The use of Exotic and Hybrid Raptors in Falconry

Information arising from the International Committee on Hybrids

UK Chair: Dr Nick Fox

Publication date: January 1999

Revised: May 2004

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Publication date: 18 November 1997

Appendix 5. Letter from Robert A. Witzeman, m.d. of the Maricopa Audubon Society to Harold Olson, NM dept. of game and fish. 1982.

Appendix 6. Extract from: recommendations of the Colorado Wildlife Federation task force on raptor law and regulation. 1984.

Appendix 7. The use of exotic peregrines to repopulate lost range. Tom Cade. 1980.

Appendix 8. Discussion on parrot hybrids - Catherine Quinones. From the www. 1997.

Appendix 9. Some Species Definitions - notes to a paper by R.M. Zink given at the Linnean Society, March 1996.

1. INTRODUCTION

1.1. This is a discussion document designed to help us clarify our thoughts on these issues. It arises from submissions made (1996 & 1997) by the UK Hawk Board on the issue of introductions of non-native species under the Bern Convention, from concern about the DFO's attitude to the use of hybrids in Germany, and from discussions at the NAFA Board meeting, November 1996 in which NAFA decided to establish an informal international working group to tackle the issue.

This is the first time that falconry has tried tackling an issue on an international, non-allied basis using the internet as a medium for a discussion group. All participants have had their own pressures of other work, also it has been impossible, because of the large numbers of documents, to properly include those with a fax but no e-mail. The difficulties have also been compounded by having two chairmen and, because of the pressure of completing this document for a deadline of 23 November for the NAFA meet in US and the DETR Wildlife Inspector's conference in UK, we have at the last minute, decided to keep the two documents separate. They do not overlap unduly and have their own flavours. Interestingly, both documents reach very similar conclusions, and both chairmen are still talking to each other!

1.2. The Mission Statement from NAFA is as follows:

a) To discuss the variety of issues related to the production of hybrid raptors and their use in the sport of falconry, and to achieve a level of consensus amongst falconers internationally regarding these issues.

b) To recommend a set of standards to the NAFA Board of Directors that might serve to govern the production/use of hybrids in the interest of maintaining the value added to our sport by hybrids, while maximizing opportunities to protect the integrity of native raptor populations and benefit raptor conservation.

This document, compiled by the UK Chairman from submissions from contributors (see 1.3) fulfils part (a) of the mission statement above. Although we have suggested some options, we have not made any recommendations as requested in (b).

1.3. During 1997 a list of people (Appendix 1) have participated or contributed to this discussion, chaired by Dr Steve Sherrod (USA) and Dr Nick Fox (UK). As chairpersons, we have as far as possible compiled material and presented blocks of text verbatim from contributors without editing. However, we have had to both present a structure and summarise arguments: and these derive from a submission made to the UK Government by the British Hawk Board in September 1997 which successfully defended us against proposed restrictions on the use of non-indigenous species and hybrids.

1.4. This document attempts to clearly present information and data, but, contrary to NAFA's second Mission point, and pro the UK Hawk Board and IAF's requests, we have not attempted to outline policy. As producers of hybrids, both Chairmen recognise that we may be perceived to be biased on this issue, and we also recognise that the situation with respect to this subject differs in each individual country. Therefore, we present the material, but leave it to each club or country to formulate its own policy, bearing in mind, as Christian de Coune warns, the potential precedent, for better or worse, a national policy may have on other countries. We have seen this happen with Germany.

1.5. We assume the following three tenets:

a) We support as a first priority, the sustainable future health of wild raptor populations.

b) We support as a second priority the freedom of individual falconers to practice legal and sustainable falconry.

c) We support as a third priority the freedom of individual falconers to decide if they wish to fly a hybrid or non-indigenous raptor.

2. THE ISSUE

2.1. Some falconers object to the use of hybrids on the basis of 'purism'. To the outsider the issue is not simply the use of hybrids in falconry, but the possibility of non-indigenous raptors becoming established in the wild, either as pure populations or by hybridising with indigenous species. This is a much wider subject which carries a potentially major impact on falconry. For example, in the UK the Harris Hawk Parabuteo unicinctus and the Redtailed Hawk Buteo jamaicensis are the mainstay species of the 'average' falconer. To lose these species would be a major blow for the sport. The Convention on the Conservation of European Wildlife and Natural Habitats (the 'Bern Convention') had several times verged on classing falconry as a 'release' of non-native organisms, and we have had to fend this off at different legislative levels. Now it is accepted that falconry is not a 'release' because falconers intend to get their birds back and use various techniques including training and telemetry, to achieve this.

