Species Hybridization and Protection of Endangered Animals

Much of what has been written recently about the plight of the Florida panther is the result of the suggestion by Stephen J. O'Brien *et al.* (*1*) that the Florida panther is a "hybrid" population resulting from an introduction of South American animals to southern Florida in the recent past. It is unfortunate that this suggestion (hybridization) has been accepted as fact by the popular press, as well as by some of those planning management strategy (Chuck Fergus, Research News, 8 Mar., p. 1178). The result has been a concern that the alleged hybridization may remove the population from protection under the Endangered Species Act and complicate any management plan (including captive breeding).

O'Brien and Ernst Mayr (Perspective, 8 Mar., p. 1187) do a service to the conservation community by showing that the occurrence of hybrids (especially between subspecies) and hybrid zones are natural and that this biological principal should be reflected in our conservation legislation (*1*). However, the Biological Species Concept (BSC) they propose may not be the most useful concept with which to identify the groups we are interested in preserving.

The BSC is defined as "groups of actually or potentially interbreeding populations that are reproductively isolated from other such groups." This definition does not address hybrids, hybrid zones, sympatric speciation, the importance of mate recognition systems, selection at levels other than the organism (genes, populations, species), or other patterns that can be observed in nature. The BSC was the species definition best suited to the orthodox, neo-Darwinian synthesis that explains all of evolution by traditional population genetics models. For conservation, however, defining species on the basis of process rather than pattern is a mistake.

For the purposes of preserving biological diversity as it occurs in nature, identifying evolutionarily significant units by characters that are shared by members of the group relies on pattern rather than process. Molecular genetic techniques allow us to survey for a large number of useful characters so that we can sort out the pattern of evolutionary differentiation and develop management strategies with which to preserve those groups. Other characters, such as morphology, habitat preference, and biogeography, can also be included. Molecular data are useful, but do not always provide the final answer.

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1. S. J. O'Brien *et al.*, *Natl. Geogr. Res.* **6**, 485 (1990).

O'Brien and Mayr accept reports of partial hybridization of the gray wolf in the United States and of total hybridization of the red wolf, thereby possibly encouraging efforts to reduce protection of these species. And yet, of the supporting references they cite, only one (*1*) provides substantive evidence, and it only concerns the gray wolf. Their reference to a "narrow hybrid zone" in the Midwest apparently is based not on the presence of animals with intermediate characters but on the reported spread of coyote mitochondrial DNA to the gray wolf in Minnesota and on Isle Royale. Field ob-

servations indicate that the wolves in those areas are morphologically, ecologically, and behaviorally 100% wolflike (*2*); this is also demonstrated by the examination of skulls (*3*). The suggestion by O'Brien and Mayr that the red wolf originated as a hybrid between the gray wolf and coyote is not supported by studies of the fossil record, nor is it substantiated by a series of modern museum specimens; such work indicates that the red wolf has existed in much the same form since the Irvingtonian, and continues to survive as a captive and reintroduced population (*3*).

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1. N. Lehman *et al.*, *Evolution* **45**, 104 (1991).
2. L. D. Mech and R. O. Peterson, personal communication.
3. R. M. Nowak, *North American Quaternary Canis* (Museum of Natural History, University of Kansas, Lawrence, KS, 1979), unpublished data.

Response: The points raised by Amato and by Nowak illustrate the anxiety generated in the scientific-conservation community over the enforcement of the U.S. Fish and Wildlife Service's "hybrid policy," which excluded all "hybrids" from protection. Increased knowledge of the natural occurrence of such events stimulated us to write the Perspective. It was our intention to provide guidance, rationale, and flexibility for the continued protection of groups that we learn have experienced introgression or gene flow in their recent history.

We are puzzled by Amato's statement, "it is unfortunate that the suggestion of hybridization is accepted as fact by the popular press." If he is suggesting that the Florida panther data (*1*) have another interpretation, he does not say what it is. If his concern is because of the legal implications for the Florida panther's endangered status, we agree, and that is why we wrote our Perspective.

