

- Paphos forest, Cyprus*. Unpublished PhD thesis, University of Edinburgh.
- MCPHEE, H. C., RUSSEL, E. Z. & ZELLER, J. (1931): An inbreeding experiment with Poland China swine. *J. Hered.* **22**: 393–403.
- O'BRIEN, S. J., WILDT, D. E. & BUSH, M. (1986): The cheetah in genetic peril. *Sci. Am.* **252**(3): 84–92.
- PEVET, P. (1987): Environmental control of the annual reproductive cycle in mammals. In *Comparative physiology of environmental adaptations: adaptations to climatic changes*: 92–100. Pevet, P. (Ed.). Basel, München: Karger.
- PFEFFER, P. (1967): Le mouflon de corse (*Ovis ammon musimon* Schreber, 1762): position systematique ecologie et ethologie comparées. *Mammalia* **31** Suppl.: 1–262.
- SCHALLER, G. B. (1977): *Mountain monarchs: wild sheep and goats of the Himalaya*. Chicago, London University of Chicago Press.
- SCHALLER, B. G. & MIRZA, Z. B. (1974): On the behaviour of Punjab urial (*Ovis orientalis punjabiensis*). *IUCN Publs* (N.S.) No. 24: 306–323. Morges: IUCN.
- SOULÉ, M. E. (1980): Threshold for survival: maintaining fitness and evolutionary potential. In *Conservation biology: an evolutionary-ecological perspective*: 151–170. Soulé, M. E. & Wilcox, B. A. (Eds). Sunderland, MA: Sinauer Associates.
- VALDEZ, R. (1976): Fecundity of wild sheep (*Ovis orientalis*) in Iran. *J. Mammal.* **57**: 762–763.
- VAN VUREN, D. & COBLENTZ, B. E. (1989): Population characteristics of feral sheep on Santa Cruz Island. *J. Wildl. Mgmt* **53**: 306–313.
- VOLF, J. (1975): Breeding of Przewalski wild horse. In *Breeding endangered species in captivity*: 263–270. Martin, R. D. (Ed.). London, New York: Academic Press.
- YEATES, N. T. M. (1949): The breeding season of the sheep with particular reference to its modification by artificial means using light. *J. agric. Sci.* **39**: 1–43.
- WIENER, G. & HAYTER, S. (1974): Crossbreeding and inbreeding in sheep. In *Animal Breeding Research Organisation report: January 1974*: 19–26. Edinburgh: Agricultural Research Council.
- WIENER, G. & WOOLLIAMS, J. A. (1980): The effects of crossbreeding and inbreeding on the performance of three breeds of hill-sheep in Scotland. In *Proceedings of world congress on sheep and beef cattle breeding*. Massey, NZ: Massey University.

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Threatened endemic artiodactyls of the Philippines: status and future priorities

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The Philippine archipelago, a vast array of over 7100 islands, supports a diverse fauna with an exceptionally high degree of endemism. Among the native mammals, for example, there is a higher percentage of endemism than any other biogeographic province in the Indo-Malayan Realm, one of the richest and most distinct of the biogeographic regions (MacKinnon & MacKinnon, 1986; Heaney *et al.*, 1987). Unfortunately the Philippines, already one of the most densely populated countries in the region, has one of the fastest growing human

populations in South-east Asia, one of the weakest protected areas systems and one of the worst records of deforestation (Collins *et al.*, 1991; Braatz, 1992). According to World Bank figures cited by Braatz (1992), about 90% of lowland forest in the Philippines has been lost in the last 30 years and only 5% of the land area remains under natural forest. These factors have combined to produce fears of unprecedented losses of biodiversity and species' extinctions (Braatz, 1992; IUCN/SSC, unpubl.) and belated recognition that the Philippines is one of the world's

highest priority countries for conservation concern (ICPB, unpubl.; IUCN/SSC, unpubl.; S. Stuart, pers. comm.).

One of the main reasons for the diversity and high levels of endemism is that the country straddles Wallace's Line and includes both Sundaic and Wallacean elements in its fauna. Palawan and its associated islands of Balabac and the Calamian group or the 'Palawan Faunal Region', is the easternmost extension of the Sunda Shelf, which includes Borneo, Java, Sumatra and the Malaysian Peninsula. As a result, many species in the Palawan region are found nowhere else in the Philippines, though many of these are quite widely distributed elsewhere in South-east Asia. Endemism, particularly at the species level, is therefore much lower in the Palawan region than in the rest of the country. East of Wallace's Line and north of Weber's Line is the Philippine biogeographic province *sensu stricto*. It includes most of the country's endemic species and is itself divided into at least four other regions or sub-centres of endemism (i.e., late Pleistocene islands). These are all faunistically distinct from Palawan and each carries its own complement of species: Luzon and its associated islands constitute the 'Luzon faunal region'; Mindoro and its satellite islets the 'Mindoron faunal region'; Samar, Leyte, Mindanao and associated islands the 'Mindanaon faunal region'; and the west Visayan islands of Panay, Negros Masbate, Cebu and associated islands the 'Negros-Panay (or West Visayan) faunal region' (Heaney, 1986) (Fig. 1).

While these divisions are basic to our understanding of the distributional relationships of the fauna, their significance to conservation has been appreciated only quite recently. Thus, there is relatively more forest remaining (or a larger percentage of that forest is within the existing protected areas system) in the Palawan, Luzon and Mindanaon regions, than in the Mindoron and, especially, in the West Visayan regions. It is no coincidence that all recently extinct Philippine

mammals and the majority of seriously endangered species are or were endemic to the latter regions while most of the few exceptions to this pattern have peculiarly restricted ranges or other idiosyncratic problems.

These factors are exemplified by the Philippine artiodactyls. Of the eight currently recognized species, at least five, possibly six are endemic, while the remainder are endemic at the subspecific level. Predictably, all the most endangered forms are from the West Visayas (*Cervus alfredi* and *Sus cebifrons*) or Mindoro (*Bubalus mindorensis*) or have highly restricted ranges (*Tragulus napu* and *C. calamianensis*). However, the precise distribution, current conservation status, ecology, behaviour, reproductive biology and future managements needs of most of these species remain poorly known or have been investigated only recently.

