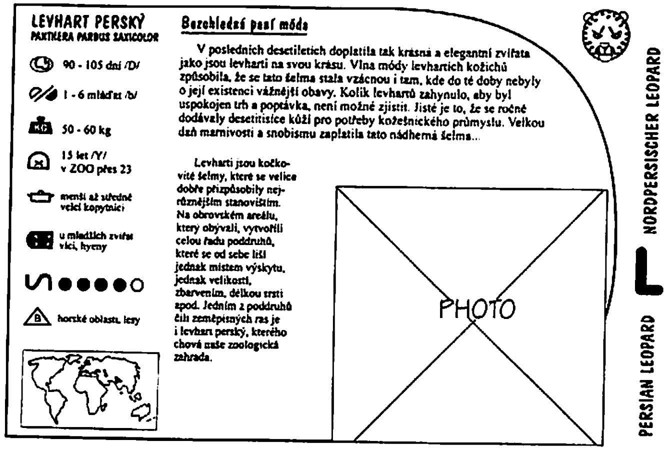

Fig. 6. An example of a page from the *Guidebook*.

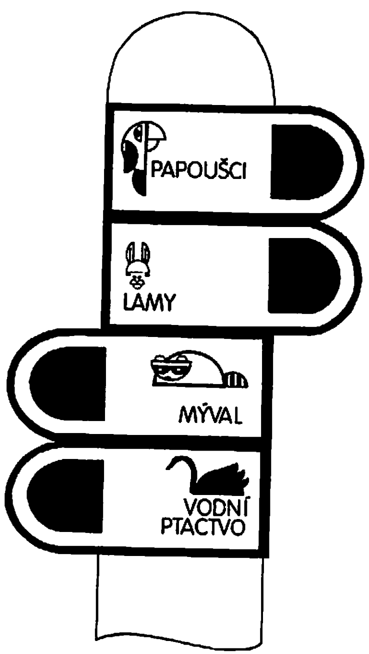

Fig. 7. An example of a direction indicator sign planned for use at Decin Zoo in 1997.

graphics more internationally intelligible. Once the new signs had been installed there appeared to be general satisfaction but there were no special comments pertaining to the graphics except from one teacher who mentioned that it was difficult to recognize individual species in some mixed-species enclosures. For some animal groups, for example, waterfowl and parrots, specific logotypes have not been developed for every species. This problem will be overcome by installing large colourful information boards using realistic illustrations of individual species in the mixed-species enclosures.

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The role of museums and zoos in conservation biology

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The taxonomic problems which affect the management of captive and wild populations of threatened species may offer an opportunity for a renaissance in the relationship between museums and zoos. As historical archives, museum collections may reflect former variation in what are now fragmented populations. Some species are poorly represented in museum collections and zoos can offer material which can be used for research into taxonomy, anatomy, pathology, functional morphology, reproductive biology and ageing. This paper discusses the ways in which zoo and museum collections complement and assist each other and describes current museum-based research in conservation biology.

Key-words: museums, taxonomy, zoos

During the 19th century there was a close relationship between museums and zoos. In the 1820s The Zoological Society of London established a museum collection and a zoological garden but the curatorial demands of ever increasing numbers of preserved animal specimens led to their purchase by the British Museum in 1855 (Blunt, 1976). The zoo–museum link is still maintained in Paris where the Muséum National d'Histoire Naturelle maintains the Ménagerie du Jardin des Plantes. Animals brought into zoological collections by early travellers were often described as new species. Once dead these animals were usually preserved as a skin, skeleton or mount, which would represent the holotype or voucher specimen on which that scientific name was based. One example of this is the Hairy-eared rhinoceros *Dicerorhinus sumatrensis lasiotis*, which was described as a new species *Rhinoceros lasiotis* on the basis of a young ♀ from Chittagong, East Bengal, which arrived at London Zoo in 1872 (Buckland, 1872). The skeleton of this animal was finally made available to the British Museum (Natural History) for research almost 30 years later (register no. BM 1901.1.22.1).

