THE BIOLOGY OF VULTURES: A SUMMARY OF THE WORKSHOP PROCEEDINGS

INTRODUCTION

P. J. Mundy

There are 22 species of so-called vulture in the world, ranging throughout all continents south of 50°N except for Australia. Seven species are cathartids, and are not related to other birds of prey but are close to storks: they live in the New World. Thirteen species are true accipitrid vultures (aegypiines), and two are sometimes considered to be vultures, the Bearded Vulture (*Gypaetus barbatus*) and the Palm-nut Vulture (*Gypohierax angolensis*): these 15 live in the Old World of Europe, Asia and Africa. These two groups, although zoogeographically and phylogenetically distinct, are nevertheless highly convergent in life style.

Modern classifications include the New and Old World vultures in that great order of birds of prey, the Falconiformes, which comprises the falcons, hawks and eagles of the world. In at least four important aspects of their life styles, however, the vultures differ conspicuously from all other birds of prey.

(1) They depend heavily, if not entirely, on carrion for food.
(2) They may gather in large numbers at a food source, and direct physical competition over the food is therefore part of their everyday behaviour.
(3) They fly long distances daily, and thus include enormous tracts of land in their foraging ranges.
(4) Many populations now subsist on domestic livestock. This provides the birds (and their researchers) with an interface with ranchers and veterinarians, and also with peasant people who may themselves be competitors for the carcasses.

As vulture conservationists, we have the welfare of the birds as our primary criterion. Because we are species-oriented rather than question-oriented biologists, we see the need to follow solutions to the birds' problems, whatever this may entail, with the ultimate goal of maintaining populations of every vulture species in the wild. Thus captive breeding, for example, is seen as a means to this end and not as an end in itself. A species-oriented approach is necessarily a holistic one, due to all the interfaces to which research leads (see, for example, (4) above); ultimately these interfaces lead to the root problem of conserving vultures for people rather than for their own sakes. A further pillar of our conservation philosophy is that the days of passive protection have given way to that of active management: 'hands off' must needs become 'hands on'. The Cape Griffon Vulture (*Gyps coprotheres*) forages over land owned by 17 nature conservation agencies and countless private landowners within an area of 3.5 million km^2: how could one passively yet adequately protect the species? As part of the holistic approach to vulture management, we need more mathematical and computer expertise; a start has been made with both the Cape Vulture and the California Condor (*Gymnogyps californianus*), but these attempts are as yet in their infancy.

Although vulture conservation has been on the map for some years, only in 1979 did vultures finally become recognized in the general bird of prey scene with the International Symposium on Vultures organized by S. R. Wilbur of the U.S. Fish & Wildlife Service. Here was the first chance for vulture biologists to tell each other what they were doing, and for New and Old World to join together. This they did for three crowded days of papers and films, in a symposium adjudged a resounding success on that level. But it failed in two important respects. Firstly, amid the wealth of detail there was no general appraisal of the life styles of vultures; and secondly there was no discussion of the plight of the California Condor, the most highly endangered species—then numbering around 30 individuals. The present workshop should redress that imbalance and, as befits a workshop, should be productive of principles, ideas and statements.

Finally, why should we bother about vultures at all? Do they indicate a healthy environment whilst they scavenge on dead animals? The 22 species exhibit a wide variety of life styles which, in addition to the four aspects listed above, accounts for the peculiar fascination they hold for vulture watchers. By integrating an enormous panorama of land and land-use, a community of vultures must indicate a certain overall ecological health of that area; and, similarly, so must a semi-wild species such as the California Condor or the Cape Vulture, simply by surviving in the technological twentieth century.

CONSERVATION AND MANAGEMENT INTERESTS OF EACH PARTICIPANT

André BOSHOFF
Research Biologist for Dept. of Nature & Environmental Conservation of Cape Province, South Africa.
Private Bag X6546, George 6530, South Africa. Tel: Sedgefield 15.
The Cape Province is one of four provinces, covering an area of 720,000km^2, 60 percent of South Africa. Main interest is conservation and management of the vulnerable Cape Vulture. The work centres on monitoring the two main breeding colonies and their satellite roosts, to determine the extent and rate of the species' decline, investigate possible causes for this and assess what can be done to improve the situation. Since all species of vulture in the Cape have declined and are considered vulnerable, they were included in a recent status and distribution survey of all birds of prey in the Province. Particular attention was paid to the stock farmer/vulture relationship.

Frédéric BOUVET
Parc Naturel Régional de Corse (P.N.R.C.), B.P. 417, 20184 Ajaccio, France.
Interested in the status and biology of the Bearded Vulture in Corsica.

J. C. del CAMPO
Icona, Arquitecto Reguera 13, Oviedo, Spain.
Censusing of Griffon and Egyptian Vultures in Northwest Spain, and reintroduction of the Bearded Vulture.

Jack Clinton EITNIEAR
612 North Main, Suite 239, McAllen, Texas 78701, USA.
Involved in researching life history of King Vulture in Belize, Guatemala and S.

Mexico. In addition, involved in determining the movements of the Yellow-headed Vulture in Belize and Mexico. Also trapping Black and Turkey Vultures and removing them from Texas ranches where they have become a pest.

Dr H. FREY
Vet. Med. Universität, Linke Bahngasse 11, A-1030 Vienna, Austria.
Chief collaborator with W. Walter in the WWF project (*see* W. Walter).

E. H. HENCKEL
RDI Box 21, Phillipsburg NJ, USA. Tel: 201/859-1916.
Interested in the Turkey Vulture: its roost population, daily foraging range and extent of migration. An age study of captive birds.

David HOUSTON
Dept. of Zoology, University of Glasgow, Glasgow G12 8QQ, Scotland.
Interested in both Old and New World vultures in undisturbed habitats. Major interest is the role played by these scavengers in mammal communities; how efficient they are as scavengers, and why these two groups of carnivorous birds should have evolved as exclusive scavengers. Studies in Africa have shown that the migratory species of ungulates form the major food supply for vultures, and the birds are major consumers of the scavenger food supply. In Central and South America studies are concentrated on birds in the rainforest, to try to determine the size of their food supply and their efficiency at locating food.

Dr John LEDGER
Occupation: Medical Entomologist at the South African Institute for Medical Research.
Vulture Study Group, Endangered Wildlife Trust, P.O. Box 4190, Johannesburg 2000, South Africa. Tel: (011) 725-0511 (work); (011) 680-8920 (home).
Vulture interests: Conservation and management of *Gyps coprotheres*: Electrocution and its mitigation; biopolitics of vulture conservation; promotion of international communication between vulture researchers.

Yossi LESHEM
Director, Israel Raptor Information Centre (I.R.I.C.), Society for the Protection of Nature in Israel, Har Gilo Study Centre, Doar Na Harei, Jerusalem 91076, Israel. Tel: 02-743808.
IRIC's aims are to intensify raptor conservation efforts, collect data, increase raptor educational activities in Israel and assess the influence of feeding stations on the population.

Prof. H. MENDELSSOHN
Chair of Wildlife Research, Dept. of Zoology, Ramat-Aviv 69978, Israel.
Mainly interested in etho-ecology of terrestrial vertebrates and their conservation. In particular, interested in the conservation of vultures, feeding stations and captive breeding.

B.-U. MEYBURG
ICBP World Working Group on Birds of Prey, Herbertstr. 14, D-1000 Berlin 33, Fed. Rep. of Germany. Tel: (030) 0235651.
Breeding ethology of the Black Vulture. Road counts of vultures during field trips to Mongolia, India, Nepal, South America and Africa.

Francesco MEZZATESTA and Paolo FASCE
c/o L.I.P.U., Vicolo S. Tiburzio 5, 43100 Parma, Italy.
Interested in *Gyps fulvus*, as the last population in Sardinia is much endangered. LIPU (Italian League for Protection of Birds) is organizing a feeding place and paying for a survey of Griffons.

Dr Peter J. MUNDY
Vulture Study Group, P.O. Box 1941, Harare, Zimbabwe. Tel: Harare 304572.
Interested in the life style of all species of vulture, but particularly in the five common species in southern Africa. Various studies of wild birds are followed, which act as a control against which the Cape Vulture population dynamics can be compared. Management schemes are being used to help the Cape Vulture, and now computer simulations of its population are being tried.

John C. OGDEN
Senior Staff Scientist, National Audubon Society, Condor Research Centre, 87 N. Chestnut St., Ventura, Ca. 93001, USA.
Past work with several species of N. American raptors, mainly Osprey and Short-tailed Hawk. Presently co-leader of the California Condor research programme and active in field research to determine factors responsible for the Condor's decline. Interested in all aspects of vulture and Condor (and stork) biology and conservation, especially as related to the Condor.

