

## NEWS AND VIEWS

## CONSERVATION BIOLOGY

## Crying wolf in North America

John L. Gittleman and Stuart L. Pimm

IN A world in which natural habitats are shrinking alarmingly, which species shall be saved? The task of classifying species falls of course to taxonomists, and among the priorities for our limited Ark are often those plants and animals that enjoy taxonomic distinctiveness at high levels (species in monotypic genera or families, for example). Taxonomists also decide which populations are to be considered legitimate species — bad taxonomy can kill when distinct species are not afforded specific status<sup>1</sup>. Wayne and Jenks, in their analysis of the specific status of the red wolf on page 565 of this issue<sup>2</sup>, describe a high resolution way of distinguishing between closely related mammals. Their finding — that the red wolf is not distinct from the grey wolf or coyote — is however less important than the issues it highlights.

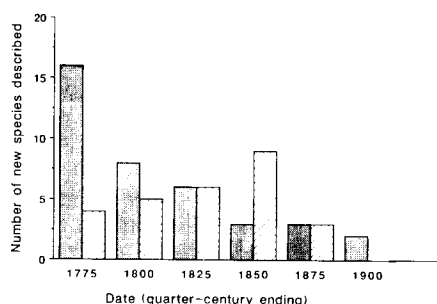
The red wolf has been the beneficiary of a substantial captive breeding and re-introduction campaign following its extinction in the wild. But its recognition as a species, *Canis rufus*, distinct from the closely related grey wolf (*Canis lupus*) and coyote (*Canis latrans*), has always been a matter of controversy. As a first indication of this controversy consider when the red wolf was first described — in 1851, by Audubon and Bachman in *The Quadrupeds of North America*, an unusually modern discovery when compared to both canids worldwide and all North American carnivores (see figure).

Why was a species of such large size, conspicuous predatory habits and widespread distribution first described at such a late date? Interestingly, the primary proponents<sup>3</sup> of species status for the red wolf drew their conclusions less than two decades ago. They prefaced their analysis by stating: "... there is such a great degree of individual, geographic, sexual, and age variation within each species of North American *Canis*, and such wide overlap in most characters, that most of the following diagnosis is necessarily general and qualitative in nature" (p. 1). Using multivariate techniques, only a few morphological characters out of over a dozen showed separation of *C. rufus* from *C. latrans* or *C. lupus*, and these characters seemed to be size-related and intermediate between those seen in the coyote and grey wolf<sup>4</sup>. This is not to say that morphologically almost identical species do not exist. Early studies with protein electrophoresis did not resolve any differences from the other *Canis*<sup>5</sup> either. Nevertheless, carnivore taxonomists have continued to accord species status to *C. rufus*<sup>6,7</sup>.

Wayne and Jenks's use of more modern techniques of assaying mitochondrial DNA (mtDNA) provides a more compelling appraisal of the red wolf's taxonomic status. First, they compared the mtDNA from a small captive breeding colony of red wolves with samples from 327 coyotes and 276 grey

wolves. Phylogenetic analysis shows the red wolf mtDNA genotype to be very like that of coyotes, and that it has particular similarity to the mtDNA of coyotes living in those areas from which the red wolf had disappeared.

The colony may not adequately represent the wild populations, however, because, as in other tiny populations, genetic variability



can be lost quickly. Fortunately, between 1974 and 1976 blood samples were collected and stored from wild animals classified on morphological grounds as red wolves. Analyses of the mtDNA from the samples corroborated the previous results. Taken alone, these results raise serious doubts about the red wolf as a species.

But these modern animals may be the last hybridized gasp of a once viable species, which became so rare that the individuals had no choice but to mate with coyotes. So how should we resolve what the red wolf was really like? Definitive conclusions are made possible by the existence of a direct source of historical information, the DNA sequence of the cytochrome *b* gene from museum pelts taken from putative original red wolf populations in the southeastern United States. Again, the DNA sequence data show that grey wolves and coyotes are clearly distinct from each other, with the red wolf always being similar to either one or the other of these species. The elegance of Wayne and Jenks's study is in the combination of baseline morphological data with a two-pronged genetic analysis: evaluation of current genetic variation along with assessment of historical variation among species.