It is often thought that the taxonomic identification of birds and mammals is more or less complete and this has led to a considerable lessening of the zoo–museum relationship to the mutual detriment of both and, ultimately, this is deleterious to the conservation of many species. Conservation biologists have not always fully explored the potential of the vast array of biodiversity that is held in museum collections. The contribution that natural history museum collections can make to the conservation of biodiversity is described by Fjeldsa (1987) and Alberch (1993). Museums should be able to offer new ways in which their collections can be used for research and develop new collections which are appropriate to the demands of current research. In association with a number of zoos, the National Museums of Scotland has formulated a collecting strategy which may help address some of the problems faced by conservation biologists by providing, often for the first time, statistically significant samples for research purposes. We are gradually moving away from museums that describe and classify the diversity of life to collections that are representative of both wild and captive populations. These new collections may help us to answer critical questions concerning intraspecific taxonomy, anatomy, functional morphology, ageing, reproductive biology, pathology, mortality and some aspects of ecology.

GEOGRAPHICAL VARIATION AND SUBSPECIES

Although taxonomy at the species level is well established for most mammals and birds, there are considerable problems at the subspecies level. Subspecies problems can affect both captive-breeding programmes and *in situ* conservation projects where the conservation value of fragmented and variable populations cannot be properly assessed. It will become even more critical to understand the taxonomic significance of scattered wild populations as they are increasingly managed together with captive populations.

In the 19th and early 20th centuries many thousands of scientific names were proposed based on minor, individual morphological variations or intermediates in clines (showing gradual changes in morphology over the geographical distribution). The variation within some species and their distribution was so poorly known that distinctive individuals and intermediate forms were often described as a separate species or subspecies based on a single specimen. For example, ISIS (Seal & Makey, 1974) recognized seven subspecies of the Asiatic black bear *Ursus thibetanus* based on Ellerman & Morrison-Scott (1951). However, the last thorough taxonomic revision of this species was carried out more than 60 years ago (Pocock, 1933) and the seven subspecies were based on only 10 specimens (Kitchener, 1993a). Thus, many subspecies names which are used by the conservation biology community may have little scientific basis and it is possible that some animals identified as hybrids could be vital members of recognized subspecies and represent valuable genetic diversity. Today, taxonomic science demands more exacting standards (Corbet, 1966, 1970; Mayr & Ashlock, 1991; Corbet & Hill, 1992) and it is hardly surprising that many Taxon Advisory Group meetings are dominated by discussion of this most fundamental problem.

Captive populations usually originate from a small number of founders which may not reflect the true morphological and genetic variation in the original wild population. This may compromise the survival of the whole species because each 'subspecies' population may be too small to survive because of accelerated loss of genetic diversity and unavoidable inbreeding. For example, it seems likely that too many subspecies are currently recognized for the Tiger *Panthera tigris* (Mazák, 1981) and that most variation is clinal, with large animals in seasonally productive northern forests being replaced by small animals in less productive tropical forests in the south of the range of the species. There is likely to be a genetic component to this cline, as has been suggested for the north–south cline in body size and winter temperature tolerance of the Raccoon *Procyon lotor* (Mugaas & Seidensticker, 1993). Although a so-called hybrid Tiger population (i.e. mixed or unknown genetic origin) introduced to the forests of north-eastern Asia might survive, Amur tigers *Panthera tigris altaica* are likely to survive and adapt to the environment more quickly, so long as the reintroduced animals are not too inbred. Apart from body size, which is often determined by seasonal productivity of the environment (Geist, 1987), Mazák (1981) gives only one external character to separate Tiger subspecies: 'in southern forms, especially *sumatrae, sondaica* and *balica*, the stripes tend to disintegrate into spots near their ends, and lines of small dark specks between regular stripes may be found on the back, flanks and hind legs'. This suggests that there are only two extant Tiger subspecies, the mainland *Panthera tigris tigris*, which is adapted to northern forest (Amur; *altaica)*, woodland savannah (Bengal; *tigris)* and tropical forests (Indochinese; *corbetti)*, and the Sunda Island *Panthera tigris sondaica*, which is also found in tropical forests but is smaller than the Indochinese animals. During the last Ice Age the fall in sea level

meant that the Sunda Islands were interconnected with the Malay peninsula, so that the current subspecies are likely to have been separate for only about 10 000 years. This reassessment of Tiger subspecies would not invalidate captive-breeding programmes (Christie, 1995) because distinct ecological types, which probably have their own particular mixes of genes adapted for particular habitats, are being maintained. However, this reclassification does raise the question of whether we are a little too severe in enforcing purity of breeding in mainland Tigers.