Luis PALMA
Direccao dos Servicas de Caca, Av. Joao Crisostoria 26-28 2°, 1000 Lisbon, Portugal. Postal address: R. Antonio Maria Baptista 2, 1° Esq., 1100 Lisbon.
Interested in establishing reserves in good vulture areas with feeding stations.

Jemima PARRY-JONES
Falconry Centre, Newent, Glos., England.
Interested in education and captive breeding; spent 8 years working at Bird of Prey Conservation and Falconry Centre on education of visitors, care of birds and rearing of young bred there. At Centre has bred Egyptian Vultures and sent one pair to Zimbabwe for research. Now lecturing to schools on Birds of Prey and their Conservation.

Rui RUFINO
Compa, Rua da Lapa 73, 1200 Lisbon, Portugal.
Shares same interests as L. Palma above.

Neal Griffith SMITH
Staff Biologist, Smithsonian Tropical Research Institute, Apartado 2072, Balboa, Panama.
Interested in Black Vulture in Panama region: its biology and life style.

Dr Noel F. R. SNYDER
Endangered Wildlife Research Program, U.S. Fish & Wildlife Service, Condor Research Center, 87 N. Chestnut St., Ventura, Ca. 93001, USA. Tel: 805-633 0161
Currently working as co-leader on Condor Research Programme.

Dr Stanley A. TEMPLE
Dept. of Wildlife Ecology, University of Wisconsin, Madison 53706, USA.
Interested in ecology of cathartid vultures, captive breeding and release into the wild, radio-tracking techniques for vultures.

Michel TERRASSE
42 rue Médéric, 92250 La Garenne, France. Tel: 1.782.63-11.
Interested in biology and distribution of Griffon and Bearded Vultures in the Pyrenees. Plans for public education on vultures and other raptors; guarding nests of threatened raptors; winter feeding of carrion-eaters; reintroduction of Griffon Vulture in the Cevennes.

Dr Jean-Marc THIOLLAY
Laboratoire de Zoologie, E.N.S., 46 rue d'Ulm, 75230 Paris Cédex 05, France.
Interest: tropical vultures.

William TOONE
San Diego Wild Animal Park, Route 1, Box 725 E, Escondido, Ca. 92025, USA. Tel: (714) 747-8702.
Home address: 14143 Melodie Lane, Poway, Ca. 92064, USA. Tel: (714) 486-2330.
Interested in avian reproductive behaviour and physiology. Employed by Zoological Society of San Diego to manage New World vulture breeding programme. At present working with Andean Condor, King Vulture, Black Vulture and Turkey Vulture. Future responsibilities will include the captive California Condor.

W. WALTER
World Wildlife Fund Austria, A-1162 Vienna, Ottakringerstrasse 120, Postfachi, Austria. Tel: (0222) 46-14-63.
Responsibility for two vulture projects: Conservation of Griffon Vulture in Austria and Yugoslavia, comprising establishment of feeding stations, guarding of nesting colonies, and release of captive-bred birds into a semi-wild and wild population; and reintroduction of Bearded Vulture in the Alps: captive birds used to establish breeding stock, with 5 breeding pairs so far formed; release of young will start as soon as 10 pairs formed; a survey of possible release sites has been made.

REVIEW OF THE VULTURES OF THE WORLD

NEW WORLD VULTURES

California Condor (*Gymnogyps californianus*) — J. C. Ogden
Highly vulnerable: 10 on a scale of 1–10 where highest number indicates greatest vulnerability. Six reasons for this:

1. Low total numbers, 1980–82 total population estimated at 25–30 birds. Only one in captivity. So far as is known, wild population still declining.
2. Restricted range. A single wild population occurring in a limited region of mountains in central-southern California.
3. Low reproductive rate and potential. There may be exceptions, but successful nesting pairs generally produce one chick every other year. Even minor reproductive or mortality problems in such a small population may cause decline.

4. Present decline due to unknown factor(s). Thus corrective action is not likely to work until adverse factor(s) known. Condor highly susceptible to shooting and poisoning.
5. Impossibility of accurate census due to rugged terrain, lack of marked birds (to date) and wide-ranging movements. Thus exact status, on a year-to-year basis, not possible to determine. Inability to detect sudden changes quickly.
6. Decline during past decades almost certainly not at a uniform rate or for consistent reasons. Evidence for one or more sudden drops in total numbers overlaying a long history of relatively slow decline. Such sharp drops presumably still possible (mass shooting at roosts, poisoning, etc.), which could still spell the end for the species.

Andean Condor (*Vultur gryphus*) — S. A. Temple

The Andean Condor occupies an extensive geographical range that runs from the Santa Marta mountains on the Caribbean coast of Colombia southward along and throughout the Andes to Tierra del Fuego. Although there are no precise figures on the total population, there are certainly thousands of Condors throughout their range. The vulnerability of the species varies geographically and appears to be related to the condition of their habitat and food supply, and the amount of human persecution to which they are subjected.

Prior to European settlement within their range, local Condor populations varied in size depending on the habitat and associated food near or in the Andes. In the northern parts of the range (Colombia and Ecuador), the Andes are flanked to the east and west by forest and the Condors were restricted to feeding on native cameloids in the high elevation grasslands. In the central part of the range, the Andes are bordered by forest to the east, but on the west a narrow coastal desert separates them from the Pacific coast. In this region the Condors forage along the coast as well as in the mountains. The coastal food supply of marine birds and mammals expands the foraging opportunities. Farther south, in Argentina and Chile, the Andes are bordered by grasslands to the east and narrow coastal deserts to the west. Here Condors have foraging opportunities on both sides of the mountains. Their numbers were probably greatest in the south-central part of their range.

After settlement, in the northern areas, native cameloids were extirpated and replaced by domestic livestock, which became the Condor's primary food. This close association with man resulted in population declines as birds were shot and poisoned. Today the species has declined and is generally uncommon, rare or extirpated in its northern range. In the central areas it has declined on a local basis wherever it has come into close contact with human activities, such as when the birds visited offshore guano islands. In the south, numbers have again declined wherever the birds came into contact with human activity. The known major threats are shooting and poisoning.

One threat of as yet undetermined significance is pesticide contamination. One Condor collected in coastal Peru was found to be heavily contaminated, but how widespread such contamination is in the population as a whole remains unknown. If a large portion of the population is contaminated, reproductive success is likely to be reduced.

King Vulture (*Sarcorhamphus papa*) — J. C. Eitniear

This is the one true tropical forest vulture, resident in central and southern America. It nests in dense forest areas and has a large foraging range. The King Vulture appears to have adapted well to a change in food supply from wild to

domestic livestock. Pesticides have not been identified as a problem for the species; rather is its survival contingent on the rate of deforestation. Birds in the northern part of Central America appear to be less vulnerable than those further south, according to the rate of deforestation.

A large captive population in the USA has shown good breeding success.

Black Vulture (*Coragyps atratus*) — N. G. Smith

This is an all-black cathartid vulture with a naked black head and, in flight, it shows white patches on the upper surface of its wings. Sexes are alike in external appearance and in weight (*c.* 1700–2000g). It is basically a lowland (rarely above 2000m) commensal of man throughout the Neotropics, but its range also extends northwards into southern and middle North America. Throughout most of its range it is not migratory in the classical sense, but individuals wander widely, apparently in search of food. They are also rapid colonists and follow man into newly opened areas.

These birds are highly gregarious, feeding, soaring and roosting together, but strangely, like all cathartid vultures, they do not breed in colonies. Their clutch of one or two eggs is usually placed on the ground under an overhanging bush or in a crevice between large rocks. They locate their food strictly by vision, unlike the Turkey Vulture (*Cathartes aura*), which apparently relies almost solely on odour. In mixed species groups they are dominant over *Cathartes*. Their ecological counterparts in the temperate zone are the large *Larus* gulls and the large corvids.

A population of *c.* 2100 birds has been sexed and marked with numbered patagial tags. A number of questions are being asked, from rather simple ones about breeding biology and population structure to more complex questions concerned with colouration. Further marking will be carried out and we will soon be ready for the experimental phase of the work. Three papers are now being prepared to summarize our work to date.

Turkey Vulture (*Cathartes aura*) — E. H. Henckel

Although the numbers of Turkey Vultures are said to have declined in certain areas, it is my belief that this bird is not in serious trouble and that the total number continent-wide has change very little.

Why has there been an increased movement to the north? Unlike the Old World vultures that have a fairly stable food source, the Turkey Vulture lacks this. More areas are developing sanitary land fills in place of dumps, there are fewer farms, the farmers no longer dispose of dead livestock by dumping but sell to renderers, and large road kills of wildlife are picked up daily. This, along with the increased human population that restricts the foraging area of the vultures, is causing the movement north, where there are more winter kills, less human population and, at this time, less restrictive disposal methods.