PHILIPPINE WILD PIGS

Recent studies have shown that there are at least three species of wild pigs in the Philippines, of which two, the Visayan warty pig *Sus cebifrons* from the west-central Visayas and the Philippine warty pig *S. philippensis* from Luzon, Mindanao and associated islands, are endemic (Groves & Grubb, in press; de Haan *et al.*, in press; Oliver *et al.*, in press). The third species, the Bearded pig *S. barbatus* is more widely distributed in SE Asia and has at least three subspecies. In the Palawan region, including Balabac and the Calamian Islands, it occurs as an endemic subspecies, *S. b. ahoenobarbus*, while the nominate form, *S. b. barbatus*, endemic to Borneo (Groves, 1981), is reported to occur in Tawitawi and Sibutu in the Sulu Islands (Caldecott *et al.*, in press) (Fig. 1). There are numerous, apparently reliable, accounts of wild pigs crossing the channel between Sabah and Sibutu, where they have sometimes been killed by fishermen. It has been alleged that on one occasion a large number of swimming animals were used for target practice by a US Navy battleship which

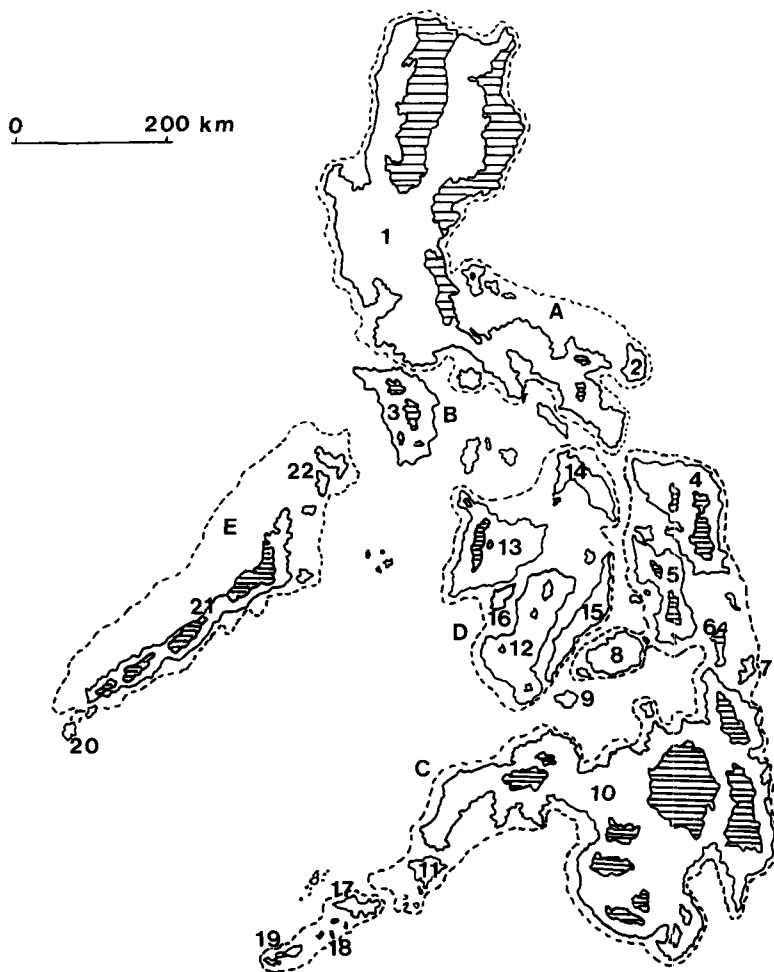


Fig. 1. The distribution of species in the Philippines. The shaded areas indicate the approximate extent of remaining forest with more than 40% crown cover. The dotted line indicates the 120 m bathymetric line. A. Luzon faunal region (*Sus philippensis*, *Cervus m. mariannus*); B. Mindoro faunal region (*Sus* sp./ssp., *C. m. barandanus*, *Bubalus mindorensis*); C. Mindanao faunal region *S. philippensis*, *C. m. nigricans*, *C. m. nigellus*); D. Negros-Panay (West Visayas) faunal region (*S. cebifrons*, *C. alfredi*); E. Palawan faunal region (*S. b. ahoenobarbus*). Islands: 1. Luzon; 2. Catanduanes; 3. Mindoro; 4. Samar (*S. philippensis*, *C. mariannus* ssp?); 5. Leyte (*S. philippensis*, *C. mariannus* ssp?); 6. Dinagat; 7. Siargao; 8. Bohol; 9. Siquijor; 10. Mindanao; 11. Basilan (*S. philippensis*, *C. mariannus* ssp?); 12. Negros; 13. Panay; 14. Masbate; 15. Cebu; 16. Guimaras; 17. Jolo; 18. Sulu Archipelago (*S. philippensis*, *C. nippon* (introduced)); 19. Tawitawi and Sibutu (*S. b. barbatus*); 20. Balabac (*S. b. ahoenobarbus*, *Tragulus n. nigricans*); 21. Palawan; 22. Calamian group (*S. b. ahoenobarbus*, *C. calamianensis*.)

encountered them while on patrol (Oliver, 1992a; R. Hilado, pers. comm.).

Status With three species and at least two subspecies of wild pig, the Philippines has a larger number of endemic suids than

any other country with the exception of Indonesia. However, the levels of deforestation, intense hunting pressure and inadequate and poorly enforced legal protection have resulted in the systematic decline of all populations. *Sus b. ahoeno-*

barbus is intensively hunted through its range (Caldecott *et al.*, in press) and the formerly extensive forests of Palawan have been greatly depleted by uncontrolled logging and agricultural encroachment (Quinnell & Balmford, 1988). Although *S. philippensis* has been extirpated over a greater proportion of its former range than *S. b. ahoenobarbus*, its range is far larger and includes some still relatively extensive tracts of forest on Luzon, Samar and Mindanao. There is, however, now very little forest remaining in the West Visayas where *S. cebifrons* is probably the second most endangered (after the Pygmy hog *S. salvanius*) of the suids (Oliver, 1992b; Oliver *et al.*, in press). The species is now extinct or close to extinction on five (Masbate, Ticao, Guimaras, Cebu and Sequijor) of the seven islands on which it is known or thought to have occurred, and is known to survive only in a few small isolated areas on Negros and Panay where all remaining populations are at risk.

