

Wildlife disease biology comes of age

Infectious diseases are of growing concern among wildlife conservationists. Although the potentially devastating impact of introduced infectious disease on wildlife populations was first realized in the latter part of the 19th century following the introduction of rinderpest into Africa (Metzler, 1993), the extent by which wildlife diseases can undermine conservation efforts is still underestimated (Scott, 1988; McCallum and Dobson, 1995).

Disease is a particular risk for endangered animals with reduced population size and restricted range, and for animals that are part of managed conservation programmes where ecological factors are artificially manipulated (Cunningham, 1996). This reflects the delicate nature of the dynamic equilibrium that exists between host and parasite populations (here we use the term parasite in its broadest sense to include bacteria, viruses and other infectious agents) and this balance is often the product of millions of years of competitive co-evolution (Anderson and May, 1978; Lyles and Dobson, 1993). Parasites are a major selective force on the evolution of animal populations, probably important enough to drive the evolution of sex itself (Hamilton *et al.*, 1990). If parasites can exert such an influence under natural conditions, what are the effects of this influence on populations under pressure from habitat destruction and fragmentation, or on animals in manipulated environments or in captive breeding and release programmes?

Two recently published papers demonstrate the alarming extent of the influence of parasites on animal populations in the modern world. The first deals with amphibians, which are undergoing population declines in Europe, Australia, Central America and North America. Hypotheses abound for the cause of these declines (Wake, 1991); however, these remain unproved. A new disease has recently been reported, which causes amphibian mortality in epidemic proportions in rain-forest species in both Australia and Central America, and in association with population declines

(Berger *et al.*, 1998). This new epidemic disease is caused by a new genus of chytrid fungus, a primitive member of the fungal kingdom. The parasite infects the superficial, keratinised layer of skin in a range of frog and toad species and has been shown to cause the death of the host following experimental transmission.

The organism was first noted in 1993 by researchers working on a project funded by the Australian Government at James Cook University and the CSIRO and was then found in amphibians from Central America in 1997. This relatively contemporaneous appearance of chytridiomycosis on two continents is striking. Even if the organism has been missed for a couple of decades (and this is quite possible because gross lesions are often not apparent) the disease is a recent and rapidly spreading phenomenon.

The second report concerns snails of the genus *Partula*, which are endemic to islands in the South Pacific. Predation of these molluscs by the introduced snail *Euglandina rosea* (released to control previously introduced *Achatina* sp.) has led to a series of *Partula* extinctions across a number of these islands. Captive breeding has become a crucial part of the conservation programme for the genus and 15 species now occur solely in captivity (*P. Pearce-Kelly*, pers. comm.). Captive populations, however, are subject to periodic crashes, which have led to species becoming extinct in captivity (and therefore globally). Results of post mortem examinations of *P. turgida* (including the last individual of the species), the most recent partulid to become extinct, are reported in the October edition of the journal, *Conservation Biology* (Cunningham and Daszak, *in press*). The cause of death of each individual examined was extensive destruction of the digestive gland by a protozoan parasite of the microsporidian genus *Steinhausia*. Previously, authors have proposed that infectious diseases may have caused historical extinctions (for example Hawaiian birds, see Van Riper *et al.*, 1986; the thylacine, Guiler, 1961) but these remain unsubstantiated (McCallum and Dobson, 1995). The description of the extinction of *P. turgida* is therefore the first definitive account of an infectious

agent causing the extinction of a species (albeit that the original decline was due to other causes).

What do these reports tell us about the impact of disease on endangered and threatened species? Because the nature of the amphibian epidemics are consistent with the introduction of a pathogen into a naive population, the findings suggest that a new pathogen introduced to a previously unexposed and fragmented population (factors augmented by a shrinking habitat) can lead to decimation from which the species cannot recover. Perhaps the lesson to be learnt here is that in the modern world, with the movement of humans into once pristine habitats and the introduction of alien parasites (a form of 'pathogen pollution'), local outbreaks of disease can become epidemic or even pandemic (Halliday, 1998), leading to local or perhaps global extinction.