2.2. Some countries or states allow only the use of native species in falconry, others the use solely of non-natives. Some are more concerned about the risk of introductions, others about the risk of thefts from the wild.

2.3. The basic premise is as follows: ***that the release, particularly the unplanned release, into the wild of non-native organisms is deleterious to the indigenous ecosystem and its species components.***

2.4. There are examples in which organisms have been invasive, have ecologically outcompeted equivalent indigenous species, or have impacted on inadequately adapted prey populations. The major impact of invasive organisms has been on isolated endemic ecosystems which tend to be less competitively adapted than continental systems. Obvious examples include mammals such as rabbits, foxes, cats, dingo's, horses and camels outcompeting indigenous marsupials in Australia. Smaller islands have been drastically affected by cats, rats, goats, pigs or rabbits. In ecologically sensitive situations such as these it is clear that the introduction of exotics poses great risk and that the basic premise holds good.

2.5. Continental ecosystems are, or have recently been, geographically linked. There is no sea barrier between Cape Town, Bergen and Hong Kong. These ecosystems are intrinsically more robust and competitive. It is less easy for exotic species to become invasive, although there are examples, such as the Rhodendron in western Scotland, and the Japanese Knotweed. Examples of competitive introductions or interbreeding in New Mexico (Witzeman 1982, see Appendix 5) include European Starling, Rainbow Trout interbreeding with Apache Trout and Rio Grande Cutthroat Trout, and dogs breeding with Red Wolves. However, over the years, many species have been deliberately or accidentally introduced by man and have become part of our flora or fauna. Most of these introductions, rather than displacing natives, have enriched the biodiversity of the ecosystem by exploiting new man-made niches. It is probable (certainly in Britain and Western Europe) that there are virtually no areas of land remaining which have not been modified by man to a greater or lesser extent.

2.6. The USA already hosts more than 2,000 species of imported plants, 2,000 species of insects and spiders, more than 140 land mammals, 70 species of fish, 90 terrestrial slugs and snails, and more than 200 microscopic plant pathogens. 29% of New England's plant species are introduced.[1] In addition, many state wildlife agencies have for many years adopted an aggressive policy of releasing exotic game and fish species for sporting purposes.

2.7. While many of our British 'wild' animals are introduced, such as the Pheasant Phasianus colchius Red-legged Partridge Alectoris rufa, Rabbit Oryctolagus cuniculus and Sika Deer Cervus nippon, as are many of our trees, such as the Sycamore Acer pseudoplatanus, many more of our introduced species were introduced for agricultural production, forestry or horticulture. Our crops and farm animals, our timbers and our gardens, our entire so-called 'natural' British landscape, is dominated by introduced species. Attempts to deny or freeze this process, according to the premise of the Bern Convention, are doomed to failure. Rather, we must examine the process, avoid introductions of invasive and harmful organisms, but benefit from the use of other organisms and genetic material. The concept of a utopia in which one strolls through a pristine natural ecosystem is an idealised dream. If all introduced species were removed from UK agriculture and food production would collapse. For a wider discussion of this see McNeely, J. A. 2001. The Great Reshuffling: Human Dimensions of Invasive Alien Species. IUCN, Gland, Switzerland and Cambridge UK.

3. HOW DO WE ASSESS 'INVASIVENESS'?

3.1. Let us take as the basic premise (whether or not we agree with its implications) a plant or animal establishing a new genetic population or strain breeding sustainably in an uncontrolled manner, for example, in the UK. What steps have to take place for this to happen, and what are the risks at each step?

3.2. Take first the situation of an exotic species establishing itself, for example the domestic cat Felis catus. We need to measure each of the following steps:

a) How many cats are allowed free range each year?

b) How many of these wanders off each year?

c) How many of these survive to breeding age?

d) How many of these meets either another feral partner or a temporarily freed domestic one for breeding?

e) How many of these breed young?

f) How many of these young survive to breeding age?

g) How many of these young breeds?