Conservation The survival of *S. cebifrons* is intimately linked with the efforts now being made to conserve remnant wild populations of the Philippine spotted deer *C. alfredi*, with which it has a common distribution. Thus on Panay the species is confined to the remaining upland forests of the western mountains, part of which has been designated as a new national park (40 000 ha) for the protection of the largest surviving population of the deer. On Negros wild pigs are known to occur in the Northern Negros Forest Reserve (45 000 ha) of which less than half is still forested (L. Cayayan, pers. comm.), Mt Canlaon National Park (24 558 ha) and in scattered forest fragments in the south of the island, including the area surrounding Mt Talinis-Lake Balinsasayao (20 000 ha). However, in all these areas the pigs are still subject to intense hunting pressure and the continued attrition of their remaining habitat through illegal logging and the spread of agriculture. A captive-breeding programme is being initiated at

Silliman University, through the aegis of a formal 'Memorandum of Agreement' (MOA) between the Department of Environment and National Resources and the Zoological Society of San Diego, which has provided the majority of funds for the project. If the programme is successful, captive-bred stocks will be distributed to other reputable breeding centres, both nationally and internationally, under the aegis of breeding loan agreements. As with the protocol established for the 'Philippine Spotted Deer Conservation Programme', any such agreements will stipulate that the title of all founders and progenies will remain with the Government of the Philippines, while also requiring any participating (signatory) *ex situ* institutions to contribute funds or other assistance to relevant *in situ* conservation activities. These and related activities should include: continued support for development and extension of habitat protection and the captive-breeding and research programme for *S. cebifrons*; investigation of the systematic relationships, conservation status and future management requirements of the wild pig populations on Masbate, Ticao, Bohol, Sibuyan and Mindoro, all of which are threatened to varying degrees and which may represent new taxa; investigation of geographic/genetic variation in *S. philippensis*, which is likely to prove to be polytypic and may have endangered subspecies in the Sulu Islands and elsewhere; the expansion of education projects intended to promote increased interest in the diversity, conservation and management of the animals.

BALABAC CHEVROTAIN

The taxonomic status of *Tragulus (napu?) nigricans*, a distinct, dark-coated race, needs to be clarified, since this will inevitably influence perceptions of the priority rating for conservation of the taxon. It occurs as a native form only on Balabac Island, between Sabah (west) and Palawan (east). Its current conservation status is unknown, but it is likely to be

threatened through extensive deforestation and intense hunting pressure (C. Custodio, pers. comm.). There are unconfirmed reports of a naturalized population having become established in south Palawan (F. Panol, pers. comm.), where the animal is reputed to have been introduced on several occasions (Rabor, 1986).

A field status survey on Balabac is required as a matter of some urgency, with a view to the development of recommendations for the future protection of the remnant population, including the establishment of at least one protected area on the island. The species has been bred successfully in captivity on Calauit Island since 1982 (J. Gapuz, pers. comm.), although current plans to release surplus captive-bred animals on Balabac should be postponed until a suitable site for reintroduction, rather than restocking, has been identified. The potential for the development of a properly structured programme, with several co-operating institutions, should also be explored, particularly if this involved the formulation of a MOA ensuring the generation of resources for conservation action priorities on Balabac.

PHILIPPINE DEER

There are four species of deer in the Philippines (Heaney *et al.*, 1987), although one of these, *Cervus nippon* from Jolo in the Sulu Islands, is introduced, while the endemic Philippine rusa *C. mariannus* has been introduced into a number of other island groups. The most attractive species, the Philippine spotted deer or Prince Alfred's rusa *C. alfredi* was extremely poorly known until recently, but this was mainly due to its former designation as a minor variant of the widespread Sambar deer *C. unicolor*, which also included *C. mariannus*. However, in their review of the taxonomy of the Philippine deer, Grubb & Groves (1983) recognized *C. mariannus* and *C. alfredi* as separate species; the latter being a

highly distinct, monotypic form, endemic to the West Visayan faunal region.

Some controversy still surrounds the taxonomic relationships of the fourth species, the Calamian deer *C. calamianensis*, which is found on three of the larger islands (Busuanga, Calauit and Culion) and some islets in the Calamian group, in the Palawan faunal region (Fig. 1). It is a representative of the subgenus *Axis* and is closely allied to the Bawean deer *C. kuhlii*, which occurs only on Bawean Island, off north-east Java. Like *C. kuhlii*, *C. calamianensis* is considered to be a relict species, although it may be an introduced derivative of the Hog deer *C. porcinus* (L. Heaney, pers. comm.).

To an even greater extent than the suids, the deer are threatened by deforestation and, despite full legal protection, intense hunting pressure. Of the three endemic species, the Philippine rusa has the widest distribution with a range broadly conforming with *S. philippensis* and including the larger islands of Luzon, Samar and Mindanao, which still support relatively extensive tracts of rain forest. The Philippine rusa also occurs on several other islands in the east (Wallacean) Philippines, including Mindoro, Leyte and Basilan, although its status in these areas is much less secure. Four subspecies are provisionally recognized by Grubb & Groves (1983), *mariannus* (Luzon), *barandanus* (Mindoro), *nigellus* (upland Mindanao) and *nigricans* (lowland Mindanao and Basilan). The systematic affinities of the populations on Samar, Leyte and certain other islands are not yet known owing to the dearth of museum specimens from these areas. *Cervus mariannus* is not yet considered seriously threatened and is not included in the 1990 IUCN Red List of Threatened Animals (IUCN, 1990) but it is likely that *barandanus* at least, is at some risk over its restricted range in Mindoro and the present status of other forms, especially *nigricans*, needs to be investigated.