In New Jersey, roost numbers start to build up in late February and peak by mid-April. By late June there is a noticeable reduction in the roost size, too great to be attributed to breeding birds alone. By now all winter kills have been cleaned up, breeding birds are nesting and others have dispersed to smaller roosts. I believe that at this time some Turkey Vultures continue their push northwards to more favourable areas, thereby accounting for a noticeable reduction in the larger numbers observed earlier. These are only personal deductions, supported by roost observations and observations at Derby Hill, NY, on the eastern Great Lakes during the spring migration.

The Turkey Vulture would rate low for vulnerability. More than 300,000 birds migrate through Panama. There is perhaps a possible decline in southwest USA from pesticide effects on eggs.

Yellow-headed Vulture (*C. burrovianus*) — J. C. Eitniear
Very little is known of this species. It is found along the coastal area from the Caribbean to Panama, and in Central Brazil. It is abundant in areas of Mexico which are most heavily inundated with pesticides used by the agriculturally oriented community. Being a coastal/swamp resident, it is particularly vulnerable to pollution, which is very evident in this region: pollution from industrial activity, off-shore oil and some volcanic activity, in addition to the widespread application of pesticides. The Yellow-headed Vulture appears to have no difficulty in relating to man other than the danger from pesticides.

Greater Yellow-headed Vulture (*C. melambrotus*) — J. C. Eitniear
Even less is known about this species, other than that it is found in heavily wooded riverine areas of South America. Considerable further research is required for both species of Yellow-headed Vulture.

OLD WORLD VULTURES

European Griffon Vulture (*Gyps fulvus*) — M. Terrasse
This species, which lives in open areas such as savannahs, steppes and deserts, profited considerably from human activity up to the end of the nineteenth century. There were two reasons for this, both linked to pastoralism:

1. Destruction of the forests, which provided the open spaces essential for its search for food.
2. The presence of carcasses of large animals.

Today this species depends almost entirely on human activity (pastoralism) for its food and this factor makes it extremely dependent on methods of stock-raising.

In addition to this cause of disappearance, others have arisen during the past hundred years: direct persecution (hunting) or indirect persecution (poison to eliminate foxes, wolves, jackals, etc.) and in the regions concerned the species has suffered a sometimes catastrophic decline. On the other hand, its dependence on the carcasses of large animals and its gregarious habits make it possible to take steps to cater for its requirements with often spectacular results.

There are up to 5500 pairs in the Mediterranean region, of which 4000 occur in Spain.

Rüppell's Griffon Vulture (*G. rueppellii*) — D. C. Houston
Two subspecies, *rueppellii* and *erlangeri*, are sometimes recognized, but their validity is most doubtful. The species ranges from Sudan to northern Tanzania, and west to the Guinea coast. A cliff nester, in drier parts of savannahs, it depends on migratory species of ungulate much more heavily than the White-backed Griffon. Pennycuick has shown that birds forage over 150km from their nest site. The northern Tanzania population is dependent on the Serengeti ungulate migrations. Pennycuick estimates 3000 nests in this region. Smaller colonies exist in Kenya and West Africa, but none approaches the size of the Serengeti region colonies. The birds are comparatively scarce away from migratory herds in East Africa. It seems that this region is their headquarters, especially the Serengeti area, but Prof. Mendelssohn reports that they are also common in Ethiopia, feeding on cattle. Provided that wildlife reserves remain intact, their status seems safe.

Cape Vulture (*G. coprotheres*) — J. A. Ledger

The Cape Vulture nests colonially on cliffs, in colonies that range in size from a few to 500 pairs. At the cliff sites, the adults may suffer disturbance and interference from humans, including at times being shot at. A proportion of their chicks suffer from metabolic bone disease, due to insufficient calcium (bone fragments) in the diet. Some chicks also show fault bars in their feathers, which seem to indicate a poor food supply. Birds are vulnerable to electrocution in transmission line towers, and to being shot at and poisoned in the veld as a result of conflict with sheep ranchers; there are also odd instances of mass drownings in circular water tanks. The food requirements for nestling and adult birds, and overall food availability (carcasses) in the environment, are currently being investigated in detail. Hitherto we have found no evidence for older birds starving due to a probably declining supply of carcasses. As yet there is no adverse effect from pesticides.

Indian Long-billed Vulture (*G. indicus*) — D. C. Houston

Two subspecies, *indicus* and *nudiceps*, are probably not valid. The bird ranges from India through Burma to north Malaya. Many accounts of this species are wrong, with plumage descriptions incorrect. Probably much of the literature is based on incorrectly identified birds. They look very like Rüppell's Griffon: white ruff in adult, light edge to feathers giving spotted appearance, and a horn-coloured bill. Very light-coloured back. Immature is very like a young White-backed, but still has a lighter back. Immatures also have horn-coloured bill and more streaked plumage.

The bird is common in Himalayan foothills; only really common in Indian regions. Birds are migratory, probably originally feeding on herds of blackbuck, gazelle, spotted deer, etc. They are cliff nesters; accounts of tree nesting probably due to incorrect identification.

Almost nothing is known of its status. In Gir Forest, Robert Grubh found that, in February, Long-bills formed 13 percent of griffons, but the birds were scarce from August to October. The birds are not associated with human settlements like White-backed Vultures and are therefore probably much more vulnerable.

Himalayan Griffon (*G. himalayensis*) — D. C. Houston

Very extensive range, from Afghanistan, Himalayas, Tibet to southern China. The largest species of griffon vulture, nesting on cliffs. Recent information available only for the Indian Himalayas, where it is the commonest bird of prey. Peter Garson, in Kulu district of Himachal Pradesh, saw 60 in the air at one time; over 100 seen in 2 hours. Usually seen between 1000 and 3500m. Nesting colonies are large, of several hundred birds. In Tibet vultures used to be the usual method for disposal of the dead, bodies being dismembered and put on hillsides. The recent deforestation of much of the Himalayas, and introduction of sheep and goats, may have favoured this species. Status is unknown, but the bird seems abundant and successful.

Indian White-backed Vulture (*G. bengalensis*) — D. C. Houston

This bird is quite distinct from the African White-backed Vulture. The bill is horn-coloured; black slate back; no grey colour; no individual variation. White underwing pattern very conspicuous. Head blackish, not mottled green, yellow and black.

Age ratio in towns about 5 immatures to 4 adults. It is very abundant throughout India and seems to be resident, as there is no evidence of widespread

migration. Its ability to live alongside man probably makes it the least vulnerable of all vultures. Large numbers roost in trees in the middle of villages; even in the middle of Delhi there are large night roosts. Sacred cattle provide chief food supply in much of India.

Possibly the most abundant large bird of prey in the world.

African White-backed Vulture (*G. africanus*) — P. J. Mundy
The commonest vulture in Africa. Adapts well to ranching areas, even to being commensal with man in Ethiopia. Breeds in trees. Vulnerable to poisoning attempts.

European Black Vulture (*Aegypius monachus*) — B.-U. Meyburg
The largest of the Old World vultures, ranging from Spain to Mongolia and China. Highly vulnerable, at least in the western part of its range, because it nests on trees. These nests are mostly easily accessible. In many areas the forests where the birds breed have been cut or will be destroyed in the future. The population is also suffering from lack of food, poisoning, direct persecution, etc.

Present status: Morocco—extinct; Portugal—probably extinct; Spain—190–250 pairs (most important population in the Mediterranean at present); France—extinct long ago (17th *c.*); Italy—one or two individuals in Sardinia, not breeding; Yugoslavia—probably extinct, formerly widespread and common in some areas; Rumania—extinct about 1965, formerly very common in some parts, especially in the Dobrogea; Bulgaria—extinct, little information on former distribution and numbers; Albania—no recent information; Greece—9–15 pairs; Cyprus—perhaps 2 pairs; Israel—extinct; Turkey—100–500 pairs (rough estimate); Caucasus—estimate 70 pairs; Crimea—*c.* 5–10 pairs; Moldavia—extinct about 1929. No exact information further east. We have seen it in Mongolia, where it seems to be rather common. We saw 4–10 daily. Probably not rare in some remote areas but no good information available at present.

Lappet-faced Vulture (*Torgos tracheliotus*) — H. Mendelssohn
There are three subspecies: *T. t. t.* in southern and eastern Africa seems all right. *T. t. nubicus* has decreased over its range in North Africa and is rare in Egypt, but recently discovered in Arabia. *T. t. negevensis* was common in Palestine in 1945, perhaps numbering 25–30 pairs, now down to 2 pairs.

White-headed Vulture (*Trigonoceps occipitalis*) — P. J. Mundy
A shy species that has large territories, and is common in game reserves. Retreats from ranching areas and is not adaptable to man.

Indian Black Vulture or King Vulture (Sarcogyps calvus) — D. C. Houston
Probably the most vulnerable of the large Indian vultures. According to Brown & Amadon, it is found in forested regions of Thailand, where it is comparatively common, but recent reports suggest that it is less common there today.

