Hybridization as a Means of Preserving Endangered Species

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[Editor's Note: The author is a graduate student at the University of California, Davis in the Avian Sciences Department where her primary areas of study are conservation and genetics. She is currently working on her thesis which is investigating the fate of confiscated smuggled birds and is also engaged in a special project with the School of Veterinary Medicine related to the anatomy, physiology and nutritional needs of the 20 members of the Musophagidae family (turacos, plantain-eaters and go-away birds). In her spare time, she tends a large flock of her own and practices law on a part-time basis. S.L.D.]

Abstract

Endangered species, including nearly 1000 species of birds, are in need of human intervention if their long term survival is to be assured. Methods such as habitat conservation, captive propagation and cryopreservation have been the standard conservation methods employed to date. Now, because so many bird species are at critically low population levels, more extreme methods such as hybridization need to be considered if extinction is to be avoided.

Introduction

Each year, there is an increase in the number of plant and animal species whose populations have declined to a critically low level, endangering their continued survival. Birds are not exempt from this phenomenon and at least 1,000 species, ten percent of all the bird species in the world, are facing the threat of extinction in the next century (Perrins 1990). Science and humanity at large have developed various plans for coping with the problem of endangered bird species but have achieved relatively minimal success. Creative approaches to the situation may, in the end, be the only means of protecting these threatened species.

Protection of Endangered Species

As stated above, the problem now facing ecologists, wildlife conservationists, and other scientists is preservation of many species[1] whose populations are dwindling rapidly due to a number of factors including loss of habitat, poaching, human encroachment on their territories, and the introduction of diseases, predators and competing species. These problems have led to the creation of various legislative programs such as the U.S. Endangered Species Act (ESA) and CITES plans designed to identify and protect species whose numbers and habitats have been depleted to the point of threatening their long term survival. Interestingly enough, the listing of certain animals as endangered has caused researchers to investigate the molecular genetics and field ecology of those species, often leading to information which contradicted previously held ideas about the species' integrity or taxonomic distinctions.

Historical Means of Preservation.

To date, there are three established methods for preserving endangered bird species which have been designated as threatened or endangered. The first involves habitat preservation and related conservation practices. While this method has worked as a stopgap measure, conservation efforts have also backfired by significantly modifying the evolutionary course of a given species.

An example of this can be seen in a project carried out by officers of the U.S. Fish and Wildlife Service who collected a number of members of a Hawaiian finch species on the atoll of Laysan in 1967. The birds had become endangered in their own habitat due to the presence of human introduced rabbits and rats. The USFWS moved the finches to Pearl and Hermes Reef, islands more than 300 miles from their home. Over the next 20 years, the birds adapted to their new habitat and different food supply by changing first their eating habits and ultimately the configuration of their beak. "As more and more species are endangered, well-meaning attempts to save them involve introducing them to new homes or reintroducing them to their old homes. Conservationists may be frustrated to find that by moving a species, instead of helping it to survive, they have helped it evolve into a new form." (Weiner 1992; see also Grant and Grant 1988).

The second method is captive cooperative breeding programs, which have been taken on primarily by zoos around the world. As an example, the American Zoos and Aquariums developed Species Survival Plans for a number of different vertebrate species including many birds. These Plans include the development of stud books to keep track of the genealogy of captive animals so that inbreeding will not occur, cooperation with and education of citizens and government agencies in the native countries of the species to increase awareness of the need for habitat conservation for the target species, and sponsorship of field-research programs to increase populations of a given species in the wild (Cohn 1992).

A third method of conservation and repopulation which has proved virtually unworkable for bird species involves the cryopreservation of sperm, oocytes, primordial germ cells, and/or early embryos for later revitalization. This conservation method is predicated on the assumption that at some future date science will have developed methods not now available for taking the genetic material contained in the frozen samples and using it to "recreate" the species anew. While the science of in vitro sperm storage has been accomplished with some success, storage of the other elements of a bird species pedigree has proved unsuccessful or

merely theoretical to date (Etches 1996).

Hybridization as a Means of Species Preservation

A hybrid is the offspring resulting from the mating of two distinct species. In the plant world a hybrid is considered to be a distinct evolutionary species, entitled to full taxonomic classification (Standley 1992). That classification can represent a single sterile offspring of two different species, a back-crossed population, a new species derived from hybridization, or a variant individual or population within a morphologically variable species.

In the animal world, however, scientists have generally taken a differing view, finding that hybrids are unnatural aberrations (Morrell 1996; Jones et. al. 1995; Mayr 1991). This position is based on the basic assumption that the different genetic traits of the parents evolved as adaptations to a specific ecosystem and that the individual species genes should be preserved and not mixed with those of another, closely-related species (Cohn 1992).

Legal Prohibitions Against Hybridization

One mandate of the ESA and CITES is a limitation or prohibition on the listing of hybrids as recognized endangered species. A prime example of this situation can be seen in the Red Wolf *Canis rufus* which was always identified as a species in its own right until its numbers became so small that it was made a candidate for endangered species status. In conjunction with that process, morphological studies and genetic analyses revealed the Red Wolf to actually be a hybrid between the Gray Wolf *Canis lupus* and Coyotes (O'Brien and Mayr 1991). Thus, endangered species status to this animal was denied.