Throughout their more restricted ranges, *C. calamianensis* and, especially,

C. alfredi are undoubtedly highly threatened. The extent of the decline of the latter was not fully appreciated until 1985 when a three-month field survey revealed that this deer, like the Visayan warty pig, has been extirpated over at least 95% of its former range in the West Visayas and that remnant populations survived only in the Mt Baloy/Mt Madja-as area of west Panay and in a few fragments of remaining forest on Negros (Cox, 1987). The species was first listed by IUCN in 1988 (IUCN, 1988), when it was accorded Endangered status. More recent data from these areas indicate that continued deforestation and hunting pressure have resulted in further losses and that Philippine spotted deer have disappeared or are now functionally extinct in at least two areas (Basay and Bias) in Negros Oriental where they were known to occur in 1985 (pers. obs.).

Philippine Spotted Deer Conservation Programme Following the 1985 field survey, two priority recommendations for conservation action were agreed with the Protected Areas and Wildlife Bureau (PAWB) of the DENR, the creation of a new national park to protect the largest population in west Panay and the establishment of an international co-operative breeding programme. To implement these recommendations, the first formal international agreement for a species' recovery programme in the Philippines, the 'Philippines Wildlife Loan Agreement' (PWLA), was signed in 1987 by DENR and Mulhouse Zoo. Under the terms of the Agreement, which now applies to all wildlife species in the Philippines, West Berlin Zoological Society provided funding for a faunal survey and the development of a preliminary management plan for the proposed national park on Panay (Cox, unpubl.). Further work on the proposal is currently being undertaken by the relevant regional authorities of DENR (J. Amador, pers. comm.), but it is hoped that the new Panay Mountains National Park (40 000 ha) will be officially

gazetted in the near future and that funds for the future development and management of this area will be made available through its inclusion in the Integrated Protected Areas System (IPAS) Project (W. Dee, pers. comm.).

In 1990 the international captive-breeding programme was launched with financial assistance from Mulhouse Zoo and the Zoological Society of San Diego. The project involved the re-negotiation of the PWLA as a new MOA between DENR and the Mulhouse Zoo, which was signed in April 1990, and the creation of a Philippine Spotted Deer Conservation Committee to oversee the development of the programme. The programme was initiated with the establishment of two local breeding and rescue centres, one for animals of Panay origin (1.2 at Bitu Farm, Iloilo) and the second for those of Negros origin (2.1 at Silliman University) plus a breeding group of 3.4 (Negros origin) at Mulhouse Zoo (Oliver *et al.*, 1991). The animals were obtained, mostly by donation, from eight owners, who had purchased them from hunters and were keeping them as pets. During the next two years, seven wild-caught animals from seven private owners, 2.3 from Negros and 2.0 from Panay were acquired and six Negros young (1.1 at Silliman University and 2.2 at Mulhouse) and 2.0 Panay young were born. With the exception of a ♂ at Bitu Farm, all the young were reared but three founders (1.1 at Bitu Farm and 0.1 at Mulhouse) died. By the end of 1992, these three groups, which comprise the 'World Herd' and are maintained on breeding loan from the Philippine Government, had increased to a total of 11.9 animals of Negros origin and 3.1 of Panay origin. A preliminary studbook is being maintained at Mulhouse Zoo.

It is apparent that progress has been confined mostly to the Negros component, where Silliman University has been successful in obtaining additional wild-caught animals. Reports have been received of several other animals being offered for sale in the north of the island

(Negros Occidental) during the last two years and a second rescue and breeding centre is being established in north Negros in association with the Negros Forests and Ecological Foundation which will be managed in close co-operation with Silliman University. The new centre will also provide additional capacity for the long-term maintenance of the local breeding stock and facilitate a variety of conservation-education and research projects in Negros Occidental. In the interim, negotiations are under way for the relocation and development of the Panay centre, where the poor results are mainly attributable to lack of expertise and institutional support.

Other recent activities under the aegis of this programme include: the production and distribution of an education poster, featuring the spotted deer as a flagship species for the West Visayas, numerous talks and seminars for local students, land managers, decision makers and environmental non-governmental organizations by project personnel, and a one-day workshop on biodiversity conservation priorities in the region. The workshop was attended by representatives of relevant governmental and other agencies throughout the country and resulted in the formulation of a series of strong resolutions calling for a variety of protection measures, including the addition of all remaining forests and other wildlife habitats in the Negros-Panay faunal region within the protected areas system.

Calamian deer: present status and future management requirements The Calamian deer has been designated as Vulnerable by IUCN since the late 1970s after a field survey which revealed that, despite full legal protection, the species was intensively hunted on the two main islands of Busuanga and Culion and was unlikely to survive unless hunting was controlled and one or more reserves were established within its range (Grimwood, 1976, unpubl.). As far as is known no effective action was taken in response to the first of

these recommendations. However, a new reserve, the Calauit Island Game Preserve and Wildlife Sanctuary was established by Presidential Proclamation in 1976. This reserve comprises the whole of Calauit Island (3760 ha) but its creation involved the eviction of several hundred people who were resettled in two locations in south-central Culion Island. The Calauit 'Game Preserve' is so-called because it was primarily intended to accommodate founder stocks of eight species of African ungulates which were presented to the then President of the Philippines during his visit to Kenya in 1976. These animals were released onto Calauit the following year where they now number several hundred individuals.

A few Calamian deer also survived on Calauit and a further 30 individuals were released onto the island in 1977 (J. Gapuz, pers. comm.). According to the annual census figures of the Conservation Resources and Management Foundation (CRMF, pers. comm.), which is contracted to manage the area by DENR, the deer population on Calauit has increased from the estimated total of 35 individuals in 1977 to some 550 individuals by the end of 1991; an average growth rate of 22% per annum. However, on closer study, the figures reveal a diminishing rate of growth which may indicate the operation of density-dependent factors, continued, albeit reduced, hunting pressure and/or disease; low incidences of both of the last factors have been recorded (J. Gapuz, pers. comm.).