A solitary feeder, unaggressive and does not attempt to dominate over griffons. Rather like the African White-headed Vulture, to which it is probably closely related. Some accounts in the literature probably confuse it with the European Black Vulture. It does not associate with human settlements; probably confined to remote areas, which are increasingly scarce. In India Grubh reports that in Gir Forest it formed only one per cent of vulture sightings.

Egyptian Vulture (*Neophron percnopterus*) — D. C. Houston
Two distinct subspecies: *percnopterus*—dark bill; *ginginianus*—yellow bill. The species has suffered a decline throughout its range, but it is not clear why. It is found over very large areas of Africa, Europe and Asia. Usually in arid, almost desert areas. In Africa it is replaced by the Hooded Vulture in moister habitats.

It has a wide range of foods: insects, reptiles, birds' eggs, scraps of meat from carcasses, excrement from carnivores and man. In India excrement is an important food supply. It will associate with man; Masai villages often have a few Egyptian Vultures round them. Partial migration from Europe.

Present status: in Europe present population is perhaps 2500 pairs, mostly in Spain. In India in 1962 Jerdon said it was abundant throughout most of the sub-continent. Formerly quite abundant in East Africa, now scarce. May be susceptible to pesticides and pollution.

Hooded Vulture (*Necrosyrtes monachus*) — P. J. Mundy
Two subspecies: the smaller *N. m. monachus* in West Africa is symbiotic with man and very common. The larger *pileatus* nests away from humans, usually in game reserves, but may scavenge off rubbish dumps. Status good.

Bearded Vulture (*Gypaetus barbatus*) — W. Walter
Three subspecies: *G. b. aureus, G. b. barbatus* and *G. b. meridionalis*. The first occurs from Spain to China. Has suffered dramatic decline in Europe and Asia Minor. On the Red List in Soviet Union.

G. b. barbatus occurs in Northwest Africa. Only little known about its population, past and present. Should be object of concern. Status survey necessary.

G. b. meridionalis occurs in eastern and southern Africa. Probably good numbers, estimated at 16,000. Decline in some areas.

Brown estimated the world population at 50,000.

Causes of decline:

1. Poisoning: baits laid out for wolves, foxes, etc. probably main cause of decline in many Mediterranean areas.
2. Shooting/trapping has been a major factor in extermination of the species in the Alps. Project of reintroduction under way.
3. Veterinary regulations/lack of food becoming increasingly a factor of limitation, affecting other vulture species even more.
4. Trade: several hundred, probably over 1000, freshly killed birds have been legally exported from China to several European states and other countries. It is doubtful if ratification of CITES will stop this.
5. Robbery of eggs/young. Probably no major cause of decline, but cases known in Sardinia. May be important in future.

Palm-nut Vulture (*Gypohierax angolensis*) — P. J. Mundy
Common in wooded river and lake areas, such as Angola and West Africa. Feeds commonly on oil palm fruits. No detailed biological study yet done. Status good, as is its habitat.

FOOD AND FOOD MANAGEMENT

The session centred on discussion of a number of key questions.

Natural availability of food

Vultures are dependent on large mammals, yet herds have greatly declined. Vultures have adapted well, in that they survive in isolated National Parks or have switched to domestic livestock. There has been a dramatic decline in wildlife herds to five percent of what they were 100 years ago. The vultures followed the migrations and therefore moved long distances between herds. Domestic livestock replacements for wildlife have lower biomass. The California and Andean Condors were dependent on seasonal food supplies, and a coastal supply, and the birds moved large distances to take advantage of these. The Andean Condor once depended on cameloids in the mountains, but these were quickly replaced by domestic livestock, so that large mammals have been constantly available. Vultures have survived mammalian extinctions.

The above points apply to the griffon and condor types. But other vultures are sedentary and live on smaller mammals, and some New World species live in forest. Mammals in the Neotropics are smaller than those found in African forests; they turn over faster and an area has twice the biomass. In addition, one or more species of cathartid can smell; possibly cathartids have a different foraging strategy and depend on a more regular food supply.

What effect does the seasonal fluctuation or regular supply of food have on the breeding success and juvenile survival of a vulture species? Although human settlement drastically reduces wildlife, the mortality of domestic livestock may be a year-round phenomenon rather than the seasonal one of wildlife. Vultures are also dependent to some unknown extent on the action of predators, whether for providing carcasses or for opening up large ones. In Europe, forest clearance into open grasslands favoured the Griffon over the Black Vulture; in addition, the latter relies on small wild animals, whereas the Griffon relies on carcasses, so that the change from wildlife to domestic also favoured the Griffon. For the Griffons, predators are very important. Many Griffons move out of Europe in winter and lose themselves in Mauretania; tens of them die annually in the Banc d'Arguin. Otherwise, they follow the domestic herds as they would have done the wildlife. On Corsica there is a good population of Bearded Vultures: there has been a good shift to feral livestock with a high mortality, but man's animal management will now interfere with this supply.

Vultures show a high intelligence and much exploratory behaviour in finding their transient and irregular food base. Today there is difficulty in studying the natural relationships of vultures and their wild food, due to the amount of man-induced change in the world.

Food requirements

Metabolic studies of Kestrels indicate that a wild bird needs about three times the food of a captive bird; for an Andean Condor this is about two times. Whilst it is easy to work on captive birds, these may give misleading figures due to temperature effects (higher in captivity); a captive is usually heavier than a wild bird; a wild bird is likely to digest its food better and is less stressed. In addition, it is known that tropical cattle can reduce their basal metabolic rate when food supply is low, and vultures may be able to do likewise. A captive Bearded Vulture is fed 250g of bone per day. A griffon of 6.5kg body weight eats 500g per day, with a largest meal of 1.7kg. For how long can a wild vulture fast? A female California Condor went for ten days without any signs of weakness, and an Andean Condor did the same, this species being able to recover from a weight loss of one-third. An American Black Vulture is grounded after losing half its body weight. An experiment on four griffons indicated that they could fast for one month; wild Cape Vultures

have fasted for five days due to bad weather. There must be seasonal variations, and in captive birds appetite may fluctuate apparently at random.

The heavy water procedure for measuring energy metabolism in wild birds is expensive, needs very careful technique and requires recapture of the bird. Studies on smaller species indicate that wild birds need 1.5 times the food requirements of captive birds (in contrast to the figures given above). Thus a wild griffon of 7.5kg body weight may need around 600g per day (8%). Vultures may have low energy requirements because they are economical fliers and are not heat stressed. Soaring Turkey Vultures, however, show much wing and feather movement, and the back feathers of one soaring bird had a surface temperature of 65°C.

Both New and Old World vultures can put on large fat reserves and thus fast for long periods.

Food quality

In the wild, vultures feed on many species, but in ranching and artificial situations (e.g. at feeding stations) they are reduced to a few species of livestock. Is there a reduction in the quality of food? The proportions of the major nutrients, vitamins and minerals change little from mammal to mammal, except that domestic livestock have more fat, so the source of vultures' food seems immaterial. Nestlings fed on wild prey do not have fault bars in their feathers, whereas Cape Vulture nestlings fed on domestic species do; but fault bars may be related to stress rather than to food quality.

The main problem with domestic animals is that they contain additives, such as antibiotics, steroids and other growth stimulants, and chemicals such as pesticides and tick-release agents. What long-term effects do these contaminants have on the vultures? Chemicals may be toxic to birds but not to humans or livestock (e.g. DDT, drugs). Griffon Vulture productivity in Europe seems unaffected over the last 20 years by sheep dips; Lappet-faced Vultures in Israel eat carcasses with antibiotics but their reproduction has remained good; vultures seem less liable to accumulate DDT than some other raptors, and pesticides anyway disappear more quickly in hot climates. Steroids are more dangerous than antibiotics. Long-term studies are needed to monitor the effects of contaminants on vulture reproduction. Vultures are resistant to botulism. Modern drugs disintegrate rapidly, but older, longer-lasting drugs are still used in the Third World.

At feeding stations in Israel Lappet-faced Vultures did not prefer antelopes over domestic livestock, but there was some evidence for a wildlife preference by the King Vulture in Belize.