The numbers in each step can be reduced by various means, for example by marking each cat with its owner's name to enable it to be returned, by killing stray cats, by neutering and releasing feral cats to hold territories; and the risks are also modified by other factors such as provision of food for feral cats, competition with existing cats and by differential survival rates of progeny in comparison with existing cats.

3.3. What about an exotic species inter-breeding with an existing species and introducing exotic genes into its gene pool? Take for example the domestic cat and the Scottish Wild Cat Felis sylvestris:

a) How many cats are allowed free range each year?

b) How many of these wanders off each year?

c) How many of these survive to breeding age?

d) How many attempt to breed with a Wild Cat?

e) How many Wild Cats attempt to breed with Domestic Cats?

f) How many pairings produce young?

g) How many young survive to breeding age?

h) How many of these are fertile and breed young?

i) What is the differential production and survival of cross-bred cats through genetic compatibility or physical adaptiveness compared to pure Wild Cats?

j) What is the ratio of genetic challenge in terms of the size of the Domestic Cat population compared with the size of the Wild Cat population in the areas where they meet?

3.4. These factors apply to all free-living populations, which is why animals and plants are found in certain areas, but not in others. In their own area they are able to sustain their breeding populations, but outside their own range these attrition factors cause the organism to die off. If the factor is temporary, such as winter, bird species may migrate and survive to return again to breed in spring: otherwise they cannot survive. Therefore, most species which are introduced outside their natural range, die off. Some of them, such as most of our agricultural species and garden species, survive through constant support and management by man. A field of wheat is not a stable ecosystem. The wheat would quickly be outcompeted by other species until in a few years none would remain. These species, in these places, are non-invasive.

3.5. On the other hand, a few species, usually those from competitive continental ecosystems entering less specialised island ecosystems, can out-compete indigenous species or utilise unfilled niches in the ecosystem. These species, in these places, are invasive. The Caucasian race of H. sapiens has been invasive in many parts of the world, establishing breeding populations either where none previously existed or by supplanting and outcompeting indigenous populations. Therefore, the concept of invasiveness depends not just on the species concerned, but also on the place.

3.6. The breeding strategy of a species is also a major factor in its potential invasiveness. At the simplest level, an asexually reproducing organism has the best invasive potential because a single individual could start a new colony. Species which do not establish a strong pair bond, such as cats, have mating strategies which tend to be competitive, indiscriminate, and therefore more easily accomplished. With raptors, which often have a long courtship and nest building phase and form strong pair bonds, both potential partners have to accept each other as a mate and even if the exotic newcomer makes overtures, if the indigenous partner does not accept him or her, then pairing will fail. The implications of this are seen in the case studies below. In order for successful breeding to occur it is also necessary for two birds of the opposite sex, with a suitable nest site, and suitable habitat, to all come together at the same time. If someone in Ohio loses a female Lanner falcon Falco biarmicus and a male is lost in Oregon, the chances are that they will die before they meet. In other species, such as ducks, an individual exotic duck can join into an existing flock and contribute genes fairly promiscuously.

3.7. Therefore, it is clear that certain conditions have to be met for a species to become invasive. Blanket criticisms of raptors on the basis of their potential for invasiveness are not only ill-founded but are also hypocritical. It is certain that the critic will either have eaten or worn material from introduced organisms or have them in their garden or house.

4. ARE RAPTORS INVASIVE?

4.1. We will use the UK as an example for this general discussion.

4.2. Firstly, many species of birds of prey are flown in the UK, and hybrids are also flown. Each of these poses different risks and must be evaluated independently. For example, while humans are invasive in UK, chimpanzees Anthropopithecus troglodytes are not. Of the genus Falco, the Gyrfalcon F. rusticolus, the Saker F. cherrug, and the Lanner are the most commonly flown exotic species. For climatic reasons, and through the lack of a small mammal prey base, these species are not indigenous to the UK. They have been flown here in falconry since the Middle Ages and no breeding has been known to occur. We can confidently say that from both biological and historical evidence these species are non-invasive here. Of 771 international introductions recorded by Ebenhard, none were of genera used in falconry.[2]

4.3. Some species, such as the Cooper's Hawk Accipiter cooperii, occur in similar ecotypes in the USA to those found in the UK. Could it breed here? In the USA, it occupies a niche mid-way between the larger Goshawk Accipiter gentilis atricapillus and the Sharp-shinned Hawk A. striatus. Interspecific mechanisms prevent breeding between these species and there, the prey base is sufficient for the Coopers.