Both papers provide evidence to suggest that tipping the balance in the parasite–host dynamic equilibrium can have serious consequences for wild and captive populations. In the case of amphibians, we have evidence for multi-species mortality forming part of a network of global population declines possibly threatening a class of animals. However, perhaps the most important message comes from the *Partula* study – that in this altered world, there may be no limit to a parasite's impact on the population of a host species. The precedent has now been set: extinction by infection.

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Extinction by assumption; or, the Romeo Error on Cebu

One of the most challenging of all species conservation projects is currently being taken on by FFI on the Philippine island of Cebu: the target is a tiny remnant patch of forest (3 sq km) called Tabunan, the only currently known locality for the Cebu or four-coloured flower-

pecker *Dicaeum quadricolor* and several other forms endemic to the island. There turns out to be an extraordinary history to this circumstance which is worth recounting for the way it illustrates an unsuspected danger inherent in the uncritical acceptance of pronouncements and assumptions of extinction.

Cebu has long been notorious for its deforestation, at least among ornithologists. Over a century ago it was noted that 'the small amount of forest remaining on the island is rapidly being cleared away' (Bourne and Worcester, 1894), and a decade later almost exactly the same comment was made: 'the little forest remaining along streams and on steep hillsides is rapidly disappearing' (McGregor 1907). So it was that, when Rabor (1959) began his collecting and survey work on the island in 1947, even with the aid of aerial survey he was 'unable to find any patches of original forest, and the best place we found was the newly developed forest near Buhisan Dam'.

Rabor's testimony, with its ominous title, was a turning point. Being a Cebuano himself, he may well have sensed the devastation of his native island long before he began professional surveys of it. At any rate he cited McGregor's problems in finding forest back in 1906, failed to find any native growth himself and, unsurprisingly therefore, failed to find more than one of the 10 bird taxa – two species and eight subspecies – endemic to the island. Although he admitted that 'some might persist in second growth we did not find', he used the past tense in his accounts of these nine missing endemic taxa, and the clear impression his paper gives is that these forms were by then effectively, if not actually, extinct. Unfortunately – and by a process that cannot be blamed on Rabor, who was recently and justly described as 'the father of Philippine conservation' (Kennedy and Miranda, 1998) – this impression was converted into a pronouncement from which some of the birds in question appear to have enjoyed no reprieve.

In 1959 Rabor was several years into a fruitful collaboration with S. D. Ripley, which resulted in many significant papers on Philippine birds between 1955 and 1968. In 1958 Ripley had become President of the

International Council for Bird Preservation, and in 1962 the Council's *Eighth Bulletin* (with Ripley a member of the editorial board) reproduced Rabor's Cebu paper in full. Presumably Ripley regarded this item by a colleague as too relevant to ICBP to let pass; and assuredly this second round of publicity proved decisive. By turns Vincent (1966–71), Gonzales and Alcala (1969), King (1978–79) and Dickinson *et al.* (1991) all included Rabor's nine missing forms in their preambular lists of extinct taxa, and influential writers like Diamond (1984) and Wilson (1992) picked up on the 'Cebu story' to illuminate their own perspectives on the global conservation crisis. In retrospect it is apparent that after c. 1960 Cebu was effectively written off the biological map, with no ornithological interest other than shorebird counts and P. M. Magsalay's work on Rabor's one known forest survivor, the black shama *Copsychus cebuensis*. The seeming irretrievability of the situation was, I suspect, enhanced by the way that the year of last sighting placed beside the presumed extinct taxa in Vincent and King's lists easily transmutes in a reader's mind into date of extinction; and for the Cebu taxa, apart from a single 1892, the date is 1906 – far away and long ago.

Credit for the rediscovery of the Cebu flowerpecker, and therefore indirectly for that of certain other 'extinct' endemic taxa of the island, belongs to a visiting birdwatcher and biologist, R. J. Timmins, who in 1992 scoured the centre of the island in search of any sort of forest. From a high point near Mt Manung-gal he described the tiny patch now known as 'Tabunan', made his way down to it, and there encountered cover in which, to date, four of Rabor's nine missing taxa have been found to survive (see Timmins, 1992; Dutson *et al.*, 1993; Magsalay, 1993; Brooks *et al.*, 1995; Magsalay *et al.*, 1995).