Various taxonomic issues are raised by this paper. First, species identification using morphological and molecular data in concert really does provide diagnosis and verification in systematics; ambiguity in the

morphological systematics of the red wolf indeed foreshadowed a similar result in mtDNA. Molecular systematics is only beginning to develop protocols for considering how much and what kind of differences in mtDNA are necessary to erect species status. (In the case of the red wolf, as in many other hybridized mammals, differentiation is non-existent so the problem is moot.) Second, when differences are detected, especially slight differences among closely related taxa, molecular studies must provide quantitative information about where the differences arise in the various classes of mtDNA (base substitution and length variation). Such information permits statistical analyses of the evolutionary differences between species that could not be easily resolved in the past.

For decision-making in conservation, there are ecological issues as well as taxonomic ones. Obviously, the areas richest in species will have to be identified. We are unlikely to arrive at tallies of species by counting one, two, three... in each area, for taxonomic catalogues will not be complete in the foreseeable future. Rather, ecological knowledge about patterns of species richness is essential. We must also expect to manage species within the fragments of once extensive habitats and, in particular, identify which species play 'keystone' roles and whose loss will cause further secondary extinctions. When selecting species for management, we must ask which are in immediate danger and, of course, understand why some species are more prone to extinction than others. And when all this ecological knowledge has been gathered, difficult policy choices will have to be addressed — which species we are likely to be able to save; which areas are easiest to protect with available resources; and the controversial topic of whether to emphasize saving species, or saving communities, or saving ecosystems<sup>8</sup>.

The loss of large predators has been particularly severe worldwide: their body size and position in the food chain makes them rare and so vulnerable to extinction (their perceived rivalry with humans even more so), and they play important functional roles at the top of food chains. Special steps should be taken to preserve them. The large geographical areas they require, combined with their public appeal, means they can demand large protected areas, where the many other species present could not. That appeal also permits us to learn about how to re-introduce species, lessons we can then apply to saving

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6. Honacki, J. H., Kirman, K. E. & Koepl, J. W. *Mammal Species of the World* (Assoc. Systematics Collections, Lawrence, Kansas, 1982).
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8. Soulé M. E. & L. S. Mills. *Oikos* (in the press).

less 'charismatic' species.

How does the re-introduction of the red wolf relate to these ecological reasons for protecting species? Information gathered by the captive breeding programmes about, for example, artificial insemination, may be valuable in saving other less controversial taxa. Likewise, the introductions of the red wolf to islands and other areas where the coyote is absent may provide information about how to re-establish similar species. From just which taxa we learn these lessons may be less important than the lessons themselves.

Wayne and Jenks's results on the red wolf suggest that here no species is being saved (and certainly nothing of great taxonomic EXTENSIONAL MAGMATISM

## The rift narrows

Rob Ellam

OVER the past few years, physical models of the melting processes that occur in the Earth's crust and mantle, producing the lavas erupted by modern volcanoes and the igneous rocks of the geological record, have reached new levels of sophistication. Igneous petrologists, who previously relied largely on chemical information to elucidate magmatic processes, have not been slow to embrace the physical approach, but some intriguing questions have emerged. One particular puzzle is the occurrence of magmatism where there is little tectonic extension and where there is no obvious relationship to anomalously hot plumes of mantle like those beneath oceanic hotspots such as Hawaii and Iceland. Previous models had difficulty in explaining even the modest amounts of basalt found in these areas, but on page 559 of this issue<sup>1</sup>, Latin and Waters discuss refinements in the melting models that appear to explain these somewhat enigmatic magmatic events.

When tectonic processes stretch the rigid continental and oceanic plates (lithosphere), the underlying convecting mantle (asthenosphere) is forced to rise. If the pressure release is sufficient, the mantle will melt. To predict the amount of melting for a given degree of lithospheric extension requires knowledge of the mantle solidus curve, the line on a plot of pressure versus temperature that defines the initial occurrence of partial melt. In 1988, McKenzie and Bickle<sup>2</sup> used the results of experimental melting studies to define the solidus and thereby calculate the melt distribution beneath a mid-oceanic ridge. They concluded that for mantle of normal temperature, that is where there is no influence from a hot ascending mantle plume, melting is restricted to the upper 50 km or thereabouts of the asthenosphere.