The principal threat to this population and to the Sanctuary itself is the 'Back to Calauit Movement'. In 1986, discontent and depletion of natural resources in their resettlement area led to the organization of the movement and the return of 51 of the 256 families evicted ten years before. By March 1992, the population of illegal settlers on Calauit had increased to 111 families, 492 individuals. Legal proceedings for the re-eviction of these people, who had been compensated at the time of their eviction, have still to be resolved and

substantial damage has been sustained by the island's forests through slash-and-burn cultivation and by its marine resources (J. Gapuz, pers. comm.; D. Ganapin, pers. comm.).

Nevertheless, Calamian deer are now abundant on Calauit, which undoubtedly constitutes the main stronghold for the species at the present time. In addition, at least 6.8 deer, either wild-caught or captive-bred on Calauit, have been released onto three other islets in the group since 1988 (J. Gapuz, pers. comm.). The Ecosystems Research and Development Bureau of DENR has also been breeding the species for a 'stock-farming' project since 1982 (Villamor, 1987, 1990). The project, intended to produce captive-bred deer for donation to Calamian residents for domestic husbandry, was only modestly successful and was officially terminated in August 1991 (C. Villamor, pers. comm.). As far as is known there are no Calamian deer in captivity outside the Philippines although it is hoped that the remaining ERDB stock, which comprised 2.5 individuals in December 1992, will be incorporated into a new co-operative breeding programme in the near future.

In early 1992, a repeat field status survey was conducted by the author and Carmelita Villamor of the ERDB to determine the current distribution and conservation status of this species and the Bearded pig on the main islands of Busuanga and Culion and to develop recommendations for their protection. The indications are that the deer has been extirpated from most parts of Busuanga, although remnants of the population are reported to survive in the north and north-west sectors of the island. They are evidently less scarce on Culion where, as on Busuanga, hunting pressure seems to have decreased in recent years; the reasons for this are not clear. There are still no proper reserves on either of these islands but relatively large parts are still undeveloped and sparsely inhabited (Oliver & Villamor, unpubl.).

Although these results, together with

the degree of protection and numbers of Calamian deer on Calauit, suggest that the species is in no immediate danger of extinction, its minuscule range and overall status undoubtedly justifies its Vulnerable designation. It is therefore hoped to establish an international co-operative breeding programme under the aegis of a MOA between DENR and the Zoological Society of San Diego, which has also provided the majority of funds for the project. However, like the protocol established for the Philippine Spotted Deer Conservation Programme, the MOA will be designed to promote the Calamian deer as a flagship species for the Calamian Islands and to generate resources for a variety of *in situ* conservation activities. These activities will include a conservation-education programme, based around the production of a poster featuring the deer and a behavioural ecology study of the wild population on Calauit. Other priority recommendations arising from the recent field survey include: the designation of most remaining wildlife habitat on Culion under the National Integrated Protected Areas System; the possibility of creating a private nature reserve for this species on the Busuanga Breeding and Experimental Station (46 000 ha), which comprises more than 60% of the total area of the island, including the Chinabayan and Wayan Mountain Ranges where deer are reported to survive; a variety of recommendations on improved management strategies for wildlife species and habitats on Calauit, including an amendment to the wording of the presidential proclamation to enable the removal of some or all African ungulates and the useful dispersal of surplus stocks of *C. calamianensis* and other Philippine species being bred in captivity of Calauit, such as the Balabac chevrotain.

TAMARAW

The Tamaraw *Bubalus mindorensis*, a dwarf relative of the Asian water buffalo *B. arnee*, is the largest endemic mammal

of the Philippines. It is now found only on Mindoro, although its remains have been recovered from Pleistocene deposits on the neighbouring Luzon (P. Gonzales, pers. comm.). The Mindoro population has been decimated by hunting and habitat destruction from an estimate 10 000 in 1900 (Harrisson, 1969) to less than 200 individuals in 1975 (Kuehn, 1976; Petocz, 1989) despite the establishment of the H. B. Harrison and Calavite reserves in 1920, total prohibition of hunting in 1936 and the creation of the Iglit Game Refuge (9000 ha) in 1961. In 1970 the Iglit Game Refuge was enlarged to 75 445 ha and subsequently upgraded as the Mt Iglit-Baco National Park. In 1982 the Tamaraw population was reported to have increased to about 250 individuals. In 1987 an island-wide survey produced 'a conservative estimate' of 356 wild individuals in seven locations on the island, including 145 individuals in Mt Iglit-Baco, the most important sub-population (Petocz, 1989). However, although the 1987 figures suggest a significant increase in the population since 1982, this estimate is based mainly on interviews with local people and is of questionable reliability (Cox & Woodford, unpubl.).

In the late 1980s, the Mt Iglit-Baco National Park, which was declared an ASEAN Heritage Site in 1982, was included in the first-round priority listing under the terms of the Integrated Protected Areas System Project and eligible for Global Environment Fund money for its enhanced future protection and development. In early 1992 the park was renamed the Mangyan Heritage Park in deference to the Mangyan hill tribes who inhabit the region (W. Dee, pers. comm.). Unfortunately, pressure from tribal interest groups who are opposed to the Project has resulted in the withdrawal of the area from the priority list and hence its eligibility for these funds (A. Alcala, pers. comm.; W. Dee, pers. comm.).

Conservation Programme In 1979, in response to growing concerns about the

survival of the species, the Tamaraw Conservation Programme was launched with a mandate to (a) prevent the extinction of the species and (b) to develop it and its habitat as economic resources. From 1979 to 1985 the management of the Programme was contracted to the Presidential Commission for the Conservation of the Tamaraw, which received an independent budget from the Government for this purpose. From 1985 to 1989, the Programme was contracted to the CRMF and, from January 1990 to the present, it has been managed by the Carabao Research and Development Centre at the University of the Philippines at Los Banos, under the aegis of a tripartite MOA between DENR, the University and the UPLB Foundation Inc.