As a first step the subspecies question may be resolved by examining the biogeographical distribution, adaptability and mobility of the species. This can substantially reduce the number of subspecies as a working hypothesis for future morphological and molecular research. For example, the number of subspecies in the Felidae can be reduced to a mere 43 from over 300 in this way (Kitchener, 1993b). The next step involves an examination of the morphological and genetic variation of the species over wide geographical areas, using museum specimens or captive animals of known origin, to help establish the variation within species. Museum collections are historical archives which contain specimens representing the original, unfragmented distribution of species and probably show a wider range of variation within populations than that displayed by captive animals. By looking for morphological discontinuities or grading of characteristics from area to area (Corbet, 1970) it should be possible to detect those populations which are most likely to represent distinct subspecies. If these discontinuities coincide with major geographical features or with barriers created by former glaciations, distinct and real subspecies will be detected more rapidly than by reinforcing the non-scientific lists of 'recognized subspecies'. A combined morphological, molecular and biogeographical approach offers the best opportunity to establish the reality of geographical variation in most species.

In collaboration with London Zoo, the National Museums of Scotland has been looking at one felid more closely (A. Kitchener & D. Richardson, unpubl. data). There are four recognized subspecies of the Clouded leopard *Neofelis nebulosa* (Ellerman & Morrison-Scott, 1951): (1) *nebulosa*, the nominate race from the mainland, excluding the Himalayas and India; (2) *brachyura* from Taiwan; (3) *macrosceloides* from the Himalayas and India; (4) *diardi* from Indonesia. When the basis of the subspecific names is reviewed, the problems become apparent. The Taiwanese race is supposed to be short-tailed but inspection of the type specimen at the British Museum (Natural History), London (register no. BM 62.12.24.25), shows that this is a trade skin (i.e. bought from a local market) with an incomplete tail. Its coloration and markings, and the tail length of other specimens, are identical to mainland animals. There is also no obvious difference between the nominate race and the large *macrosceloides*, except for its 'generally darker, greyer, less yellow hue' (Pocock, 1939) and possibly thicker coat associated with a colder climate. However, the Indonesian *diardi* differs strikingly from the nominate *nebulosa;* its smaller almost spot-like cloud-shaped markings contrast with the large clouds of the mainland race (Table 1; Fig. 1). Therefore, two distinct subspecies of the Clouded leopard seem to have evolved in geographical isolation probably caused by the contraction of the tropical forests during the last Ice Age. A similar review of variation in Fishing cats *Prionailurus viverrinus* seems to show only clinal variation, with southern animals being darker with larger more blotchy spots and stripes than northern animals (A. Kitchener & C. Barwick, pers. obs). Therefore, Sri Lankan and Javan fishing cats are similar in appearance because they occur at

	NEPAL/ SIKKIM/ASSAM	BURMA/ CHINA	TAIWAN	THAILAND/ ANNAM/MALAYA	SUMATRA/ BORNEO
Large clouds	6	10	3	4	
Small clouds					5

Table 1. Geographical distribution of the two main phenotypes of Clouded leopard *Neofelis nebulosa* from skins in the British Museum (Natural History), London, Field Museum of Natural History, Chicago, and the American Museum of Natural History, New York.

roughly the same latitude and in the same habitat.

In order to assess pelage patterns and coloration more objectively, the National Museums of Scotland is collaborating with A. Smith of Oxford Brookes University, Great Britain, to develop a computerized image analysis method which will be used to investigate the geographical variation in felids and other mammals.