In Britain, there is less habitat suitable for the Coopers Hawk; the Sparrowhawk A. nisus is larger than the Sharp-shinned Hawk and would compete with the Coopers' for mid-sized prey. The Sparrowhawk is also a widespread and well-established native, whereas few Coopers Hawks are flown by falconers. Therefore, the chances of introducing this species are infinitesimal, even if one mounted a major effort such as that made with peregrines by The Peregrine Fund in the USA. From experience with various support and/or reintroduction efforts of birds of prey into their own original range, it appears to require a protracted conservation effort to introduce a population of a certain critical mass for it to sustain itself. Until this point is reached, a withdrawal of effort, or even minimal persecution, will cause the potential population to die off.

4.4. There is not enough space in this submission to provide an evaluation of every single falconry species and its potential for invasiveness as new species in the UK. The point is that each species is different and policy should be handled on a species by species basis, not on a catch-all basis. Definitions of 'species' are given in Appendix 10.

4.5. But what of the risk of introducing exotic genes into an existing endemic species, as with the Domestic Cat inter-breeding with the Scottish Wild Cat or the Racing Pigeon with the Rock Dove? Examples might include the Red-tailed Hawk Buteo jamaicensis from the USA interbreeding with the closely related Common Buzzard B. buteo. One would suspect that of all the species flown in falconry, this would be the one case where interbreeding might occur. And yet, despite over thirty years of large-scale use in falconry in UK, there has been only one failed attempt at interbreeding (see case studies).

4.6. The British Goshawk A. gentilis gentilis, extirpated by shooters in the 19th century, was reintroduced to the UK by falconers with major releases of wild-trapped juveniles of Scandinavian and European stock. Although of the same species, these came from phenotypically different sub-populations. This genetically mixed stock is now gradually selecting for the optimum types for the British situation. A similar situation pertains with the Red Kite Milvus milvus in the UK and the peregrine in the USA.

Similarly, if a Spanish Peregrine Falco peregrinus brookei was released in Britain, and survived and bred with a British Peregrine, not only would its genetic contribution be very rapidly diluted out (50% at each generation), but also would be weeded out through natural selection, through failure to compete with the ecologically more optimal British stock. Many sub-species of Peregrine have been flown in Britain over the centuries with no noticeable impact whatsoever. A similar situation would prevail if a European Goshawk Accipiter gentilis gentilis were lost in North America and bred with a Northern Goshawk A.g.atricapillus.

A similar case exists with the hybrid falcons, for example the gyr/peregrine. These are even less likely to have a genetic impact, because both sexes possess markedly lower fertility both in the first generation and in the second than pure peregrines. The genetic selection against them is therefore extreme. They also have major difficulties in pairing because either potential partner will fail to respond to the other's courtship signals: and ecologically they are even less able to compete with existing Peregrines because they are so far removed from the optimum wild type. The ease with which breeding raptors can be disrupted by human interference, while of long concern to conservationists, also demonstrates how easy it is to prevent interbreeding. With species which breed more privately, such as the Scottish Wild Cat, it is less easy to disrupt breeding attempts.

4.7. Where hybridisation occurs in the wild, it is through interbreeding of two established closely related populations, such as Domestic Cat/Wild Cat, Racing Pigeon/Rock Dove, Red Deer/Sika Deer, where there is a significant large-scale gene flow. Individual hybrid birds attempting to breed with a wild population are genetically outcompeted by the first generation.

4.8. Together with the biological hurdles that introduced birds would have to overcome, falconers add others: in compliance with Section 14 (3) of the Wildlife and Countryside Act, domestic birds of prey carry a ring and anklets to identify them as domestic and, in most cases, to trace them to their owner. They are also trained to come back and supervised during the period of flying free. Most birds also carry radiotelemetry to assist prompt recovery. Falconers in the UK have supported the compulsory close ringing of exotics, but this was discontinued two years ago, and we would support the compulsory use of radiotelemetry on exotics. We take all reasonable steps under 14 (3).
Do all other user groups match up to the responsible standards already set by falconers?