The fact that prognostications of extinction proved to be wrong in this case is not a particularly unusual circumstance. The first of three real twists to this story is the recent discovery by FFI project staff that, because of its forests, Tabunan was the main base of the Cebu resistance in World War II, and was subsequently celebrated in a locally published book

The crash site of President Magsaysay's plane above Tabunan in 1957, 2 years before the island of Cebu was pronounced devoid of native forest. Note the forest also covering hilltops in the background. Photograph reproduced by courtesy of the Ramon Magsaysay Awards Foundation, through the kind help of Ms Angelina de la Torre.



(S. Pendry, pers. comm. 1998). I have been unable to uncover more than this, but the consideration in any case is merely that one might have expected the existence of Tabunan to be common knowledge among Cebuanos in the post-war era. It is clearly a pity that Rabor did not know and was presumably never told the story when he began his surveys in 1947.

The second and rather more startling twist lies in the fact that Mt Manung-gal is the site of the air crash that killed President Ramon Magsaysay, a well-loved Philippine leader, in March 1957. When I visited Tabunan in 1996 to help promote its conservation, I was told that Magsaysay's plane had struck the ridge immediately opposite and above the forest, and that rescuers had experienced extreme difficulty in getting to the site. Nobody seemed to be sure what had caused this difficulty, but one guide thought that the main problem had been dense forest.

A check of contemporary sources by colleagues at the Haribon Foundation shows that this was indeed so. The day after the crash, the *Manila Chronicle* (18 March 1957) reported that 'residents of Mt Manung-gal said it was not possible to determine if there were any other survivors because of the thickness of the forest in the area', and the Mayor of Cebu City, Sergio Osmeña, was quoted as saying the forest there was so dense 'you can hardly see 10 ft away'. The following day the same paper reported the thwarting of a paramedic airdrop by 'reduced visibility, the thick jungle and

tricky winds'. A year later, Bernad (1958) visited the site and remarked: 'At one time this entire mountain range must have been thick forest. Now the mountain sides are all denuded and either cogon land or planted to corn. The undulating ridges however are still densely forested. The Mt Pinatubo crashed upon one of these ridges ...' More tellingly, Bernad (1958: 70-71) published a photograph of 'the eastern end' of Manung-gal, which, from the map he provided, appears to line up on the area where the Tabunan patch is found today: several fairly extensive swathes of closed-canopy forest stretch across the middle and further distance. Unfortunately, this photograph cannot be reproduced here, but another, taken from the air and depicting the crash site itself a short time after the disaster, gives at least an impression of the extent of forest that might then have been present.

The extraordinary thing about all this is simply that Rabor, a distinguished university professor writing a paper probably little over a year (it was published in January 1959) after the death of his country's president, appears somehow totally to have missed the details of the disaster. Equally bizarre is that during his aerial surveys in search of forest – assuming of course that at least one of them took place after March 1957 – his own pilot was not sufficiently mindful of those details to mention them. Moreover, in 1957 the Manila Observatory had produced maps of forest cover on Cebu, showing two small but by no

means insignificant areas in the middle of the island, one of them exactly covering the area where Tabunan survives today (P. Walpole verbally to J. C. Lowen, 1997). How so energetic and dedicated a researcher as Rabor happened to pass all this information by is, today, anyone's guess, although his presence at Yale for part of the period 1957–58 may well have contributed; but in any case his pronouncement of Cebu's total deforestation had the effect of unwittingly shutting a cat in a shed – the 1957 and 1958 photographs strongly suggest that the amount of forest then present at Tabunan might easily have supported all 10 endemic taxa.