Alternatively, poor taxonomic work can result in hybridization of previously unrecognized subspecies and species in captivity. In recent years there have been taxonomic revisions of douroucoulis *Aotus* spp, titis *Callicebus* spp, squirrel monkeys *Saimiri* spp, galagos *Galago* spp and *Galagoides* spp, and lemurs *Eulemur* spp and *Lepilemur* spp, which has led to an explosion of 'new' species (Corbet & Hill, 1991; Wilson & Reeder, 1993). Poor captive breeding of douroucoulis could be a result of the fact that this former monospecific genus actually may consist of up to nine distinct species (Hershkovitz, 1983). These new assessments were based largely on studies of museum collections, comprising specimens collected mostly in the 19th century.

However, for some species, there are too few specimens available in museums for research, even though the species may be relatively common in captivity. Only 71% of bird families have all genera represented by at least one skeleton and spirit specimen in museums world-wide (Fjeldsa, 1987). In the past collecting has been mainly opportunistic and haphazard, with emphasis on the biases of particular curators. Therefore, while some species are well represented, so that a good assessment can be made of geographical variation and subspecies, in other cases there is a dearth of specimens. There are more than 350 specimens of the Western lowland gorilla *Gorilla g. gorilla* in British museums (Jenkins, 1990), covering the whole subspecies range, but there are only two specimens of the Emperor tamarin *Saguinus imperator* (Napier, 1976) and many other primate species are represented by only a few skins and skulls and often by no skeletons at all (Table 2). Zoos can contribute by making dead animal specimens available to museums for research purposes.

OTHER USES OF MUSEUM COLLECTIONS

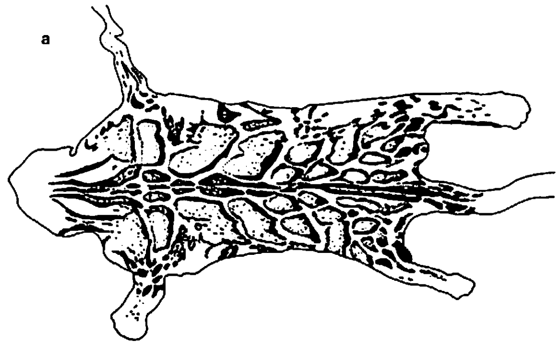
Natural history museum collections are increasingly being used for a diverse range of research projects and can provide a historical archive of the environment as well as a catalogue of biodiversity. Eggshells of birds of prey can be used to demonstrate a thinning of the eggshell resulting from the use of organochlorine pesticides (Ratcliffe, 1967). More recently, museum collections have been used for the Endangered Spanish Imperial eagle *Aquila adalberti* (Gonzalez & Hiraldo, 1988), whose distribution has been shown to have declined on the basis of museum specimens (Gonzalez *et al.*, 1989).

It is now possible to measure the level of heavy metals in bird feathers and comparisons of mercury levels during the 19th and 20th centuries indicate increasing levels of pollution over long periods of time (Thompson & Furness, 1992).

By far the most frequent request is for skin samples for the extraction of DNA for molecular systematics. In recent years the National Museums of Scotland has supplied skin samples of cats (Felidae), hares (Leporidae), bovids (Bovidae), gulls (Laridae), geese (Anatidae), skuas (Stercorariidae) and petrels (Procellariidae) for DNA analysis. This research allows a historical record of key species to be obtained, which can be compared with samples collected today. However, this kind of analysis does damage the skins and we have to review the need for this procedure carefully. In order to obviate the need for this in newly acquired specimens, we routinely take soft tissue samples which can be used by researchers and we have recently collected muscle and liver samples from felids, langurs *Presbytis* spp, *Trachypithecus* spp and *Pygathrix nemaeus*, gorillas, gibbons *Hylobates* spp, gulls *Larus* spp, bustards (Otididae), Stone curlews *Burhinus* spp and petrels.