In a continental rift, like the North Sea graben studied by Latin and Waters, the pre-rift lithospheric thickness probably approaches 120 km, so that the lithosphere would need to thin by a factor of about 2.5

(distinctness); that in areas where the coyote is already present, no new ecological role in the community is being created by the introduction of red wolves; and that any lessons about re-introducing species are likely to be obscured by hybridization with the coyote. No new reserves are being created for the red wolf. In this case, then, the re-introduction comes down to asking whether the red wolf's undeniable cuddliness is enough to warrant according it special attention. □

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(the  $\beta$ -factor) while stretching before the rising asthenosphere penetrates the maximum depth at which melting occurs (about 50 km). Not least because the amount of extension is critical in the assessment of the petroleum potential of a rifted basin,  $\beta$ -values tend to be well constrained in the North Sea. For the most stretched part  $\beta$  is only about 2, yet basalts from the Forties volcanic province indicate that quite substantial magmatism has occurred, apparently without the influence of elevated mantle temperature.

McKenzie and Bickle<sup>2</sup> themselves identified the uncertainties likely in laboratory experiments as an important restriction on their conclusions. Experimental charges are, by necessity, both very small and enclosed. Thus the experiments simulate batch melting, in which all the melt produced remains in equilibrium with the solid residue until it separates as a single batch. In the mantle, even very small melt fractions (less than 2 per cent by volume) are probably able to escape from a deforming matrix<sup>3</sup>, and a 'dynamic' melting model is perhaps more appropriate (see, for example, the recent paper by Elliot *et al.*<sup>4</sup>). The melt distribution generated by dynamic melting might differ significantly from the experimental prediction.

Now McKenzie and O'Nions<sup>5</sup> have used an inversion technique to calculate melt distributions from rare-earth-element (REE) abundances in mid-ocean ridge basalts, assuming a Rayleigh melting process in which melt and matrix separate as soon as the melt is formed, and which therefore better approximates a dynamic melting process. Critically, melting commences at about 80 km depth, which corresponds to  $\beta = 1.5$  for a normal initial lithospheric thickness. Using the new calculated melt distributions it is possible to have melt formation between 80 km and the base of the stretched lithosphere in low- $\beta$  rifts such as the North Sea, without recourse to elevated mantle temperatures.

However, when Latin and Waters apply

the results of the REE inversion to the North Sea case, there is significant discrepancy between the relatively low light-REE concentrations predicted by the Rayleigh melting model and the light-REE-rich basalts of the North Sea. An additional source of light REE is required. Nephelinite and ultra-potassic magmas found towards the flanks of the graben apparently provide the additional REEs, and have suitable Nd isotope compositions to explain the low (close to bulk Earth) <sup>143</sup>Nd/<sup>144</sup>Nd ratios of the Forties basalts compared with typical depleted mantle. The nephelinites are taken to originate in lithospheric mantle, not the asthenosphere, that has been metasomatized (altered by fluids). This melts in response to rifting because the presence of volatile-rich phases substantially reduces its solidus temperature.

The role of lithospheric material in magma generation is of great interest to geochemists because the mechanical boundary layer (approximately the upper 100 km) of the lithosphere is isolated from the homogenizing effects of asthenospheric convection. In the mechanical boundary layer, isotopic heterogeneities can evolve for long periods of time ( $1-2 \times 10^9$  years) in response to ancient changes in trace-element ratios. For example, domains in the boundary layer with low Sm/Nd ratios will gradually evolve lower <sup>143</sup>Nd/<sup>144</sup>Nd ratios than the average (higher Sm/Nd) asthenosphere. On melting, the mantle portion of the boundary layer yields melts of broadly basaltic composition, but with unusual isotopic signatures. A recent breakthrough has been to define rather precisely the lithospheric contribution to extensional magmatism. Thus in the North Sea, Latin and Waters demonstrate the involvement of magmas similar to locally occurring nephelinites, whereas Thompson *et al.*<sup>6</sup> in northwest Colorado and our own work<sup>7</sup> in the Karoo flood basalt province of southern Africa have identified ultra-potassic, lamproitic end-members also attributed to fusion of volatile-rich lithospheric mantle.

Even these few studies serve to illustrate the assortment of magmas that might be produced by partial fusion of enriched lithospheric mantle. Clearly the geochemical effects of interaction between asthenospheric and lithospheric melts will be very variable. An obvious goal for the future must be to relate those variations to the diverse metasomatic processes that apparently control the formation of the low-melting-temperature fraction of the mantle lithosphere. □

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