The third twist in the story, and the greatest irony of all, is the fact that Tabunan lies in the middle of a protected area called the Central Cebu National Park, established as long ago as 1936 and originally intended to protect an area of forest some 140 sq km in extent, although at the time of gazetting this was reduced to 110 sq km (E. Arregadas and A. Mapalo, pers. comm. 1996). Unfortunately, this appears always only to have been a paper park, and the local branch of the Department of the Environment seems never to have been allowed a budget to post a single guard to protect it. It is still rather mystifying that Rabor should not even have mentioned it, but he clearly had no inkling of any forest there (otherwise, scourge as he was of any conservation backsliding, how little would he have spared his pen!); possibly the gazettelement was so much a paper transaction that only a handful of civil servants ever knew it existed. On the other hand, Rabor was convinced that World War II had taken such a heavy toll of Cebu's timber that no native stands remained, so he may have assumed that this applied within the national park too (although of course today the first thing biological surveyors tend to do is identify a region's protected areas and start there). At any rate, the plane crash was apparently the spur to some local rescuers to clear land more intensively, in the genuine or self-excusing belief that this was the wish of the authorities (E. Arregadas and A. Mapalo, pers. comm. 1996): indeed for a time the site became a place of pilgrimage for

the president's mourners, and 10–20-year-old documents held at the World Conservation Monitoring Centre indicate that the park's post-1957 tourist function remained the principal one it served. Certainly by the time Timmins made his momentous discovery the place was all but a wasteland. I know of no comparable case where a national park has experienced such utter erasure with such utter public and official obliviousness.

One might have hoped that the preservation of the remnant forest at Tabunan, now its existence and exceptional biological value have been established and publicised, would entail no more than the final (after 52 years) enforcement of park regulations, and elicit the first proper government investment in the conservation of the site. However, settlers' rights are very strong in the Philippines and, as in some other parts of the world, title commonly falls to those who first clear the land of trees. By 1997, despite 5 years of effort by P. M. Magsalay to encourage local recognition of the value of the area, there were four families settled inside the forest and around 20 on its fringes, posing an immediate threat to the site and a major logistical and financial challenge concerning alternative arrangements (S. Pendry, in litt. 1998).

Over the past few decades there have been enough rediscoveries to warn us against over-hasty assumptions of extinction (which may, I suspect, sometimes derive from simplification of the CITES (Convention on International Trade in Endangered Species) criterion of 50 years without a record). However, it seems fairly doubtful in this instance whether more than one or two of Cebu's six still missing avian taxa can have any better future than to serve as warnings of how such assumptions can become self-fulfilling. This is all the more disturbing for Cebu being an Endemic Bird Area (Stattersfield *et al.*, 1998): one of the theories behind the EBA concept is that endemism in birds predicts endemism in other life-forms, and if indeed future study reveals that Tabunan harbours such creatures (a lump of mud off the boot I wore on my visit proved to contain an as-yet undescribed dictyostelid slime-mould), there will always be questions

about what other forms may have become extinct on the island, especially in the fateful period since the late 1950s.

Phrases such as 'living dead', 'basket cases' and 'committed to extinction' are rather frequently used to describe the plight of species in what are perceived to be irremediable circumstances. My hope is that FFI, in taking up the challenge of Tabunan in the face of desperate odds, will prove such phrases to be more colourful than true. At any rate, I prefer Soulé's (1987) view of things – 'there are no hopeless cases, only people without hope and expensive cases' – and while it is too soon to reckon how expensive the saving of Tabunan may be, it is particularly encouraging that FFI has already won Darwin Initiative support from the UK government for plans to manage and reforest the area (although, as FFI is aware, it still remains to be proved that Tabunan is the only patch of native forest left on the island). Perhaps the only real kind of 'living dead' and 'commitment to extinction' in this world are the products of those accidents when we declare species extinct too soon, sealing them off from further investigation and only realising our mistake when evidence like Bernad's emerges from some unexpected quarter.