We respect Amato's opinion concerning the appropriateness of the Biological Species Definition (BSC) in conservation issues but, after some thought, we have found that we are simply more comfortable with the objectivity of the BSC than with alternative species concepts. We recognize that more than 50 papers that provide arguments for the best definition for biological species have appeared during the last several decades and that there is clearly a lack of consensus (*2*). Part of the difficulty is that the term "species" is used by biologists with at least two different objectives in mind. The first is in taxonomy as a unit of classification or naming; the second is that species are the end product of an evolutionary process (termed "speciation") and as such are basic entities of evolutionary theory. Historically, the BSC replaced the "typological species" concepts of Linnaeus and Lyell, which defined species as classes of organisms that differed from other species by constant phenotypic characters. This and derivative species concepts (for example, Amato's patterns) reject the primacy of reproductive isolation and suggest that equal weight should go to other diagnostic characters (morphological and molecular) produced by the process of species differentiation. We believe the BSC is less subjective because organisms themselves achieve (or fail to achieve) isolation, whereas the typological concepts require an arbitrary selection of phenotypic characters by the taxonomists. Certainly one must often use such characters as the evidence that the speciation has occurred in allopatric populations, but we would caution against the confusion between the evidence for speciation and the process itself.

Typological species concepts are fraught

with interpretive difficulties such as sibling species being assigned to one species, full species assignment to reproductively compatible (BSC) subspecies, arbitrary selection of diagnostic characters, and numerous species designations that err in the direction of excessive taxonomic splitting. Thirty years ago, George Gaylord Simpson formulated a perspective analogy when he noted that monozygotic twins are not defined as twins because they are so similar, but they are so similar because they are twins (*3*). In the same sense, individuals do not belong in the same taxon because they are similar, but they are similar because they belong in the same taxon. The BSC recognizes that species develop and acquire reproductive isolation in nature and that process is accompanied by varying degrees of distinction. Amato's statement that the BSC "definition does not address hybrids [or] hybrid zones" is precisely the mistake made by the U.S. Fish and Wildlife regulators in designing the ill-fated "hybrid policy." The BSC addresses the hybrids in extenso (*2*), but the failure of policy-makers to notice that prompted our Perspective.

Nowak is aware of the extensive literature dealing with possible hybridization of the red wolf with coyote, as his own masterful treatise, cited in our Perspective (*5*), discusses this concern. Early suspicions were actually prompted by the observation that most morphological characters that discriminated red wolf from gray wolf and coyote were size related. A recent molecular description of captive red wolves, of tissues from wild-caught animals used for establishing the captive stock, and of museum specimens from their historic range revealed composite mitochondrial DNA genotypes that were indistinguishable from those of modern populations of gray wolves or coyotes (*6*). Whether red wolves represent recent genotypic hybrids or a now extinct (in the wild) subspecies of gray wolf (perhaps a New World analogue of the Old World subspecies of gray wolf *Canis lupus pallipes*), or both, cannot be unequivocally discerned from the available data. The analysis of morphological characters unrelated to size and nuclear molecular markers from specimens that predate recent coyote–red wolf overlaps would be an important measure with which to resolve this question. The possibility that Nowak is correct in recognition of a distinct evolutionary lineage of *Canis* provides, to us, a compelling case for continued legal protection.

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5. R. M. Nowak and J. L. Paradiso, *Walker's Mammals of the World* (Johns Hopkins Univ. Press, Baltimore, MD, 1983).
6. R. K. Wayne and S. M. Jenks, *Nature* **351**, 565 (1991); J. L. Gittleman and S. L. Pimm, *ibid.*, p. 351.

Fergus' article does not discuss the most significant way in which the recent legal settlement between the Fund for Animals and the U.S. Fish and Wildlife Service (FWS) concerning the federal government's captive breeding program for the Florida panther could help pave the road to recovery for the panther—by compelling the FWS to ascertain what must be done to safeguard habitat for both existing and reintroduced panthers.

While it is true, as the article points out, that there has been disagreement among wildlife groups and experts regarding the wisdom of a captive breeding effort, there is consensus that the single greatest threat to the panther is the degradation and loss of essential habitat. Thus, by requiring the FWS to analyze long-neglected habitat issues, such as "reintroduction goals and strategies for sites both within and outside the State of Florida," as well as the specific "actions that would be taken to ensure the preservation and suitability of such sites for reintroduction," the settlement could play a key role in panther recovery.

Captive breeding may or may not prove to be part of the solution to the panther's problem (one of the other features of the settlement agreement requires the FWS to evaluate the option of introducing other subspecies of *Felis concolor* into the existing wild population as a means of increasing the number of animals and restoring genetic variability). But it *is* certain that captive breeding in the absence of a concerted effort to preserve habitat will not succeed—at least if the objective is, as it should be, to ensure the survival of the panther in the wild instead of in captivity.

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Erratum: In the Special Report "Science careers" edited by Constance Holden (24 May), Michigan State University should have been given as the institution that granted a Ph.D. to Christopher Uhl (p. 1123) and the University of Illinois as the institution that granted an M.S. and a Ph.D. to Alfred Cho (p. 1124).