The principal activities identified for implementation by the Programme were captive propagation, field protection, public education and scientific research (Cox & Woodford, unpubl.). However, with the possible exception of public education at a local level, little substantive progress has been made with any of these objectives. With the benefit of hindsight, this situation is largely attributable to an undue concentration of effort and resources on the first activity, namely the creation in 1980 of a Tamaraw breeding facility, referred to locally as the 'gene pool', which was constructed inside the southern boundary of the National Park. The maintenance of this 281 ha enclosure and the capture of wild Tamaraw to be transferred to it have constituted the principal activities of the project since that time.

Between February 1982 and April 1989 at least 12.7.1 Tamaraw were captured in Aruyan, near Sablayan Penal Colony, west of Iglit-Baco; six animals died during or shortly after capture; a further two ♂♂ died as a result of fighting within the enclosure and at least two of the seven or more calves believed to have been born died as neonates. Several animals which died were discovered only as skeletal remains. In December 1989, it was esti-

mated that there were 8.5.1 animals in the breeding facility, 1.1 held in a 0.75 ha enclosure and a young ♂ held at Aruyan. Owing to the difficulties of making a count of the animals, which were rarely seen, these figures appear to have been unduly optimistic since only eight individuals have been accounted for during subsequent attempts to recapture the stock for controlled breeding. The recaptured animals were five adult ♂♂ now held in pens, and an adult ♀ found dying in June 1992; two or more animals, one of which is believed to be a ♀, have yet to be recaptured. Thus, of the total of >27 Tamaraws captured in Aruyan or born in the enclosure, only ten are known to survive. Moreover these figures do not include a ♂ calf born to the captive pair on 18 October 1990, which died of fluke infestation on 19 October 1991 or twin stillborn calves (one of which was a free-martin) from this same pair on 28 September 1992 (V. Momongan, pers. comm.).

The concentration of effort on the captive-breeding component of the Programme has also detracted attention and available resources from other more pressing priorities including the protection and restoration of the wild population and its habitat. Moreover, it is clear that the 'gene pool' concept is fundamentally flawed. Although intended as a captive propagation facility, it has never served this purpose as no active management of the animals is feasible in such a large enclosure; since the animals were rarely seen, it could not be determined how many individuals survived at any one time, when or how many animals died or how many calves were born or reared. On the other hand, the enclosure was not large enough to allow the animals' freedom of movement or the space to establish and maintain proper territories; this factor alone would account for the deaths attributed to fighting between ♂♂ which are reputed to be highly territorial.

The recent attempt to recapture the remaining Tamaraws in the breeding fac-

ility is therefore to be welcomed, although there are serious problems with the way these animals are being managed and it seems unlikely that breeding will be successful without major reorganization and investment (Dee *et al.*, unpubl.). It would also be preferable if any such investment were obtained from elsewhere so that government resources allocated to the conservation programme may be more usefully directed towards the protection and restoration of the Tamaraw's remaining habitat. In 1990, a IUCN/SSC-affiliated technical evaluation of the conservation programme unreservedly supported the development of the breeding attempt but only as one of a whole range of recommendations (Cox & Woodford, unpubl.). To date shortage of funds and the prioritization given to the management of the captive stock has again precluded the implementation of any of the higher priority recommendations: a reassessment of the current conservation status and future priorities for the wild population and the development and implementation of management plans for Mt Iglit-Baco National Park (Mangyan Heritage Park) and the Mt Calavite Tamaraw Reservation (15 000 ha).

SUMMARY AND CONCLUSIONS

Concern about the declining status of Philippine artiodactyls has resulted in the development of conservation initiatives for the Visayan warty pig, Balabac chevrotain, Calamian deer, Philippine spotted deer and Tamaraw. All these plans have included or are intended to include captive breeding. The longest running project, the captive propagation of Tamaraw, has been the least successful and has been a consistent drain on the resources available. By comparison, the chevrotain is being maintained and bred with considerable success in captivity on Calauit but no action has been taken to conserve the wild population and the future of the breeding programme is compromised by regulations which pre-

clude the dispersal of surplus animals. The same regulations also curtailed an apparently successful series of Calamian deer 'translocation' projects, utilizing surplus wild or captive-bred animals from Calauit for release onto neighbouring islets. Calamian deer were reared with some success under the aegis of ERDB's stock-farming project at Laguna (Luzon), although this programme was largely unsuccessful in achieving its primary objective of developing the species for domestic husbandry purposes. The Philippine spotted deer and Visayan warty pig projects are still in their infancy, although the latter species is now being bred in three separate locations and the project is showing promising potential.

By the nature of the archipelago, its biogeographical divisions and the disproportionate levels of habitat destruction in particular regions, the most endangered of these artiodactyls and the overwhelming majority of other seriously threatened species are confined to those regions or sub-centres of endemism which have been most denuded and are least well represented within the existing protected areas system, namely, the West Visayas, Mindoro and the Sulu Islands. Outlying islands associated with these or other areas, such as Balabac, the Calamians, Bohol, Sequijor and Sibuyan, are also of great importance, though their levels of endemism are either lower or less well known. It is apparent that the overriding priorities are not so much for species' conservation projects as for selected island or regional biodiversity conservation strategies and, hence, the channelling of additional resources into wildlife habitat protection and restoration programmes.

Being the largest and among the rarest and most economically and/or perceptually important Philippine animals, artiodactyls are also potentially ideal vehicles for generating increased conservation interest and activity in their respective ranges. Given that the West Visayas region is undoubtedly the single greatest

priority and challenge for conservation interests in the country, the importance of the Philippine Spotted Deer Conservation Programme lies not so much in the attempt to circumvent the possible early extinction of the species, as in the fact that it is being promoted as a flagship species for this region. Several species and subspecies of birds and fruit bats endemic to the West Visayas are already extinct, and a whole range of endemic vertebrates are now considered seriously threatened (see Heaney *et al.*, 1987; Collar & Andrew, 1988, Dickinson *et al.*, 1991; Oliver & Wirth, unpubl.). The main thrust of the Philippine Spotted Deer Conservation Programme must, therefore, be directed towards habitat protection (irrespective of the occurrence of remnant populations of deer or warty pigs), habitat restoration, status surveys and other field research and conservation-education initiatives. Equally, the importance of the captive-breeding programme lies not so much in its insurance value for the survival of the species, as in its potential for drawing attention to the conservation issues, the 'leverage' implicit in possible future reintroductions and the fact that the protocol established for this programme will enable the continued generation of resources for the support of relevant *in situ* conservation activities through the direct involvement of *ex situ* institutions in breeding programmes.