- Individual identification
- Trained to return
- Supervision during release
- Radio-tracking for control

4.9. Some of these discussion points will be examined in more detail in the following sections. (See 11.1)

5. CASE STUDIES OF INTERBREEDING ATTEMPTS IN THE WILD

5.1.

a) **Red-tailed Hawk Buteo jamaicensis Western race with Common Buzzard Buteo buteo in the UK. John Murray.** A female redtail was flown at hack, without parental imprinting, in British Columbia and then trapped - virtually as a passage bird - and sent to the UK. She was lost while being flown for falconry but survived on rabbits and settled on the Arniston Estate, 15 miles south of Edinburgh in 1969. As a third-year bird she paired with a pale male Common Buzzard and nested in a solitary oak near the river. She was still recognisable by her jesses, and easily located but would not come to a trap. She laid 4 eggs but these were taken by crows and Mr Murray could not tell from the shells whether or not they were fertile. She moved away to another estate where she preyed on domestic chickens and ducks. She was out in total for two and a half years but got heavily into taking pheasants and the keeper shot her and Mr Murray stuffed her.

b) **Peregrine Falco peregrinus male with female Prairie Falcon F. mexicanus in Colorado in 1949. Vern Siefert cited by Lynn Oliphant 1991.** These were both completely wild birds.

c) **Peregrine Falco peregrinus male with female Prairie Falcon F. mexicanus in Utah in 1986. Clayton White cited by Lynn Oliphant 1991**. The male had been hacked out in a release programme.

d) **Peregrine Falco peregrinus male with female Prairie Falcon F. mexicanus in Saskatchewan. Lynn Oliphant 1991.** The male had been hacked out in a release programme without parents:

HYBRIDIZATION BETWEEN A PEREGRINE FALCON AND A PRAIRIE FALCON IN THE WILD

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ABSTRACT: - Interspecific hybridization in the wild between members of the order Falconiformes have rarely been reported. A successful pairing between a male Peregrine Falcon and a female Prairie Falcon that produced two young occurred in 1985 in southern Saskatchewan. Although actual copulations were never seen, several food transfers between the Peregrine and Prairie Falcon were observed, both birds incubated the eggs and both actively defended the eyrie site. The two young, both males, looked distinctly different from Prairie Falcons and after moulting had blue backs, heavy malar stripes and rufous napes, characteristics typical of captive produced hybrids between these two species.

Interspecific hybridization in birds occurs infrequently. Mayr (1963) estimates that perhaps one in 50,000 birds is a hybrid. Although individual occurrences of natural hybridization are rare, Mayr and Short (1970) have recorded hybrids from over 10% of North American birds (52 of 516 non-marine species.) Hybridization is most common in groups that do not have elaborate or long-term pair bonds such as grouse (Tetraonidae) and hummingbirds (Trochilidae). It also is most often reported in species that are abundant. Mayr and Short (1970) were unable to find accounts of North American hybrids of 'rare' species, including the entire order Falconiformes. It is therefore with some interest that I report on a successful pairing between two species of large falcons. Both species are relatively rare and have an elaborate and prolonged courtship, and a strong cooperative pair bond through the breeding season.

OBSERVATIONS In mid-April 1984, an adult male Peregrine Falcon (Falco peregrinus) was observed on the South Saskatchewan River in Southern Saskatchewan at a breeding site regularly used by Prairie Falcons (F.mexicanus); G. Stewe, pers. comm.) Although peregrines have not been documented breeding on this river system in Saskatchewan, they were reported further west in Alberta until the early 1970s (Cade and Fyfe 1970). On 25 April, the site was visited again by Gerhard Stuwe, Bob Rafuse and myself. We observed a male peregrine flying with a female Prairie falcon. Little or no aggression was seen and our impression was that the two birds were paired. These falcons occupied a territory that contained a potential nesting site (a hole dug in a cliff face) that was within two kilometres of three active Prairie falcon eyries where females were incubating. In June 1984, when the area was visited again to band young, neither bird was present.