Our osteological collections are used by archaeologists to identify bone fragments found at archaeological sites. This can be invaluable in establishing the former distribution of threatened species so that assessments can be made of possible sites for reintroduction. The National Museums of Scotland is collaborating with the Environmental Archaeology Unit

a



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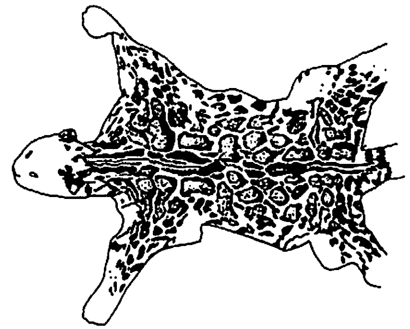

Fig. 1. a. Mainland form of Clouded leopard *Neofelis nebulosa* with large cloud-like markings; this specimen is from Indochina. b. Indonesian form of Clouded leopard *N. n. diardi* with small cloud-like markings; this specimen is from Borneo.

SPECIES	SKINS	SKULLS	SKELETONS
Coquerel's mouse lemur *Microcebus coquereli*	8	5	
Mayotte lemur *Eulemur fulvus mayottensis*	2(0+2)	3(0+2)	0(0+2)
Red ruffed lemur *Varecia variegata ruber*	14	7	
Pygmy or Lesser slow loris *Nycticebus pygmaeus*	10	10	
Goeldi's monkey *Callimico goeldii*	5(2+4)	3(1+5)	1(0+5)
Silvery marmoset *Callithrix argentata*	11(2+4)	11(0+6)	0(0+6)
Pygmy marmoset *Callithrix pygmaea*	16(2)	14(0+3)	0(0+3)
Golden lion tamarin *Leontopithecus rosalia*	16(10)	21(12)	5(12)
Emperor tamarin *Saguinus imperator*	1(0+2)	0(0+2)	0(0+2)
Red-faced black spider monkey *Ateles paniscus*	4	4	1
Diana monkey *Cercopithecus diana*	42(2+2)	28(2+2)	2(2+2)
Hamlyn's or Owl-faced monkey *Cercopithecus hamlyni*	3	2	1
L'Hoest's monkey *Cercopithecus lhoesti*	11	4	
Sulawesi crested or Celebes macaque *Macaca nigra*	8(0+3)	18(0+3)	3(1+3)
Lion-tailed macaque or Wanderoo *Macaca silenus*	9(1+1)	13(0+2)	4(0+2)
Red-shanked douc langur *Pygathrix nemaeus nemaeus*	5(3+2)	4(2+3)	0(2+3)
Moloch or Javan grey gibbon *Hylobates moloch*	8	10	1
Pileated or Capped gibbon *Hylobates pileatus*	11(1)	5(1)	0(1)
Siamang *Hylobates syndactylus*	21(1+2)	28(1+2)	0(1+2)

Table 2. Skins, skulls and skeletons of some primates in museums in Britain (Napier, 1976, 1981, 1985; Jenkins, 1987, 1990). Figures in brackets indicate specimens added to the collections of the National Museums of Scotland since the publication of the catalogues either as processed or unprocessed (after the + sign).

at York University, Great Britain, and the National Avian Research Center, United Arab Emirates, to establish an osteological collection for the Arabian peninsula with the help of the Al-Areen Wildlife Park, Bahrain, and the Oman Natural History Museum (see also Bailey *et al.*, this volume).

ANATOMY AND FUNCTIONAL MORPHOLOGY

Despite the accessibility of many species in captivity, little is known about much of the basic anatomy and functional morphology of mammals and birds. This lack of knowledge can have far-reaching consequences for the management of threatened species in captivity and for reintroduction programmes.

Information on functional morphology and anatomy can be used to plan enriched environments for captive animals, which facilitate the development of a more complete behavioural repertoire. For example, much of the work on skin glands was carried out during the 19th and early 20th centuries (Macdonald & Brown, 1985) but it is still unknown whether domestic cats and other felids have cheek glands (Macdonald, 1985). Skin glands are used in scent marking, which requires appropriate substrates for eliciting such behaviour.