Similarly, the problem with the present Tamaraw Conservation Programme is not just that the captive breeding effort has been unsuccessful but that the programme has had few, if any, tangible benefits for the wild population or any of the many other equally threatened Mindoron species and habitats. Because Mindoro and its satellites constitute one of the principal centres of endemism in the Philippines and the region includes many other endangered taxa, this is a major shortcoming. Figures recently published by Bird Life International lists Mindoro as one of the 12 endemic bird areas in the world scoring the highest ranking for both

biodiversity and degree of threat (ICPB, 1992). The conception and continued management of the TCP as a single species' initiative and particularly the concentration of resources on the captive component is clearly at odds with the greater priority of biodiversity conservation on the island. Indeed, the Programme has had an essentially negative role by detracting attention and available resources away from this overridingly important requirement. The conservation of the Tamaraw should be a means to this end rather than an isolated objective.

What is needed therefore is a major switch of emphasis from a poorly performing breeding programme to a 'flagship Tamaraw' or 'Mindoron Biodiversity Programme'. Such a programme should include but should not be confined to research and practical management of Tamaraw. Rather it should capitalize on national and international interest and concern about the status of the species to develop conservation initiatives for a variety of species, the protection and restoration of important remaining wildlife habitat throughout the island and its islets, and conservation-education projects focused on insular Mindoro. The need for a more comprehensive programme has become paramount as a result of the recent withdrawal of the Mangyan Heritage Park from the 12 priority sites under the auspices of the IPAS Projects. The strength of the proposed IPAS programme on Mindoro was that it espoused the principle of conserving as many native species of plants and animals as possible, while also recognizing the Tamaraw (and other threatened or economically important taxa) as key indicator species for planning and wildlife habitat management purposes (Dee *et al.*, unpubl.).

Captive breeding should not constitute the main thrust of the TCP, particularly if it utilizes most of the few resources currently available, but, provided that additional resources and management expertise can be found, captive breeding

should be an integral component of a more comprehensive programme. The crucial distinction between a conservation programme and a captive-breeding programme needs to be drawn. The former incorporates a set of related activities, including status surveys, ecological research, assistance in the formulation of protected area management plans and conservation education at a local level, while the latter, even with long-term population management and conservation objectives in mind, remains simply a breeding programme, unless so organized as to generate additional resources for relevant and concurrent conservation activities. These extra-curricular activities are often not prohibitively expensive and, because they address the needs of wild populations and whole communities of threatened species, have the potential for a far greater return on the investment. They also enormously enhance the significance of the captive-breeding component and the overall contribution of participating institutions.

A small number of zoos, in the Philippines and elsewhere, are now actively contributing to biodiversity conservation in some of the world's highest priority areas, while maintaining their primary role in assisting the development of co-operative breeding programmes for some of the most threatened species in these regions. These zoos are leading the way and have done so by the simple expedients of (a) formulating agreements with relevant governmental and/or non-governmental organizations in the countries of origin of the species, which are designed to address priority requirements of wild, as well as captive populations and/or (b) providing financial or other assistance, such as personnel training, technical equipment, education materials, for the implementation of in-country conservation strategies. The amounts of money involved are often quite small, even insignificant in comparison with the costs involved in the development of *ex situ* breeding programmes and modern animal

exhibits. Assistance in the development of biodiversity conservation initiatives is urgently required. It is also within the means and province of zoos, particularly if given a species' focus. It is hoped that the wider community of zoos will take up this challenge.

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REFERENCES

BRAATZ, S. (1992): *Conserving biological diversity: a strategy for the protected areas in the Asia-Pacific region. (Technical Paper No. 193, Asia Technical Dept Series.)* Washington, DC: The World Bank.
 CALDECOTT, J. O., BLOUCH, R. A. & MACDONALD, A. A. (In press): The bearded pig *Sus barbatus*. In *Pigs, peccaries and hippos, IUCN/SSC Action Plan for the Suiformes*. Oliver, W. (Ed.). Cambridge and Gland: IUCN.
 COLLAR, N. J. & ANDREW, P. (1988): *Birds to watch:*