In the avian world, an unfortunate example can be seen in the Dusky Seaside Sparrow *Ammodramus maritimus grescens*, a melanistic species which inhabited the coast of Florida. By the early 1980s the population was dropping so dramatically that five of the birds were brought into captivity and crossed with a morphologically similar species, Scott's Seaside Sparrow *A. m. peninsulae*. The federal government decided that the production of a hybrid between these two species was not in the interest of the Endangered Species Act and therefore refused to consider protected status for the bird (O'Brien and Mayr 1991). The Dusky Seaside Sparrow became extinct in 1987.

Mechanistic Limitations on Hybridization of Birds.

In a number of mammalian species hybridization has been observed in wild populations and in human-aided crosses such as mules (Jones et al. 1995). The possibility of hybridization in mammals as a species survival technique is made easier by the fact that fertilization can also be conducted in vitro, and the resulting embryo then implanted in a host female where it completes its prenatal growth and development. A similar procedure has not been perfected in avian species, due to the uniqueness of the egg as a prenatal home for the developing embryo (Etches 1996). While it is possible to create chimeras or to manipu-

late the primordial germ cells in living bird species for the purpose of genetically modifying their offspring, no reports of successful transfer of in vitro created avian zygotes to hens has been reported (Ballou 1992).

Pseudo- and Actual Hybridization Techniques

Some attempts have been made to increase populations of endangered bird species using techniques that are not quite hybridization but which involve significant modifications of the normal breeding strategy of the target species.

One example is the cross-fostering of the Black Stilt *Himantopus novaezelandiae*, a New Zealand bird whose population was reduced to 70 adult birds (10 breeding pairs) in 1981. Individuals of this species would naturally hybridize with Pied Stilts *H. himantopus* if no appropriate mates of their own species were available (Reed et al. 1993). Over a six year period, an attempt was made to artificially increase the Black Stilt population by inducing multiple-clutching and the cross-fostering of eggs to Pied Stilts. The experiment was deemed a failure primarily because the manipulated juveniles adopted behavioral traits of their foster parents, resulting in improper migratory patterns and a refusal to breed with mates of their own species (Pierce 1984).

Another example involved the intentional hybridization of the endangered Venezuelan Black-hooded Red Siskins *Spinus cuculatus* with Canaries *Serinus canarius canarius* for the twofold purpose of ensuring the Siskin's survival and the production of a more colorful red-factor Canary (Olszewski 1996). This attempt was also deemed a failure due to an inability to recover a "pure" Siskin strain following multiple back-crosses and outbreeding. Obviously, had the procedure worked as planned, the hybrids would have been bred over successive generations to eliminate the Canary genes, leaving only Siskin genes in the progeny.

Moral and Ethical Considerations.

As stated above, the Endangered Species Act of 1973 and the international treaty CITES do not allow designation of hybrids as threatened or endangered. This rigid position overlooks the fact that hybridization of naturally occurring populations is a common event. In fact, some researchers believe that the basic eukaryotic cell exists as a hybridization between two lineages established prior to a complete definition of the genetic code and, as such, hybridization is part of normal evolutionary processes (Jones et al. 1995). The argument to be made is that technically, all vertebrate species have a hybrid origin and to limit the protection of a given individual because of its "hybrid" status takes too narrow a view of life.

A close examination of species using the recent advanced techniques of molecular genetics may and has revealed that birds and other vertebrates currently designated as separate species are, in actuality, subspecies of a larger taxon. Subspecies can and do interbreed in a natural process; they are often defined by genealogical concordance and geographic partitioning which lead the way to biological diversity and eventually complete species divergence.

Out of the nearly 10,000 bird species in the world, roughly 1000 are known to hybridize in nature. Hybridization is common among grouse, partridges, woodpeckers, hummingbirds, hawks, herons, ducks and geese. In fact, 67 of the 161 species of anseriformes in the world are known to hybridize under normal environmental conditions (Reed 1996).

If the hybridization rate is so high under natural conditions, it is unreasonable to consider it morally or scientifically reprehensible to hybridize endangered species to ensure the continuation of genetic lines. Current technology, coupled with social, economic, and political constraints, limits the options for preserving the unique genetic composition of hundreds of bird species on the brink of extinction. "When the only remaining genetic information of threatened species can be recovered through or from species hybrids, a case by case assessment of the benefits of preserving hybrids or their descendants versus the disadvantages of species hybridization would be required." (O'Brien and Mayr 1991).

[1] End Note

There is no one accepted definition of species, but the most popular explanation is the "biological species" or isolation " theory, which states that a species is an interbreeding community of populations which are reproductively isolated from other such groups and which occupy a specific niche in nature (Mayr, 1983). While most distinct species do not interbreed in nature because of some sort of isolating mechanism, many scientists feel that speciation and reproductive isolation are evolutionary independent (Endler, 1989). However, taxonomy has also recognized "incipient species"—geographical races generally distinct from other populations is a few characters but which integrated when they were in overlapping zones of contact. These "subspecies" or "races" have been viewed as incomplete stages in evolution where divergence was not complete and reproductive isolation had not yet been attained (Standley, 1992).

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