We have recently described a new gland, the preputial gland, in the Coati *Nasua nasua* from an animal at Edinburgh Zoo (Shannon *et al.*, 1995). The marking behaviour associated with the use of this gland had been reported for wild coatis (Kaufmann, 1962) and can be observed daily in captivity, yet the gland had never been described.

We are currently collecting specimens for a study on the arboreal adaptations of felids, such as the Margay's *Leopardus wiedii* highly flexible ankle joint (Taylor, 1989). This adaptation has arisen two or three times within the Felidae but has only been described in the Margay (A. Kitchener, unpubl. data; see also Mansard, this volume).

In addition to research on taxonomy, skeletons can provide information about body size, sexual dimorphism, diet and behaviour. We are currently using a CT scanner to look at brain size and the importance of olfactory lobes in all species of bears (A. Kitchener & S. Howe, unpubl. data). This technique means that non-destructive testing of specimens can be carried out. By looking at the way in which the sizes of limb bones vary in pigeons (Columbidae) it has been possible to demonstrate that the Dodo *Raphus cucullatus* was a thin and highly active bird that was not as large as usually perceived (Kitchener, 1993c).

Information on the anatomy of the gastro-intestinal tract and the reproductive organs are also important for the management and successful breeding of captive animals. Because the development of the gastro-intestinal tract is affected by diet, birds which are fed on a concentrated artificial diet, such as Barnacle geese *Branta bernicla* (Owen, 1975) and Red grouse *Lagopus lagopus scoticus* (Moss, 1972), have shorter intestines than wild conspecifics. Although langurs are often fed on a diet which is comprised of more fruit than they would eat in the wild, little is known of the effect of this diet on gut morphology.

The effects of captive environments on the anatomy and morphology could also have profound effects for reintroduced animals. A reintroduced goose with a short gut would not survive because it would be unable to digest the food in the wild. A reintroduced monkey may suffer limb fractures or increased predation if its locomotion is compromised by a greater body weight or maladapted bones. There are endless possibilities for research which is mutually beneficial to both zoos and museums, yet much of this material is simply discarded after post-mortem.

PATHOLOGY

When we receive animal specimens for preparation as skins and skeletons, we often come across pathological signs, particularly on bones and teeth, that are not seen during post-mortem. These findings are reported back to the donating institution in case this information is important in refining husbandry techniques. A wild-caught Asian lion *Panthera leo persica*, recently donated by London Zoo (register no. NMSZ 1995.005), had a greatly distorted skull which was not apparent when the animal was still alive or during post-mortem (Plate 1). Investigations are under way to see whether this is a result of metabolic disease, trauma during development or a genetic defect that may be prevalent in the wild popu-

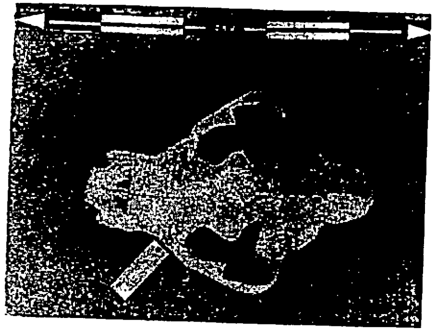

Plate 1. Dorsal view of the skull of a wild-born ♂ Asian lion *Panthera leo persica* (register no. NMSZ 1995.005). Note the severe torsion. *Ken Smith, National Museums of Scotland.*

lation owing to the population bottleneck in the early 20th century (Pocock, 1939).

Methods for ageing mammals and birds based on their skeletal remains can also be developed. Port Lympne Wild Animal Park recently donated a ♀ Sumatran rhinoceros *Dicerorhinus sumatrensis* to the National Museums of Scotland (NMSZ 1994.131). Although this animal was thought to be young when it was wild-caught 8 years earlier, irregular deposits of bone on the skull, ossification of the nasal septum and considerable tooth wear suggest that the rhinoceros was a considerable age. A preliminary analysis of the teeth of wild-caught and captive Sumatran rhinoceros has revealed a predictable amount of wear and although tooth wear may be slowed in captivity the findings support the view that the ♀ was particularly old (30+ years) when she died (Kitchener, 1997). By adding known-age specimens to museum collections it may be possible to establish ageing criteria for many species and to identify the effects of different diets on tooth wear when comparing captive animals with known wild conspecifics.