the ICPB world check-list of threatened birds. (ICBP Technical Publication No. 8.) Cambridge: International Council for Bird Protection.
 COLLINS, N. M., SAYER, J. A. & WHITEMORE, T. C. (Eds) (1991): *The conservation atlas of tropical forests; Asia and the Pacific*. London: Macmillan Press.
 COX, C. R. (1987): The Philippines spotted deer and the Visayan warty pig. *Oryx* **21**: 37–42.
 COX, C. R. (Unpublished): *A preliminary survey of the proposed Panay Mountains National Park*. Report to Zoologischer Garten Berlin, 1987.
 COX, C. R. & WOODFORD, M. (Unpublished): *A technical evaluation of the Philippine Tamaraw Conservation Programme*. Report to DENR, IUCN/SSC and The Zoological Society of London, 1990.
 DEE, W. DE G., CUSTODIO, C. C. & OLIVER, W. L. R. (Unpublished): *The Philippine Tamaraw Conservation Programme: a critical evaluation*. Report to DENR/PAWB, 1992.
 DICKINSON, E. C., KENNEDY, R. S. & PARKES, K. C. (1991): *The birds of the Philippines. BOU Checklist No. 12*. Tring: British Ornithologists' Union.
 GRIMWOOD, I. R. (1976): Hunting a deer to extinction. *Oryx* **13**: 294–296.
 GRIMWOOD, I. R. (Unpublished): *Field notes on the Calamian deer (Axis calamianensis)* Heude 1988. Unpublished report, 1975.
 GROVES, C. P. (1981): Ancestors for the pigs: taxonomy and phylogeny of the genus *Sus*. *Tech. Bull. Dept Prehistory Res. School Pacific Stud. Austral. natn. Uni.* No. 3. 1–96.
 GROVES, C. P. & GRUBB, P. (In press): The Eurasian suids, *Sus* and *Babirusa*: taxonomy and description. In *Pigs, peccaries and hippos, IUCN/SSC Action Plan for the Suiformes*. Oliver, W. (Ed.). Cambridge and Gland: IUCN.
 GRUBB, P. & GROVES, C. P. (1983): Notes on the taxonomy of the deer (Mammalia, Cervidae) of the Philippines. *Zool. Anz.* **210**(1/2): 119–144.
 DE HAAN, N. A., BOSMA, A. A., MACDONALD, A. A. & OLIVER W. L. R. (In press): A species of wild pig in the Philippines with a type of centric fusion new to *Sus*: 13/16. In *Proceedings 10th European colloquium on cytogenetics of domestic animals*. Utrecht.
 HARRISSON, T. (1969): The tamaraw and Philippine conservation. *Biol. Conserv.* **1**: 317–318.
 HEANEY, L. R. (1986): Biogeography of mammals in SE Asia: estimates of rates of colonization, extinction and speciation. *Biol. J. Linn. Soc.* **28**: 127–165.
 HEANEY, L. R., GONZALEZ, P. C. & ALCALA, A. C. (1987): An annotated checklist of the taxonomic and conservation status of land mammals in the Philippines. *Silliman J.* **34**(1–4): 32–66.
 ICBP (1992): *Putting biodiversity on the map: priority areas for global conservation*. Cambridge: International Council for Bird Preservation.
 ICBP (Unpublished): *Outline proposal on the Philippines*. Internal report, 1989.
 IUCN (1988): *1988 IUCN red list of threatened animals*. Cambridge and Gland: IUCN.

- IUCN (1990): *1990 IUCN red list of threatened animals*. Cambridge and Gland: IUCN.
- IUCN/SSC (Unpublished): *Conservation and recovery of threatened species in the Philippines*. Project proposal to IUCN/SSC, 1990.
- KUEHN, D. W. (1976): Tamaraw: endangered buffalo of the Philippines. *Nat. Pks Conserv. Mag.* **50**(3): 18–20.
- MACKINNON, J. & MACKINNON, K. (1986): *Review of the protected areas system in the Indo-Malayan Realm*. Cambridge and Gland: IUCN/UNEP.
- OLIVER, W. L. R. (1992a): The Philippine wild pigs *Sus* spp. *Silliman J.* **36**: 55–64.
- OLIVER, W. L. R. (1992b): The current taxonomic and conservation status of wild pig and peccary species, with particular reference to captive breeding. *Int. Zoo News* **39**(8): 6–16.
- OLIVER, W. L. R., COX, C. R. & DOLAR, L. L. (1991): The Philippine spotted deer, *Cervus alfredi*, conservation project. *Oryx* **25**: 199–205.
- OLIVER, W. L. R., COX, C. R. & GROVES, C. P. (In press): The Philippine warty pigs, *Sus philippensis* and *S. cebifrons*. In *Pigs, peccaries and hippos, IUCN/SSC Action Plan for the Suiformes*. Oliver, W. (Ed.). Cambridge and Gland: IUCN.
- OLIVER, W. L. R. & VILLAMOR, C. I. (Unpublished): *The distribution of the Calamian deer Cervus (= Axis) calamianensis and the Palawan bearded pig Sus barbatus ahoenobarbus in the Calamian Islands, Palawan Province, Philippines*. Unpublished report on the 1992 field survey.
- OLIVER, W. L. R. & WIRTH, R. (Unpublished): *Outlines for the Philippines: biodiversity and (preliminary) listing of species' conservation priorities*. Report to Fauna and Flora Preservation Society, 1992.
- PETOCZ, R. (1989): Status of the tamaraw (*Bubalus mindorensis*). *Asian wild Cattle Spec. Grp Newsl.* **2**: 1–4.
- QUINNELL, R. & BALMFORD, A. (1988): A future for Palawan's forests? *Oryx* **22**: 30–35.
- RABOR, D. S. (1986): *Guide to Philippine flora and fauna* **11**. Manila: Natural Resources Management Centre and University of the Philippines.
- VILLAMOR, C. I. (1987): Breeding of Calamian deer (*Axis calamianensis*) in captivity. *Sylvatrop. Philipp. Forest Res. J.* **12**: 49–60.
- VILLAMOR, C. I. (1990): *Backyard raising of Calamian deer*. Manila: ERDB/DENR.

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Introductions and reintroductions of ungulates in Israel

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In the past, the wildlife of Israel included a number of ungulate species but at the time of the establishment of the State of Israel only four survived in the wild: the wild pig *Sus scrofa libycus*, the Nubian ibex *Capra ibex nubiana*, the Dorcas gazelle *Gazella dorcas isabella* and the Mountain gazelle *Gazella gazella* of which two subspecies *G. g. gazella* and *G. g. acaciae* are now recognized. In 1954 the Wild Animals Protection Law, which replaced the mandatory 'Game Ordinance', extended total legal protection to almost all wild mammals and birds.

Among the species which had become extinct in the region some time from the

mesolithic to modern times are the Arabian oryx *Oryx leucoryx*, the Hartebeest *Alcelaphus buselaphus*, the Mesopotamian fallow deer *Dama dama mesopotamica*, the Roe deer *Capreolus capreolus coxi*, a possible subspecies of *Equus asinus* and the now totally extinct Aurochs *Bos primigenius* and the Syrian onager *Equus hemionus hemippus*.

When the Nature Reserves Authority was established in 1964 as a government conservation agency, the reintroduction of 'biblical animals' was favoured as a theme which would have more public appeal than investing in the protection of the 'unpopular' and the 'ugly' such as