I have commented before that the new IUCN criteria require rather black-and-white judgements about extinct species, and have preferred to maintain a list of such forms for which hope of survival may legitimately linger (Collar *et al.*, 1994: 210). A protocol is currently being developed to ensure that more than one authority 'signs off' on the categorization of species on the IUCN Red List, and it seems to me important that this requirement should be extended to include those forms classified as extinct; indeed, we may even need an 'Apparently Extinct' or 'Provisionally Extinct' category simply in order to prevent any repetitions of the Romeo Error that overtook the avifauna of Cebu in 1959.

Acknowledgements

I am most grateful to T. M. Brooks, D. S. Butler, H. Hodgson, M. V. Lepiten, J. C. Lowen, N. A. D.

Mallari and S. Pendry for their considerable help in relation to this note.

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Questioning new conservation approaches

The opinions and arguments developed in the guest Editorial and News and Views of the April issue (32 [2]) of *Oryx* were interesting and important. Conservation is changing and we have to face new situations. I would like to express some personal comments.

If we are to deal effectively with biodiversity conservation, i.e. keeping the greatest biodiversity possible on Earth, then we need to know 'why' it is necessary. The 'why' question is of great concern, as can be seen from the elephant and whale issue. Sustainable development and sustainable conservation may prove to be different. To link conservation to commercial use is dangerous if it means that only species with a known commercial value have to be protected. It should be looked at from a different perspective. If a species is well protected and population numbers are sufficiently high, then commercial and sustainable uses can be considered. However, the proof of this situation has to come from those wishing to exploit the species, and independent scientists, like those of IUCN/SSC specialist groups or any other independent organization, should evaluate any proposition. The exploitation of some species will be ethically difficult or questionable (apes are a good

example, but by no means the only one).

The situation of the North Atlantic cod *Gadus morhua* is quite relevant in this context. With no real 'save the cod' lobby or non-governmental organization, a no-catch quota in the North-West Atlantic was agreed recently. Nobody can argue that this species is not of real economic importance for human consumption, and that its 'sustainable' use has to continue. But the current level of exploitation is just not sustainable. If we can bring such a species to a level of near economic extinction, then the same can happen to any other species. The idea that any species has to pay (to human kind) for its survival represents a great misunderstanding of biology and of evolution. Every individual of every species already has to work hard for its own survival. The argument that each species has to pay us for its survival makes humans 'racketeers'. This means that we are asking all other species to pay a life-tax. I understand and admit that sustainable use is something quite different.

Why should we try to protect biodiversity? Perhaps we should ask first, is there any reason not to protect it?

Another question is the difficult discussion about traditional uses of endangered species or resources. The danger is that 'traditional' may represent very different situations. How far back in time (1, 10, 100 or more years) must we go in order for the term 'tradition' to be used for any exploitation or claim? Is the hunting of 'traditional' species with modern firearms the same as hunting with traditional weapons? Is it in the spirit of tradition for local produce and traditional ways to be open to the world market through the World Trade Organisation (WTO), when the scales and the rules are so different? Traditional practices used to exploit local resources for global markets, whilst providing short-term profits, run the risk of destroying the resource base. Real traditional use is certainly possible, if also sustainable, but the word 'traditional' needs to be clearly defined.

To the questions 'why' and 'how' to protect species, immediate answers are essential. If not, we may soon lose many species. There may be large, short-term profits for some indi-

viduals, agencies or companies, but very few resources left for the future. The answers for today must not mean desolation for tomorrow.

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Who will garrison the fortress? A reply to Spinage

It would be easy to dismiss Spinage's polemic (*Oryx*, 32 [4], 267–278) as the last gasp of the conservation old guard, which seeks to discredit new participatory models of conservation by tarring them as 'neopopulist', 'Marxist' and 'left-wing'. After all, the main international conservation agencies have already distanced themselves from the classical conservation model, which seeks to establish protected areas by clearing them of resident human populations. For example, in May 1996, after several years of dialogue with indigenous peoples' organizations, the World Wide Fund for Nature (International) adopted a new policy on indigenous peoples and conservation, which – in line with existing and emerging principles of international law – explicitly recognizes the rights of indigenous peoples to the use, ownership and control of their traditional territories, approves the current draft of the United Nations Declaration on the Rights of Indigenous Peoples and emphasizes the principle of free and informed consent in all interactions between indigenous peoples and conservation organizations (WWF, 1996).