We have also made skulls available for the planning of dental work on a Jaguar *Panthera onca* and Canadian beavers *Castor canadensis* at Edinburgh Zoo.

COLLECTING

We are totally dependent on the goodwill of the public, research institutions and zoos to build-up our collections. We have contacts with zoos throughout the United Kingdom and we are increasingly widening our net to the rest of Europe. We have signed a memorandum of understanding with the Jersey Wildlife Preservation Trust for the preservation of dead animal specimens at the National Museums of Scotland. Where possible, we aim to collect specimens of threatened species through EEP, so that research can be co-ordinated and organized centrally. Most specimens are prepared as skins and skeletons for the research collections and a few are mounted for educational displays, where we attempt to show animal behaviour or illustrate a particular zoological theme (Plate 2).

In the last few years we have added about 40 000 specimens to the collections, including 1300 marine mammals, 25 000 eggs and 2000 British carnivores. The aim is to collect statistically significant samples from different locations so that we can explore geographical variation more fully, often for the first time. The collection of specimens from zoos is still at a relatively early stage and our research aims cannot be fully established until larger samples have been assembled. However, some important specimens have recently been received, including Sumatran rhinoceros, Asian lion, six Bush dogs *Speothus venaticus*, two Maned wolves *Chrysocyon brachyurus*, Marbled cat *Pardofelis marmorata*, three African golden cats *Profelis aurata*, three Rusty-spotted cats *Prionailurus rubiginosus*, seven Clouded leopards, eight Snow leopards *Uncia uncia*, two Rodrigues fodies *Foudia flavicans*, eight Mauritius kestrels *Falco punctatus*, 12 Mauritius pink pigeons *Columba mayeri*, four Bali starlings *Leucopsar rothschildi* and a number of primate species (Table 2).

Eventually research on zoo specimens may help to establish the effects of cap-

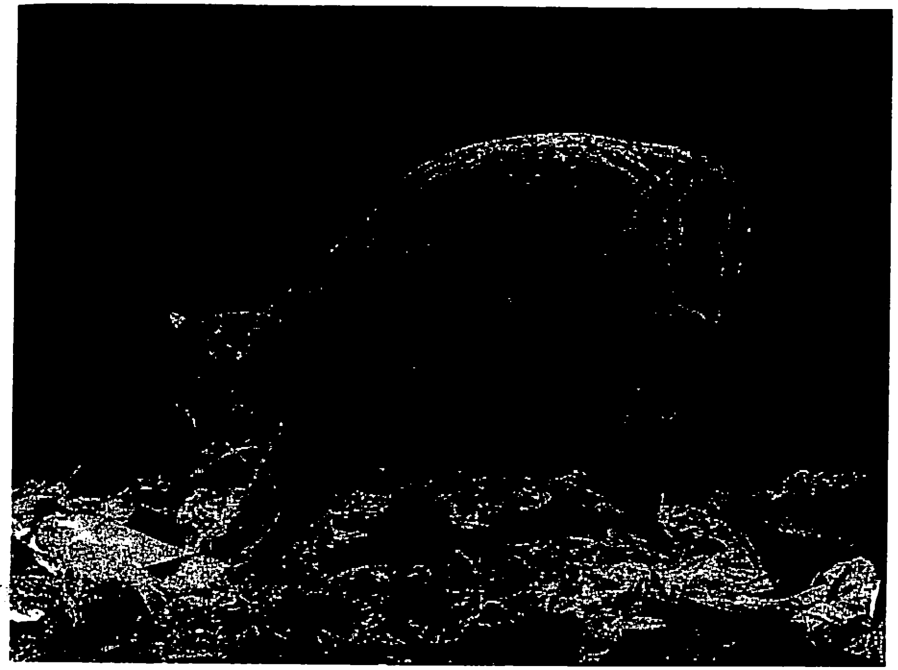

Plate 2. A ♀ Fishing cat *Prionailurus viverrinus* playing with a dead fish. New taxidermy techniques allow museums to show rare or transient behaviours more realistically. *Leslie Florence, National Museums of Scotland.*