Food as a limiting factor

It is usually said of the California Condor that the food supply is not a factor in its decline. The birds make little use of feeding stations and seem able to find food daily when raising a chick. In Israel in the 1950s there was no evidence of a lack of food for griffons, but in the last decade emaciated juveniles have been found; and over the last 50 years the Lappet-faced Vultures have not been molested by humans, yet the population had declined to three pairs by 1979, when a feeding station was established, which the birds frequently use, obviously requiring food. But vultures' food is usually abundant in one season and scarce in another, and a feeding station is likely to bring in birds from a large area, and far from their nesting sites; thus the numbers are artificially boosted. In southern Africa there is a seven-year cycle of drought and rabies epidemic, and this clearly has an impact on the vultures, particularly on their breeding frequency and success. It is

essential in vulture management to try to identify the limiting factor for each species; thus, if it is nest sites, artificial feeding is a waste of time. Feeding stations, however, whether necessary or not, do have a function in conservation for the public's benefit at least. A feeding station can also help in research, but one must beware of allowing the birds to become too dependent, as they must then re-adapt later; one may also be feeding only those birds which are truly surplus to the population. Such stations can serve multiple purposes but need to be continuously evaluated, and their use may be constrained by veterinary regulations.

Disease transmission

The vulture is potentially able to spread disease. In the case of anthrax, the bird digests all but the spores, which can be passed out elsewhere; so farmers blame vultures and vets insist that carcasses are destroyed or that those used at feeding stations are checked (as in Israel). So why is anthrax not breaking out wherever vultures fly? Vultures probably help to prevent its spread by eating carcasses quickly, before sporulation occurs. At garbage dumps in Panama there are no flies and rats when Black Vultures feed there; the migratory Turkey Vulture does not spread foot and mouth disease into Panama, yet it must feed on many infected carcasses in South America; in Europe there are 50 feeding stations for vultures with no evidence of any disease transmission, yet vets do not allow such stations in Greece (G. Handrinos). In South Africa, too, the prevailing opinion is that vultures spread disease; vets need education, and it may be more hygienic to feed carcasses to vultures than to bury them (this was the standpoint of the first Spanish feeding station). However, the vet sees the potential problem here, and it is a valid opinion; so the vulture conservationist should compromise with him. Food for vultures is dwindling as garbage dumps are covered over and veterinary attention to livestock improves; thus supplementary feeding may have to be offered over wide areas. In southern Africa there is a definite role for the Cape Vulture in ranching systems, as a cheap means of disposal of carcasses 'unfit for human consumption'. A small area is fenced off to prevent access by mammalian scavengers.

Given the human population increase and better livestock husbandry, what long-term future is there for vultures? Optimism must be the key-note, and it is certainly feasible to maintain a small population, by means that include feeding stations if necessary, in the hope that conditions will improve later. We do not know what the future holds, but that is no reason to let up on our concern for vultures and their food supply.

BREEDING

Aspects covered were grouped under the following headings:

Factors influencing nest sites

The essential difference between New and Old World species is that the former are solitary, cliff- or ground-nesting species that build no nest structure, whilst the latter are often colonial and cliff- or tree-nesters. The probable reason for colonial nesting in some Old World species is the advantage to be gained from transfer of information on suitable food supplies. New World species, being less dependent on migratory ungulates, never developed the habit of colonial nesting. Many of them nest in apparently vulnerable sites, but the chicks' ability to regurgitate foul-smelling fluids seems to be an effective deterrent to predators. Nest sites may

be limiting the population of some griffons, which need cliff ledges; artificial nests provided for Turkey Vultures in New Jersey enabled birds to breed in areas where natural sites were scarce.

Age at first breeding

Information from wild birds is limited and most data come from captive birds, suggesting that birds can breed when aged five or six for *Gyps fulvus* and nine for *Aegypius monachus*. Birds do not always begin breeding as soon as they acquire adult plumage. It was emphasized, however, that this is a factor which may be very variable in wild birds, and the age at which breeding is physiologically possible may not be the same as the age at which it first occurs. Food availability may be the major factor determining age at first breeding.

Frequency of breeding

Information from wild birds is again very limited. It seems likely that many small vultures, griffons and possibly even the California Condor can breed in consecutive years. However, this again is probably a variable factor which would be expected to reflect the food supply available. In poor conditions the intervals between breeding attempts are presumably longer.

Clutch size

All Old World species lay a single egg except for the Bearded and Egyptian Vultures, which lay two. Probably all species, however, are able to replace a lost egg after an interval of five or six weeks. Among New World species, the Condors lay a single egg, but both wild and captive birds have been shown to lay replacement eggs if the original is lost. The importance of this for captive breeding programmes was emphasized. The smaller New World species, the Black and Turkey Vultures, usually lay two eggs.

Factors influencing fledging success

Pesticides. Studies of Cape Vultures in South Africa have shown only mild levels of contamination of eggs by pesticides and no significant shell-thinning or reduction of breeding success. Studies of the California Condor indicate a dramatic reduction in shell thickness apparently associated with pesticide poisoning, but this does not seem to have caused any decline in breeding success. More information is needed, but initial findings suggest that Condors may not be highly vulnerable to toxic chemicals. Evidence of the supposed hormone imbalance in Condors caused by poisoning is rather questionable.

Nutritional imbalance. The *Gyps* group face a problem of calcium intake because their diet consists of soft tissues from large mammals, containing little calcium. Much evidence was presented to suggest that birds overcome this deficiency by seeking calcium-rich food items such as bone fragments or limestone rock chips. A few Cape Vulture colonies have shown severe calcium imbalance in about 20 percent of chicks. It is suggested that this is due to a shortage of bone fragments because large carnivores are no longer found in the area. Present studies on provision of bone chips for these colonies aim to try and overcome this problem.

Disturbance and nest site abandonment. Species seem to react to disturbance in varying degrees. Among Old World species the White-headed Vulture seems particularly susceptible, and some large griffons may also change their nest sites

in the year following human disturbance. But most evidence on this factor is anecdotal and few conclusions can be drawn on present knowledge. The difficulty of proving nesting failure to be directly due to disturbance rather than to poor-quality nesting areas was emphasized. But even mild disturbance can be important if it provides opportunities for ravens or crows to attack an egg left unguarded for a few minutes.

Post-fledging dependence. There are clear indications that young birds are more vulnerable than adults to such factors as electrocution from badly-designed electricity pylons, drowning at sea, or grounding by bad weather. There may be a difference in the degree to which New and Old World species remain in association with, and are fed by, adult birds on the nest site. Periods of up to six months after fledging have been recorded in the Lappet-faced Vultures, but feeding of young by adults away from the nest site has never been observed in any species. New World species, however, do not return so regularly to their old nest sites, and juveniles are fed by adults at food sources for over one year after leaving the nest in the case of the Condors.

Captive breeding

A recent survey of major zoological collections in the USA has shown a wide range of both New and Old World species, but some—e.g. the South American Yellow-headed Vulture and the Indian Long-billed and Himalayan Griffons—are not represented. Professor Mendelssohn outlined his experience over 40 years' captive breeding of European Griffon Vultures and their release in Israel and elsewhere to augment declining wild populations. Lappet-faced Vultures are also being reared from eggs taken from wild birds. Michel Terrasse then described the programme for reintroduction of European Griffon Vultures in the Massif Central region in France. This area formerly sustained large breeding colonies and still has a potentially large food supply. Some 35 birds were kept on the site in aviaries, and in 1981, 10 birds were released, all of which had bred successfully in captivity. Two pairs had already built nests and laid eggs in the wild.

Reports on captive breeding of New World species were deferred to the session on the California Condor.

MARKING AND MONITORING

Capture methods

A cannon net is suitable for social feeders as it is capable of capturing large numbers of birds at a time, has a safe detonator which is relatively cheap, and the whole system costs US$1000. The chief problem is that birds must be removed quickly from the net because of overheating, but one solution is to place wet sacks over them until they are removed.

A rocket net has two possible advantages over the cannon net, namely that it covers the birds much faster and a very large net may be used, although for vultures this may seldom be desirable. The disadvantages are the fire risk caused by the rockets and the excessive noise.

Walk-in traps are cheap, cause no mortality and can catch a relatively large number of birds. They are perhaps suitable only for cathartid vultures. Wire traps can damage birds, so nylon or similar mesh material is preferable.

Padded jaw-traps are good only for docile species; non-selective, as they may catch other animals; inexpensive; light and easily transportable.

Drugs are useful in some special cases, but the problems encountered with birds having full crops may discount any advantages, as birds may fly away in a semi-drugged state.

Marking techniques

Rings are cheap and universally obtainable, but hard to see at a distance and the colour combinations require expertise to read. They are visible only when birds are perched, but perched birds often conceal their legs. Some cathartid vultures defecate on their legs, when the excreta fills the gap between ring and leg, often causing injury.

Some types of narrow plastic leg rings may be used on cathartid vultures. PVC leg rings have good potential but must ideally be made of UV resistant colour, which is particularly important for tropical species. Dyes and windows cut in remiges and rectrices have a short life but are useful for certain projects and have no lasting effect on the birds.

Patagial tags are excellent, such as PVC cattle ear tags with numbers, but careful placement is necessary to prevent rotation and feather coverage. The use of streamers in combination with cattle ear tags is not recommended. All materials so far tested break down under UV light and in certain circumstances cause flying problems due to turbulence. Because of fighting at carcasses, there is a possibility of entanglement with wing tags in Old World vultures.