In a similar spirit, the General Assembly of the IUCN – the World Conservation Union, at its meeting in Montreal in November 1996, approved several resolutions that refer to indigenous peoples and protected areas. The resolutions provide guidelines for the secretariat and members of the IUCN, stating not

only that they should recognize the rights of indigenous peoples in protected areas but also that the personnel and members of the IUCN should contribute to indigenous initiatives in intergovernmental fora such as the Convention on Biological Diversity, which itself makes provisions for securing customary rights. The IUCN resolutions propose that the rights of indigenous peoples in protected areas should be respected and that conservation policies should be compatible with the current draft of the United Nations Declaration on the Rights of Indigenous Peoples.

As a step towards the promotion of these new models for conservation, the IUCN has likewise revised its set of definitions of types of conservation areas, recognizing that protected areas need not only be managed and controlled by state agencies, but should include other types owned and managed by non-governmental agencies, private companies, individuals, local communities and indigenous peoples. To accommodate the economic activities of resident peoples, the WWF and IUCN now give particular emphasis to the need to increase the number of protected areas in the IUCN's Categories V, 'Protected Landscapes/Seascapes', and VI, 'Managed Resource Protected Areas'. The IUCN World Commission on Protected Areas is currently engaged in an internal review to see how it can best put these new principles into effect, given that in many countries national protected-area legislation, developed during the heyday of the 'classical' conservation model, does not contemplate non-state institutions managing, owning, controlling or using protected areas (WWF/IUCN, 1997).

These changes within the conservation agencies' thinking reflect a growing sophistication in their understanding of the relationship between protected areas and the civil societies within which they are embedded. Increasing pressures on natural resources surrounding protected areas throws into doubt the long-term sustainability of the areas themselves if local communities resent their existence. Protected-area managers in the field have recognized that parks become management nightmares if local people neither benefit

from them nor have a say in decision-making. Indigenous peoples, once unable to articulate their own concerns because of their cultural and political marginalization, are now increasingly able to assert their rights to own and control the lands and environments they have customarily relied on. Meanwhile, as pressure increases globally on natural resources, the government bureaucracies that used to be able to defend protected areas from other outside interests are increasingly prey to political manipulation and predatory private companies. Under these changing circumstances new alliances with local peoples who also resist these outside pressures are not only ethically preferable but may also make conservation sense.

These welcome changes in the policies of the conservation organizations, while resisted by elements such as Spinage, must be seen as only the first steps on a long road to achieving more viable long-term relations between human beings and their natural environments. The recognition of indigenous peoples' rights to own and manage their ancestral lands does not automatically mean that sustainable land use will result (as many of the authors that Spinage criticizes have emphasized). On the contrary, as a recent conference between indigenous peoples and conservationists in Latin America highlighted, indigenous peoples are fully aware that the integrity of their territories is now at risk not just because of external pressures to exploit their areas, which they seek to resist, but also because their own economies are undergoing change. They seek help from conservationists to address these problems, as partners in promoting change rather than as controllers of their lives (Gray *et al.*, 1998). As the International Alliance of Indigenous-Tribal Peoples of the Tropical Forests notes:

Indigenous peoples recognize that it is in their long-term interest to use their resources sustainably and respect the need for environmental conservation. Indigenous peoples recognize that the expertise of conservation organizations can be of use to their self-development and seek a mutually beneficial relationship based on trust,

transparency and accountability
(International Alliance 1996: 144).