tivity on morphology. This would allow us to assess the balance between phenotypic plasticity and genetic influences on the morphology of each species. For example, the differences in pelage coloration and skull characters between the Kulan *Equus onager kulan* and the Onager *Equus onager onager* (Groves & Mazák, 1967; Wilson & Reeder, 1993) seem slight and there are no obvious geographical barriers which would cause subspeciation. Captivity may remove the environmental effects on morphology, allowing a reassessment of the taxonomy of such species. It would also allow us to consider skeletal development to assess whether captive environments offer the same locomotory opportunities available in the wild. This is vital when considering reintroductions, because heavy-boned captive-born animals which are not used to the appropriate exercise would be at a severe disadvantage in the wild.

In addition to our collecting activities, we offer taxonomic and other advice to the Joint Management Species Programme in the United Kingdom and to the EEP TAGs for monotremes and marsupials, rodents, small carnivores, bovids, bears and cats.

COSMETIC POST-MORTEM PROTOCOLS

Although post-mortem of zoo animals is essential, the process often damages the specimens. Dead animals from zoos are an important source of information concerning anatomy, taxonomy, geographical variation and pathology of teeth and bones. Many species are only poorly represented in research collections and the scientific basis for the existence of many so-called subspecies is non-existent. In association with the National Avian Research Center, United Arab Emirates, the Jersey Wildlife Preservation Trust and other institutions, we have been developing a post-mortem protocol which allows for a full medical investigation to be carried out and maintains the essential integrity of the skin and skeleton for museum use. A cosmetic post-mortem for mammals (Appendix) and birds allows full access to all tissues required by the pathologist but does not take significantly more time to carry out.

RESEARCH ON WILD POPULATIONS

The National Museums of Scotland has not yet received sufficiently large numbers of specimens from zoos in order to carry out, for example, taxonomic research. However, following certain environmental disasters, large sample sizes become available from wild populations. Following the 'Braer' oil spill in January 1993, the National Museums of Scotland was involved in collaborative research on *c.* 1500 birds that were collected after the spill. Large sample sizes meant that studies on geographical variation and mortality of Iceland gulls *Larus glaucoides* (Weir *et al.*, 1995), geographical variation, pathology and mortality of Great northern divers *Gavia immer* (Weir, McGowan *et al.*, 1996) and geographical variation in Kittiwakes *Rissa tridactyla* (Weir, Kitchener & McGowan, 1996) could be carried out for the first time. By preserving over 300 skeletons we were able to show that almost 40% of Great northern divers suffer from non-fatal gunshot injuries and that 10% of breeding ♀♀ in Iceland died in the 'Sullom Voe' oil spill in Shetland in winter 1978–1979 (Weir, McGowan *et al.*, 1996).

Current mammal projects include a study on hybridization between Polecats *Mustela putorius* and Ferrets *Mustela furo*, the recolonization of the West Midlands, England, by the Polecat based on more than 200 road casualties and, in work carried out in collaboration with the Vincent Wildlife Trust, London, and the University of Leeds, establishing reliable morphological and molecular criteria for distinguishing these two taxa. Spin-off studies on Polecats include research into the diet from stomach contents, reproductive biology, incidence of rodenticides (Shore *et al.*, 1996) and incidence of exposure to viral haemorrhagic disease of Rabbits *Oryctolagus cuniculus*. Geographical variation and growth rates of Porpoises *Phocoena phocoena* and Common dolphins *Delphinus delphis* around the British Isles are also being studied. Geographical variation in European otters *Lutra lutra* suggests that Irish populations may be a separate subspecies (Lynch *et al.*, 1996).

ZOOS AND MUSEUMS: THE FUTURE

It is essential that we begin to plan for the new museum collections that are going to help us to find the answers to the questions relating to conservation biology which are currently unanswerable. By working together, zoos and museums can assist in the conservation of threatened species.

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