure they maintain sustainable numbers.

   For some taxa, such as *S. b. barbatus*, *S. s. vittatus* and *S. s. leukomystax*, *S. v. verrucosus*, *S. celebensis and B. b. celebensis*, this work has begun, but little or no progress has made on this for many other taxa, including *S. b. oi*, *S. b. ahoenobarbus*, *S. philippensis* and most other Asian subspecies of *S. scrofa*.

2. The type(s) of hunting activity on each population should be investigated, since this will determine future management policy and requirements.

   For example, subsistence hunting is of primary importance with *S. barbatus*, *S. cebifrons*, *S. philippensis* and many introduced and feral *S. scrofa* and *S. celebensis* populations; market hunting is known to affect many populations of *S. s. vittatus*, *S. v. verrucosus*, *S. celebensis* and *B. b. celebensis*; and sport hunting is of primary importance to *S. s. leucomystax* and some populations of *S. s. vittatus* and *S. v. verrucosus*.

3. Reliable and easy-to-use methods must be devised to gather data on pig population parameters, such as number, fecundity, and sex and age ratios.

   Whilst these data may be difficult to obtain from observational studies of wild pigs in their natural habitats, counts can be made of animals visiting waterholes or saltlicks or, at night with spotlights, those feeding in agricultural areas. Much invaluable data for an understanding of population dynamics may also be gathered from hunter-killed animals, particularly those brought to markets for sale, such as *S. scrofa riukiuanus*, *S. celebensis* and *B. b. celebensis*. Whatever methods prove most successful will need to be repeated at regular intervals to monitor the effectiveness of any management strategies.

4. Monitor the number of pigs killed annually.

   This has been done in Sarawak for S. b. barbatus by indirect methods such as determining the number of shotgun shells sold and the amount of wild pig meat purchased at rural schools. Direct surveys of hunters and markets will also prove useful in many cases.

5. Determine the number of wild pigs to be taken annually, basing this on population data, and establish an equitable method of distributing the hunting rights. A system for the enforcement of these regulations will be necessary.

Whatever system is implemented will also need to take into consideration the traditional ways in which the local people have exploited these pigs. For example, a quota of permits may be issued to a village or longhouse rather than to an individual hunter, and village headmen could be actively involved in enforcement. In order for any system of control to work properly, it will be essential that local people understand the need for sustainable management practices.

C. Personnel Training and Conservation Education

In most government agencies involved with the management of parks and wildlife in South and Southeast Asian countries, there is an evident need for more personnel trained in protected area and wildlife management. In order to obtain basic data necessary for the management of protected areas and wildlife populations, wildlife officials need a proper understanding of wildlife biology and ecology, as well as the ability to liaise effectively with local people and deal with the visiting public. These skills can be obtained only by facilitating their attendance at universities or academies, though relatively few of these in the region have relevant curricula, and by their participation in specialized training courses, preferably in situ.

Various training efforts have been developed in the region, but many more are required. Since 1986, the Smithsonian Institution in cooperation with the Malaysian Department of Wildlife and National Parks has conducted 7-week wildlife conservation training courses annually in Peninsular Malaysia, bringing participants mainly from Southeast Asia, but also from Africa and Latin America. The Gunung Batu Training Centre operated by the Indonesian Forestry Department in cooperation with the Dutch Government has been providing valuable wildlife training to rangers and middle management personnel from Indonesia and other countries for several years. The Wildlife Institute of India at Dehra Dun has initiated a wildlife biology curriculum with help from the Food and Agricultural Organization of the United Nations. However, obtaining funding for these training programs is a constant concern. Donor organizations such as the international aid agencies of the developed countries and the World Bank should be encouraged to provide such support and to facilitate the development of similar programs elsewhere in the region.

Environmental education programs aimed at the general public also needs to be given much higher priority by the relevant governmental and non-governmental agencies in the region. In the Philippines, for example, there is an almost complete lack of a conservation ethic or any understanding or appreciation of the natural environment of the country amongst the general public, or even amongst even to the most well-educated, land-owning and decision-making, classes - a factor caused, at least in part, by the widespread use in schools of imported text books. In this and many other South and Southeast countries, conservation issues receive very low priority and there is as yet little recognition, let alone popular support or pressure for improved environmental protection measures.

In the case of wild suids, there are particular problems in promoting their conservation in predominately Islamic countries or regions, and/or areas where wild pigs are perceived mainly as agricultural pests, but these issues can be addressed through conservation-education initiatives designed to allay prejudice and promote awareness of their very positive role in other cultures and the ecology of habitats to which they are native.

Future Research Priorities

Current knowledge of the suid taxa of South and Southeast Asia is mostly limited to the results of preliminary surveys conducted on some of the more obviously threatened species. There is a great pressing need for more research on the biology of all the taxa in order to obtain information necessary for the formulation of practical management decisions. A major constraint is the lack of trained local personnel to do this work. In addition, those scientists who are interested in wildlife research are only rarely interested in wild pigs, either because of cultural attitudes or because pigs lack the perceived glamour of some of the better known Asian mammals.

Commendably, western scientists have recently begun longer-term research into the biology of some of the wild Asian suids. However, a priority of these and any future studies should be to involve and train local biologists and wildlife personnel and to encourage them to conduct their own research projects on these animals. Far more applied research, on a wide range of scientific disciplines, is required as a matter of some urgency, and much of this research could and should be conducted by local scientists and field officers. The highest priority areas for such research include:

1. Field studies of the behavior and ecology of the least-known species, such as *S. salvanius, S. cebifrons*, *S. verrucosus*, *S. philippensis*, *S. celebensis* and *B. babyrussa*. Research into the population movements and dynamics, group sizes, diet and habitat preferences, and responses to hunting pressure and commercial logging, are especially relevant in this regard.

2. Development of techniques to give reliable indices or estimates of population sizes and compositions, applicable to all species, in order to formulate appropriate management strategies.

3. Study of captive animals, particularly of the least known species, which would complement field studies by providing information impractical to obtain from wild animals. These should include the accumulation and analyses of routine records data, as well as properly structured investigations into all aspects of the species' life history, its social and reproductive behavior, reproductive biology, nutritional physiology, pathology, etc.

4. Investigate the ecological and genetic relationships between taxa occurring sympatrically, namely: *S. scrofa cristata* and the highly restricted *S. salvanius*; *S.*

scrofa vittatus and the less abundant *S. v. verrucosus* (Java) and *S. b. oi* (Sumatra and Peninsular Malaysia), *S. celebensis* and the less abundant *B. babyrussa*.

5. Conduct zoological-anthropological surveys and studies wherever wild pigs (including introduced and feral populations), and/or semi-domestic and domestic pigs, are of prime importance to surviving tribal, particularly hunter-gatherer, societies. These surveys/studies should investigate the socio-economic importance of these animals to these people, and their cultural traditions with respect to the hunting and husbanding of these animals. Priority for such research includes the Andaman and Nicobar Islands, Simeulue and Nias Islands, the Moluccas, the Lesser Sunda Islands and New Guinea.

6. Further systematic, particular cytogenetic studies to determine the affinities of the various taxa, including feral and domesticated varieties, which may have been transported far from their place of origin. Priorities include the wild and ancient domestic pigs of the Philippines, Taiwan, Buru and the Sulu Is., the Moluccas, the Lesser Sunda Islands, the Mentawi Islands, Nias and Simeulue, the Andaman and Nicobar Islands, and Sri Lanka.