Radio-telemetry is helpful in projects meriting the expense and expertise. Solar power provides for very long transmitter life. The transmitter and antenna do not affect the bird's capabilities. Back packs with harnesses cause problems through entanglement. Radio-telemetry is relatively labour intensive.

Aims of a monitoring programme

These depend on the species involved, what is already known, and the questions that need answering. The objectives of a monitoring programme need to be established at the outset and follow-up arranged accordingly.

As much information as possible should be obtained from captured birds. Determination of sex and gonadal condition by laparotomy is deemed worthwhile in some easily-handled species but may be difficult in others, especially in some of the larger Old World vultures.

After release of marked birds, follow-up monitoring programmes should be systematic and effective, so as to provide the information sought. A good publicity campaign is an essential component but, where possible, the programme should be carried out by the biologists themselves, since errors can occur if amateurs are involved.

Capture-recapture techniques do not appear to have much relevance for vultures, although they may indicate trends. One suitable monitoring technique is to count repeatedly the number of breeding pairs, or to photograph cliffs in the case of certain species. This may obviate the need to mark the birds, but it excludes the non-breeding segment; nor is it feasible with New World species or other solitary nesters. An alternative plan is to count only adults. However, although this will reflect trends in breeding population, it offers no basic information on recruitment.

Mortality data may be difficult to obtain from marking programmes involving long-lived birds. Some pairs change nests or partners, so that birds which disappear from the study site may not be dead. However, it is important to mark the birds to establish nest site retention and breeding frequency of individual pairs. If possible, marking should be carried out at various sites so as to monitor influx and efflux in particular colonies.

A non-marking technique that has proved useful for limited populations involves the recognition of individual birds by their distinguishing features, e.g. moult patterns, broken or damaged feathers, abnormal feather growth, etc.

Where possible, both nestlings and adults should be marked so as to be able to determine survivorship of different age-groups. It is important that markers are not lost or broken.

The extensive Cape Vulture ringing programme had defined objectives, *viz.* juvenile dispersal, age at first breeding and fidelity of breeding birds to natal colonies, and to date information has accrued on all aspects.

Most existing methods of determining survivorship rely on the ratios between age groups, but recently statisticians have discounted some of these.

Marking/monitoring programmes should be evaluated periodically, e.g. after five or ten years, and discontinued if no longer worthwhile.

CONCLUSION

The problems involved in monitoring a marked population are considerable and should be evaluated in terms of the defined objectives of the marking programme.

THE CALIFORNIA CONDOR

This session opened with a review of the overall programme by Snyder, Ogden and Temple, followed by a question period and, finally, a general discussion.

Historical aspects — Noel Snyder

The Condor is semi-gregarious and of inconsistent sociality. Its population is currently estimated at 20–30 birds, which form one population. Its range of 50,000sq. miles comprises:

(a) a feeding range on the edge of the San Joaquin valley, hilly ranching land owned by a few large corporations and landowners (i.e. private land) with a food supply of deer and mainly cattle and some sheep, with staggered calving, and

(b) a breeding range in the mountainous areas on the outside of the 'horseshoe' range, National Forest land well-protected but very rugged and difficult of access. Nesting sites are in cliffs and easily accessible; one recorded high in a tree. The deer, elk and pronghorn have been largely replaced by domestic livestock.

Research was started by Karl Koford in 1939; originally a 'hands-on' researcher, he later became 'hands-off'. Other researchers included Ed Harrison, Alden Miller, the McMillan brothers and Jan Hamber. Fred Sibley was the first USFWS researcher 1966–69, followed by Sandy Wilbur 1969–79; John Borneman (1965) was the National Audubon naturalist; Dean Carrier (Forest Service) was also involved. Thus a considerable number of man-years of research have been spent, yet little is still known; the species is very difficult to study, mainly due to the terrain. In late 1979 Congress recognized the Condor's plight following the AOU/NAS report which recommended radio-telemetry and captive breeding. Ogden (NAS) and Snyder (USFWS) were then brought in to lead the new recovery effort, but this has been fraught with political difficulties in spite of the support of Congress and the ornithological community. Thus, to date, there are no radio-tagged birds, and no more in captivity.

So far the team has concentrated on intensified 'hands-off' research, on finding pairs and watching nests. One 1981 nest had an egg with 30 percent shell thinning, yet it hatched and the young survived; this nest is in use again in 1982. In the 1960s eggshells averaged 31–32 percent thinner, yet nesting success seemed good, with a number of young fledged, so DDT had little effective impact. Egg-breakage, rather, seems site specific, with rock-filled nests accounting for about half the known instances of egg breakage in both Koford's and Sibley's studies. Condors are very aggressive to Ravens, but only in the nesting territory. Ravens may be responsible for some egg breakage; they have been seen to eat an already broken egg. Condors also chase off Golden Eagles, which are known to stoop at Condor nestlings. In one pair of Condors (1980) the male was very aggressive to the female when the chick hatched and would not let her brood it. The chick survived. In 1982, the male would not allow the female even to incubate, and the egg rolled out of the cave and broke; the pair has re-laid. In another pair, watched for two years, one bird is only just adult and there have been persistent difficulties in copulation, which has not yet occurred successfully. Possibly these inter-sexual problems are normal.

In 1982, ten immatures were identified, eight dark-heads and two sub-adults, and as we know only five pairs of breeding birds, this suggests that reproduction is reasonable. Is the decline in the population therefore caused by mortality factors? Potential factors are:

(1) Oil drilling in the area. Sumps are not covered or fenced as they should be and it is rumoured that Condors fall into them.
(2) A maze of high-tension powerlines. One collision has been seen, resulting in the bird's death. However, Condors do not perch on the towers, so they do not get electrocuted. It is very difficult to get manpower to search the lines.
(3) Much shooting. The gun community want to retain their shooting rights in the forests, so there might be a backlash if closures were attempted.
(4) Poisoning campaigns against ground squirrels, using strychnine, 1080, etc. Condors feed on poisoned squirrels but the secondary effect of this is unknown. There are no recent instances of poisoned Condors.

The team can go some way with observational techniques, but other questions need an active management approach.

Capture and radio-telemetry — John Ogden

Koford's later 'hands-off' approach and his vigorous opposition to the recovery plan has spawned groups of other opponents, culminating to date with the book *Captive or Forever Free* (Friends of the Earth). Condors must be trapped for radio-telemetry and for captive breeding. In the summer of 1979, radios and tags were tried on the Patuxent Andean Condors, a solar-powered patagial fixed radio seeming best. In September 1980, experience was gained with the cannon net in South Africa and in October 1980 techniques were evaluated on the Andean Condor in Peru. The walk-in trap catches small vultures but not the Condor; the clap trap has an injury risk, though it was tried on Condors years ago; a rocket net was used with success. Transmitters attached to the Andean Condors gave tremendous success in one month, with more data on movements than has been learned in 40 years on the California Condor. We decided on the cannon net, as efficient and with a low injury risk: the net must be fired when the bird is at the carcass and with head down. We also visited the Los Angeles and San Diego Zoos to gain experience in handling vultures.

In late summer/autumn 1981, as a final test of the cannon net and radio tagging,

we caught three Turkey Vultures. There were no problems keeping track of the birds, nor in the birds suffering ill effects from the tags; they were tracked by means of portable receivers and a Cessna 180 aeroplane. The radio has a range of up to 85 miles. In the summer of 1981 we had radio-tagged two Turkey Vulture nestlings. One soon disappeared and we had a ten-day search before finding it dead in a canyon, probably preyed on by a Golden Eagle. Thus radio tagging can assist in identifying the causes of mortality.

We have proposed and developed an automatic tracking system. California has issued a trapping permit, but too late for us to have caught any Condors so far. We have two trap sites in ranching country.

Captive breeding — Stanley Temple

Our aim is to increase the number of Condors. In small populations there is a risk of in-breeding effects; there must now be a great risk of genetic problems for the Condor. These can be lessened if the population increases as rapidly as possible, and if maximum use is made of the genetic material. In the wild, reproduction is painfully slow, but in captivity the rate of increase can be greatly accelerated.

The Andean Condor is a surrogate species. It has proved relatively easy to breed in captivity (e.g. at San Diego, Bronx, Miami, and Patuxent in particular). Pairs can breed every year and are even triple-clutched. Thus in two years, six young can be produced instead of the usual one, which is a rate of increase favoured by geneticists.