Spinage's reluctance to embrace such participatory approaches to conservation appears to be predicated on three underlying preconceptions. In the first place he seems unable to recognize that conservation is a cultural process. Indeed, he is so blind to the fact that conservationists are social actors that he can ask, 'does there have to be a social purpose?' for establishing a protected area – as if protected areas somehow created themselves without the intervention of human agencies with their own ideas, interests, institutions, legislation and objectives. Yet it is clear from Spinage's unreflective discourse that he does have a social purpose in mind. Behind his no doubt real concern for biodiversity conservation, he gives unquestioning priority to the interests of wildlife tourists who 'soon complained' about ugly fishing villages in the Queen Elizabeth National Park and for whom the uniquely rich fauna of African national parks 'is the attraction'. The question that Spinage cannot even ask, it seems, is: why are foreign tourists given priority over African residents?

Spinage is equally reluctant to see conservation as a political process. Yet the unstated assumption in his article is that depopulated 'fortress' protected areas *can* be defended, but the reader is left less clear *who* these defenders will be. The classical conservation model relies on the bureaucratic power of government agencies, backed where necessary with the firepower of modern weaponry, to exclude people from access contrary to imposed rules. That these impositions may constitute violations of international law and internationally agreed human rights standards is apparently justified by the higher purpose of securing biodiversity according to his culturally informed perception of natural law: 'in nature there is only one law of possession and that is the law of occupation by force'. Leaving aside the questionable morality of this approach, the question arises: for how long can such politically isolated and socially beleaguered protected areas survive? The 'fortress' model of conservation, which Spinage supports, relies

on urban bureaucrats and park rangers to defend areas otherwise emptied of human inhabitants, even though the long-term allegiance of these sparse garrisons may be in doubt. In contrast, the new, participatory model seeks to help local communities to garrison their own territories, supplementing local and customary political institutions with the force of law, and the support of government agencies and conservation organizations.

Spinage appears to have no confidence in such an approach because of his evident misanthropy. In Spinage's modern world, apparently all human beings (except perhaps bureaucrats and tourists) constitute a threat to nature due to the dual problems of 'population increase' and the adoption of new technologies. His undifferentiated 'technocratic man' offers conservationists no allies and little hope. Creating protected areas may, he admits, imply displacing indigenous peoples from their territories (he laconically notes in an aside 'where else could they [protected areas] be established?'). But is Spinage right in assuming that the peoples inside the areas that are now thought suitable for protected-area status are as much a threat to these areas as those who live outside them? Spinage dismisses the notion that the very fact that these areas seem to conservationists to be worth conserving suggests that the local peoples may have different relations to their environment to those in surrounding areas. However, Spinage is not even consistent. In his eyes, the inevitability of population increase disqualifies people from a right to control and manage their customary lands, but even where the indigenous people's numbers are very small, like the 500 traditional hunters in the vast expanse of Tsavo, he scoffs at the idea that their customary rights should be recognized.

Despite the hostile tone and questionable underpinnings, Spinage's article does also raise some important questions. He is right to highlight the complexity of relations between human populations and their natural environment, and right to emphasize that many indigenous societies are also undergoing rapid social and economic change. These are the very problems to which many indigenous

peoples themselves are seeking solutions. In trying to help provide answers, however, ecologists should be careful not to exaggerate the extent of their own knowledge. Recent research in Africa shows how often scientists completely misread the relations between peoples and their environments, to the point where people who create forests around their communities in savannah areas are portrayed as agents of deforestation invading the last remaining forest islands in the way of an advancing agricultural frontier (Fairhead and Leach, 1996, 1998; Leach and Mearns, 1996).

The 'new model' of conservation results from conservationists and others being more self-questioning about their motives and the extent of their knowledge. Who is conservation to benefit? Who is best placed to manage 'protected areas' in the long term? What are the best means of re-establishing sustainable relationships between humans and their environments? A raft of new publications shows how conservationists and social development institutions are actively seeking answers to these questions and seek to complement the insights of indigenous knowledge with western science (Western and Wright, 1994; McNeely, 1995; Borrini-Feyerabend, 1996; Kothari, Singh and Suri, 1996; Redford and Mansour, 1996; Poffenberger and McGean, 1996; Buchi *et al.*, 1997; Hitchcock, 1997; IUCN, 1997; Stevens, 1997). For my part, I don't think that western scientists have all the answers. Some of them aren't even asking the right questions.

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