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Primate research faces extinction

Last September, the International Union for Conservation of Nature and Natural Resources (IUCN) released its 'Red List' of endangered species (www.redlist.org). The list is revised every four years, and one prominent feature of the latest update is the large number of primates that are in imminent danger of extinction. The disappearance of our closest biological relatives would be a tragedy for all humanity, but neurobiologists have a particular stake, given the importance of primates for understanding the human brain.

There is no escaping the fact that if neuroscientists want to understand human cognition, they must study animals that resemble humans. Many important advances in systems neuroscience have come from studies on awake behaving macaques, and future generations of researchers will want to ask questions that we cannot begin to articulate, both in macaques and in other species closer to humans, using techniques that are as unimaginable today as (say) fMRI would have been a century ago. Yet the long-term prospects for primate research are bleak. Many of the most widely used species are on the Red List, including *Macaca mulatta*, *M. fascicularis* and *M. nemestrina*; the first two are categorized as 'near threatened' (the lowest risk category), whereas *M. nemestrina*, at greater risk, is categorized as 'vulnerable', defined by IUCN as "facing high risk of extinction in the wild in the medium-term future". Indeed, of the 220-odd known species of primates, 180 are on the list.

Perhaps most tragic is the case of the great apes, our closest relatives and among the most endangered of all species. Bonobos (pygmy chimpanzees), gorillas, orangutans, and perhaps even chimpanzees, are all expected to go extinct in the wild within the next decade: they live in impoverished countries where public order has largely collapsed, and they are being driven inexorably toward extinction by a combination of hunting and habitat destruction.

The plight of the great apes is likely to gain increasing attention with the completion of the human genome. Among the most compelling of all scientific questions is how humans (in particular, human brains) evolved from apes, and a sequence comparison between humans and their closest relatives would be extraordinarily interesting. Human and chimpanzee genomes have diverged by about 1.5% during the 5 million years since their lineages split, and an obvious question is which differences arose along the human branch and might therefore explain the emergence of human intelligence. This can be answered by further comparisons with other species, notably bonobos and gorillas. But sequence comparisons provide only limited information, and in order to draw functional conclusions, it is essential to study the relationship of the genome to the organism it encodes. Sadly, this is becoming an increasingly unrealistic prospect.

What, if anything, can be done to mitigate the damage? Obviously, field conservation should be attempted wherever possible, and in a welcome move, the US Congress recently passed the Great Apes Conservation Act, providing five years of funding for local conservation efforts. The imminent birth of a cloned guar (an endangered species of ox) has also highlighted the possibility of a 'Jurassic Park' scenario in which endangered species might be regenerated, either from frozen cell or perhaps—more speculatively—from sequence data. Clearly, we cannot know what new technologies may emerge in the future, and it makes sense to start archiving as much as possible. Whether this will ever be sufficient to rescue a species from extinction is anyone's guess.

The best hope for most primates may be captive breeding programs, but these would have to be greatly scaled up from their present size if they are to have much impact. Well-developed breeding programs exist for some species of macaques and (to a lesser extent) chimpanzees, driven by their value to the biomedical research community. However, the number of species involved is small, and it would be both expensive and politically difficult to expand these programs. Part of the problem, paradoxically, is the animal rights movement. Primates clearly have great scientific value, and the biomedical research community might well be willing to contribute more to their preservation. In practice, however, the obstacles to primate research are enormous, and the opposition to any program involving animal experimentation makes it very difficult to reach consensus—witness, for example, the chronic debates that have surrounded efforts to establish sanctuaries for retired chimpanzees.

Although most research primates now come from breeding colonies rather than wild populations, there is one major exception, namely the Japanese macaque, *M. fuscata*. The use of this species for research has been fraught with controversy. It was listed as 'endangered' (meaning "facing a very high risk of extinction in the wild in the near future") on the 1996 Red List, but Japanese researchers protested this designation and persuaded the IUCN to re-classify it as 'data deficient'. The monkeys, which are endemic to Japan, have disappeared over much of their former range, but certain local populations have expanded dramatically as a result of access to agricultural crops, leading to their designation as a pest. This allows animals to be captured and sold for research, a practice that has been much criticized. Whether the removal of animals for research purposes is a threat to the species is unclear. The Japanese Environmental Agency has argued that the sale of captured animals provides an incentive for unnecessary—and in some cases illegal—capture. The president of the Japanese Neuroscience Society, Kunihiko Obata, argues, however, that the numbers of animals used for neuroscience research are too small to have any impact on the species' future survival.

Obata acknowledges the importance of conserving the monkeys in the wild, and says that Japanese neuroscientists are discussing with field researchers how the competing interests can be reconciled. One can only hope these efforts will succeed. As a rich country, Japan could set an example for the preservation of an endangered species as a sustainable resource. This will not be achievable, however, in Japan or elsewhere, unless concerns about conservation can be divorced from the debate over animal experimentation.