Can, however, captive-produced young be returned to the wild? Bronx and Patuxent birds have been taken to northern Peru, where there are wild Condors. The area is isolated, with a good food supply, and birds can be easily monitored. Birds of one, two and three years of age, as well as fledglings, have been released after acclimatization in a release pen. Pens were opened and the hacking method was used—food was put out at increasing distances (up to 10km), the young birds thus being taught to forage. They quickly learned to search, and soon switched to natural carcasses. Birds were radio-tagged and released in small groups in which they remained aggregated. To date, the longest survivors have been wild for nearly two years; their movements and behaviour, especially at carcasses, seem normal. Some young Condors have got into difficulties, however: two became oiled in a pool by a pipeline; one died in an accident, perhaps being scared off its roost at night; two had disease-related problems, intestinal troubles possibly related to the bacterial load in natural carcasses as compared to the hygienic diets in zoos; one bird starved to death during a period of dense fog (it had previously been 'slow' at learning). All the other birds are now essentially independent.

QUESTIONS

The California Condor recovery effort will be a test case in vulture conservation.

Where are the problems in getting the permits? A vocal minority is philosophically opposed to 'hands-on' research as the Condor symbolizes wilderness: to touch it is to spoil it. The extremists would prefer to let the bird go altogether. Main opposition opinion is that the problem is one of habitat and perhaps of shooting, and these should be resolved. The Sierra Club, Friends of the Earth, etc. are not open to discussion, yet they are influential with the State. The State ignores the support given to the programme by the ornithological community.

The Condor is a victim of the historical dispute between the State and Federal governments. The process is now one of painstaking education and discussion. The people of California feel that they 'own' the bird, which is a *world* endangered species.

Effect of previous researchers? Koford was the senior statesman of the Condor, yet some later workers did not pay homage to him. This may have sparked off his antagonism to the programme. It is clear that man management is a priority, yet experience in the field of endangered species conservation shows that a programme is influenced, if not directed, by personality conflicts. The present team could certainly do with a third leader, one with administrative ability, but the problems of employing the right person are great. To date, the recovery effort has been bedevilled by 'opera singer' egos.

Bureaucrats? These are trained to retain permits rather than issue them, as they would prefer nothing to go wrong. Yet the biologist working on the Condor needs bureaucratic/administrative back-up, whereas the public want to speak with the researchers themselves and not with a representative. This takes up much valuable time, and the team has to be careful not to mislead the public into thinking that captive breeding is quick; otherwise there would be a real risk of alienating public opinion and losing financial support.

Relevant experience? The team now has some experience of handling large vultures and has handled two wild Condor nestlings and one captive adult. Mountaineering skills have improved. But the Condor is highly endangered and any handling must be absolutely safe and kept to a minimum, although there can be no definition of minimum/excessive. There seem, incidentally, to be no problems in handling wild Andean Condors. Wilbur's data indicated a decline of two birds per year (up to 1980), thus the population has about 15 years left. The situation is urgent and leaves little time for data collection by 'hands-off' methods, whereas radio-telemetry (which obviously requires handling of the birds) will provide certain answers in order to define the Condor's problem. Other options risk losing the whole population, whereas the risk involved in trapping/handling/following is slight and should be considered worthwhile. Any programme must involve a period of learning, when the animal may suffer extra mortality (e.g. in a large study of African vultures there was a two percent capture mortality early on, but none later): this, however, cannot be allowed a second time with the Condor (one handled chick died in 1980), so perhaps experienced biologists should be imported into the recovery effort on a temporary basis. In addition, bureaucrats may be awkward to handle when the researcher lacks considerable experience with vultures, and bureaucrats must in any case be disabused of the opinion that 'endangered' means 'delicate'. On the contrary, vultures are very robust animals. A compromise could surely be agreed on, of a cautious research approach by sensitive and experienced biologists using a limited amount of well-monitored 'hands-on' methods.

Details of the 1980 chick's death? The recovery team was of the opinion that there was so much misinformation and lack of information on the Condor's biology that research should start again from the beginning. This biology includes details of the growth and development of chicks, and permission to visit two nests in 1980 was given. The first chick, about 45 days old, was docile throughout the one hour of handling and measuring. The second (about 65 days old) was in a cave

inaccessible to Ogden and Snyder, and a staff biologist who was a mountaineer and had had experience handling falcon chicks examined the Condor, which was aggressive. This chick died of stress after 25 minutes; the autopsy revealed normal fat levels. The death was totally unexpected; but subsequent experience in handling Andean Condor chicks showed that older chicks struggled (captured adults by contrast being docile) and were therefore vulnerable to stress. The chick handled in Work's study was docile throughout its development; however, cardiac failure occurred in a captive Lappet-faced Vulture during handling—the only occasion in handling many vultures. It had to be admitted that the recovery team was inadequately prepared for examining chicks. Thus the obligatory presence of a veterinarian has been written into the trapping permit, although this raises logistic difficulties. In any case, netting the wild birds promises to be a nerve-racking experience, as there is now much tension felt by the researchers.

DISCUSSION

The Condor has used several accessible nesting sites in country where many inaccessible ones are potentially available, but to date there are no records of predation by terrestrial animals. The bird is a formidable opponent when protecting its nest. Protection is perhaps also affected by the nestling's odour.

There has been much concern over the poisoning campaigns for Ground Squirrels and Coyotes in the Condor's range. Coyotes are now scent-trapped, as poisons against them are illegal. In recent years 1080 has been used on the squirrels, and this compound is known to have secondary poisoning effects. The mammalian community was badly affected, but no effects on birds (including the vultures) were noted. The compound was thus deemed safe for birds, but from only a short-term study; a long-term study with various dosage rates is needed. There was an outcry against 1080, so that only government officials can now use it. If the compound was banned, it might possibly be replaced by a worse one; the use of an anticoagulant killed raptors but had no effect in experiments. As rodents are a great problem it is politically impossible to ban all poisons. One of the recovery team's priorities is to screen the secondary effects of poison on cathartids. A German study 20 years ago showed that zinc phosphide was a safer poison in terms of secondary effects but was a less efficient rodenticide. In California zinc phosphate is commonly used and requires no permit.

The recovery team has requested permission to take eggs for artificial incubation and to keep the birds for captive breeding (a wild pair in 1982 lost the first egg and laid a replacement). There has been a high rate of success with artificially incubated Andean Condor eggs. The State of California seems sympathetic to this request, yet at the same time it does not favour telemetry on wild birds. Telemetry itself seems unlikely to produce answers fast enough, whereas captive breeding would at least produce birds. This is a priority.

Causing a wild pair to double-clutch seems a preferable technique, as the birds have at least chosen each other. The chick hatched artificially from the first egg would be returned to the wild parents and the second egg taken, the chick from which would be kept. In this way the optimum breeding rate would be maintained. Much comparative information has been gained from rearing Andean Condor chicks, avoiding imprinting on the keeper by using a puppet; in this way it was also discovered that the chick at first preferred the colour white (the parent's bill), but

after a few days it greatly preferred red. The puppet's eyes should look at the chick for communication purposes. With an Andean Condor chick, meat was fed after it had been vomited by a Turkey Vulture; chemically digested food was not used. Three hand-reared Andean Condors released into the wild initially showed tameness but survived. Each chick was at first fed in isolation; subsequently, when they could feed themselves, they were put into a group. No digestion occurs in a vulture's crop, so the chicks had a taste preference for the food vomited by the Turkey Vulture. It was assumed that whole mice contained all the necessary nutrients (especially vitamins and minerals) so none was added. Whilst some workers (Mundy, Toone) considered that digestive enzymes need not be added to a hatchling vulture's food, others (Houston, Mendelssohn, Temple) stated that enzyme additives were necessary. It was agreed that fresh meat is fed to wild vulture chicks from the second week or so of their development, but whether hatchlings are fed on enzyme-rich 'dribble' from the parent's stomach or on fresh meat well wetted with saliva was unresolved. Certainly Toone's Andean Condor was raised from hatching on fresh food, as was a King Vulture at the Los Angeles Zoo.

There is, however, a potentially serious disease problem for artificially reared birds. How they will adapt to the wild in their immune system if they have not had access to their parents' vomit. Care must be taken in giving medication to vulture chicks: an application for nematodes in five young Cape Vultures caused one death and the loss of feathers from all the others. Parent birds are likely to pass on information for the chick's immune system via their salivation, at least to train the chick's system to respond and not just to certain specific organisms. Birds of prey also produce a nasal gland secretion (salty), which may help too.

Out of five Condor pairs, four have shown problems between the sexes—actual aggression in two pairs and unsuccessful copulation in the others. In one pair the male was very dominant and prevented the female from incubating; the egg was eventually broken, but its shell was 12 percent thicker than the historical average. Thus there was probably no pesticide contamination, although there may have been an effect of pesticides on behaviour. In a small population, however, where there is little choice of partners, there may naturally be some mate incompatibility; the two pairs which failed to copulate successfully may well have been in process of adjusting. Some albatrosses, for example, take three to four years over this process of mate adjustment before they lay fertile eggs. Sexual-type behaviour (e.g. mounting) is also used in social contexts and there is the possibility that pesticides have affected this behaviour; unfortunately, little is known of the effects of pesticides on Andean Condors. One bird (1969) had a high level of 320 ppm DDE in the lipid; Condors in Peru were certainly contaminated in the organo-chlorine era and the marine ecosystem remains polluted. Currently, there is little, if any, breeding by wild Andean Condors in the Peru study area, although the reason is possibly food-related. Eggshell fragments are, however, thinner than fragments from captive birds.

It is most unlikely that Condors are being exposed to the isomer of DDT that mimics oestrogen and thus has a feminizing effect. Such an effect has been experimentally shown in gulls but is not known in any wild species, including Brown Pelicans which would be the most likely to show it. No collections have been made of proven condor faeces in order to check steroid levels. A control study could certainly be done on captive Andean Condors and other cathartids. California Condors are reproducing in the wild, so the pesticide effect, if any, seems to be now historical.

RESOLUTION

The workshop decided to support the recovery team in its total programme and to prepare both an ICBP resolution and a strongly-worded letter to this effect.

THE NEGEV LAPPET-FACED VULTURE (*TORGOS TRACHELIOTUS NEGEVENSIS*)

Y. Leshem & H. Mendelssohn

This bird was recently described as a new subspecies by B. Bruun, H. Mendelssohn & J. Bull (1981, *Bull. Brit. Orn. Club* **101**, 244–7). A remnant population of this subspecies survives in Israel in the Southern Arava, where it appears to have reached the verge of extinction. The vultures do not nest on the east (Jordan) side of the valley, which has steeper slopes and is less savannah-like. They nest in acacia trees, and pairs may raise one chick every year; originally they bred in small groups of two or three pairs.

The Lappet-faced Vulture is an opportunistic feeder, formerly on ibex, gazelles and camels and now on domestic livestock; hares, spiny terrapins and dab-tailed lizards are also eaten.

H. Mendelssohn estimates that in the 1940s, 25–30 pairs nested throughout the Negev. Since establishment of the State of Israel a continuous and significant decline has been noted in the population of these vultures. In 1975 there were still three pairs active in the Northern Arava, one pair in Nahal Hayon, and three pairs in the Southern Arava. By 1980 only three pairs remained in the Southern Arava, and in 1981 only one nestling succeeded in hatching. The drastic decline in nesting pairs is apparently due to a combination of factors: the use of pesticides (especially thallium sulphate); shooting by soldiers (nine instances known, mainly during the early years of the State); the disappearance of readily available food sources (there is some indication of food shortage in recent years); disturbance of nesting sites (by deployment of military units and the increased presence of hikers in the Negev); and the birds' late sexual maturation. On occasions not only mates but also pairs have disappeared. In 1981 the female of one of the three remaining pairs had an accident, after which her mate disappeared; and in 1982 there were only two pairs left.

In the nesting regions of the Southern Arava the Nature Reserves Authority set up feeding stations (and supplied water) in order to supplement dwindling food supplies, and closed the nesting areas to army personnel and hikers to prevent disturbance. A research project was conducted between April 1980 and May 1981. Once every two weeks, carcasses of calves were brought to the feeding stations and followed up by three to five days of continuous observation—in all, 72 days of observation. These aimed at ascertaining the effects of the feeding stations: how many individuals fed on the carcasses, what quantities of carrion were consumed, and the interaction between the vultures and other raptors and carnivores. Data were gathered from the nesting sites to provide information on nesting biology and the connection of the young with their nesting area after leaving the nest. Radio-telemetry devices were acquired to track the movements of the young vultures but, in view of the nesting failures, were not put to use. About 1600 pellets were collected from the nesting sites. These revealed that calf carcasses consumed at the feeding stations constituted the main food component. Despite the regular supplies of food at the stations, the vultures did not rely on this alone but also consumed other animals. Foraging ranges were extensive. Negev

Lappet-faced Vultures were sighted over Aqaba and the mountains of Edom to the east, at Kibbutz Grofit to the north and Kuntilla to the west. Carnivores, mainly wolves and hyenas, play significant roles by tearing apart and scattering pieces of the carcasses. During the day, this food attracts Brown-necked Ravens, Egyptian Vultures and other raptors, serving the Lappet-faced Vultures as important indicators of potential danger and helping to guide them to food. After several months, the young Lappet-faced Vultures disappear and it is not clear what becomes of them.

Captive breeding nuclei can save populations on the verge of extinction. From the seven pairs in 1975, three chicks were taken into captivity: one died, and the other two, although male and female and now six years old, do not court. The single 1981 nestling was also removed. Over the years, three birds have been confiscated, a male and a female with damaged wing and leg, and a 30-year old female that no longer lays eggs and is imprinted onto the keeper. These two females started laying eggs at the age of nine years. There were thus six captive birds by the beginning of 1982. The question was whether to capture the entire remaining population and try to stabilize a healthy breeding nucleus without the danger of inbreeding; or whether to continue investing efforts to maintain these birds in the wild (by still providing food, closing nesting areas, etc.) so that the population could recoup its losses by itself. However, one instance was known of double-clutching by a wild pair, so in 1982 an egg was removed a few days after being laid. This was artificially incubated at 34°C and 35 percent RH, and was turned once every two hours. The hatchling vulture was at first fed on whole small animals to which digestive enzymes had been added, and it grew in the presence of a mirror. When the feathers sprouted it was exposed to the older Lappet-faced Vultures by being kept in a small cage adjacent to the large aviary. The wild parents laid a replacement egg which hatched, and these adults are now rearing a chick, as is the other pair. It is planned to take both these chicks into captivity, as well as all those hatched in future years. However, the lack of success so far in breeding these birds in captivity makes the future of a breeding nucleus doubtful because of the long time required to reach sexual maturity and the uncertainty that released individuals will acclimatize themselves in natural habitat; there is also a likelihood of inbreeding depression. On the other hand, the nesting statistics during the past decade, and the disappearance of the young birds, provide little hope for the Negev population to re-establish itself on its own. The problems are similar to those facing the California Condor.

DISCUSSION

The programme of removing wild-produced chicks met with general approval. The suggestion was made of adding birds of the *nubicus* subspecies if there proved to be inbreeding problems (Mendelssohn, Snyder), but another view was that such hybridizing should in no circumstances be permitted (Mundy). Lappet-faced Vultures generally feed on small animals much more than on larger carcasses, although they will eat pieces left lying around after hyenas have torn up a large carcass. In southern Africa, *tracheliotus* frequently visits large carcasses and may even depend on them (Namib Desert). It was realized that very little is known of the habits of *nubicus*. But how effective can a population of four birds (1982) be in finding food, and can such a grouping be maintained? As the birds breed every year, the problem does not seem to be one of food shortage so much as of persecution, perhaps poisoning and shooting in neighbouring Arab countries. Disturbance, however, must still be a factor, as the area is closed to the army but

not entirely to the public; it is imperative to have total closure of the area for several years.

RESOLUTION

It was agreed to draft a resolution for strict protection of this subspecies, both in its nesting area in Israel and in its potential foraging range in Israel, Jordan, Saudi Arabia and Egypt (Sinai). The political difficulties inherent in this resolution were recognized, as well as the need to inform the UN multi-national peace-keeping force.

INTERNATIONAL COMMUNICATIONS

Communications

The Vulture Study Group was set up on an informal basis in March 1973 by Ledger and Mundy. Publication of its first bulletin *Vulture News* in March 1979 coincided with the first International Symposium on Vultures, organized by Wilbur in Santa Barbara (California). Since then, vulture workers in America have formed their own study group and the issue of their first bulletin *Vulture Watcher* in April 1982 coincided with the ICBP Conference on Birds of Prey in Thessaloniki. The Vulture Study Group should be global in approach and it is planned that in 1983 the subscription will be raised and all members will receive both *V.N.* and *V.W.* In view of the need for a proper complementing of these two bulletins, it is also planned for the *News* to become rather more scientific in approach, whilst the *Watcher* will remain news-oriented, with an attractive lay-out. Enlarging the format of the *News* and improving its design will also be considered.

Support for the ICBP

It was clearly important for the vulture fraternity to remain in contact with, and as a group support, the ICBP in the latter's work to preserve threatened birds of prey. It is likely that the ICBP Secretariat will be well served simply by receiving the VSG publications. Meanwhile, the vulture workshop framed two important resolutions:

(a) In support of the research programme undertaken by the California Condor recovery team.
(b) A plea to Israel, Jordan, Saudi Arabia and Egypt, for the protection of the subspecies of Lappet-faced Vulture (*Torgos tracheliotus negevensis*).

It was intended that appropriate letters would be prepared and signed by Ledger, Fyfe and the President of the ICBP.