A number of visits to the area were made in 1985. On 19 April, an adult male peregrine was perched on a fence post eating a Common Snipe (Capella gallinago) near a nest site used by Prairie falcons in 1984. The peregrine 'cakked' aggressively when approached and flew off. When the site was approached several minutes later from the base of the cliff, both the peregrine and a female prairie falcon were perched about 50m from each other on the cliff face. The prairie falcon flew toward the peregrine which responded by bowing and 'eechipping'. The prairie falcon displaced the peregrine from his perch and both flew together with additional bowing and 'eechipping' by the peregrine. The prairie falcon bowed and appeared to be soliciting copulation, although no copulations were ever observed.

The cliff face occupied by these two falcons in 1985 was near the centre of a cluster of five potential eyries, as opposed to 1984, when they occupied a peripheral site. Two other Prairie falcons were seen in a short time soon after our arrival on 19 April. Following the interaction between the peregrine and the prairie falcon described above, the peregrine made a short, direct flight to the west and engaged in a short combat with a male prairie falcon. The peregrine dominated the interaction, drove off the prairie falcon and returned to the cliff.

The site was next visited by Gerhard Stuwe and myself on the afternoon of 8 May. A male peregrine appeared to be incubating in a pothole in the same cliff where the birds were seen on 19 April. A female prairie falcon flew past the eyrie 'cakking' and then flew to a fence post near the top of the cliff. During the next few hours, the prairie falcon flew out twice to chase other prairie falcons away from the eyrie at distances of 1km or more. Both times on her return she flew past the eyrie 'cakking.'

The second time, the peregrine flew from the eyrie and displaced her from her perch. The Prairie falcon flew directly to the eyrie and made movements typical of a falcon settling on eggs. The peregrine made two flights to the west in the next fifteen minutes 'eechipping' and chasing another Prairie falcon.

Continuous observations were made on 16 and 17 May from a camp about 200m west of the eyrie, and the events were recorded on film. The peregrine and prairie falcon alternated incubation duties and made several food transfers. The peregrine wore a US Fish and Wildlife

Service band on its left leg. On 31 May the prairie falcon was feeding small young in the eyrie and another food transfer occurred.

On 5 June the male peregrine was trapped at the eyrie. This peregrine falcon (F. peregrinus anatum, band number 686-04921 hatched in 1980 at the Canadian Wildlife Service Breeding Facility at Wainwright, Alberta, and was released in the same year from an artificial site located about 75 km east of the present eyrie. We removed two large downy young and three addled eggs from the eyrie and replaced them with three young, captive-bred peregrines between two and three weeks old. Both adult falcons defended the eyrie during the transfer. The site was visited again on the 9, 18, and 19 June and 7 July. Both falcons were in attendance on all visits and their three foster young fledged successfully.

The two young which had been taken from the eyrie were both males. They were darker, heavier and had larger toes than typical prairie falcons. Both were given to falconers and raised as imprints. After their first moult the falcons' backs were blue, their breasts more spotted than barred, their napes were a rich chestnut colour and their malar stripes were wide. The one in my possession weighed 680grams (range for prairie falcon males is 420-639g; Clark and Wheeler 1987) and was easily distinguished from either parental species.

In both 1986 and 1987, the same male peregrine, identified by the band and a missing secondary feather on one wing that was permanently injured during the trapping of the bird in 1985, was paired with a female prairie falcon at the same site. The five young that were produced in 1986 and the three young in 1987 were removed from the eyrie by directive from the Sasketchewan Department of Parks and Renewable Resources. None of these birds exhibited any characteristics that would suggest they were hybrids. All of them appeared to be 'pure' prairie falcons. In March 1988 the adult male peregrine and a female prairie falcon were seen at the same eyrie, but they did not breed. In 1989 and 1990, the peregrine had moved to a site about 1km east of the previous eyrie that also contained a man-made hole dug in a cliff face. He was in the company of a female prairie falcon. No evidence of attempted nesting occurred in either of these years. On 25 April 1990, Stan Rowe, Patrick Thompson and I visited the site and released a falconry-trained 2-year old female peregrine. The released female flew to the top of the cliff and began food begging, and the male peregrine responded with vigorous courtship flights and much 'eechipping.' He also flew to the nest ledge and began bowing and 'eechipping.' The female Prairie falcon ignored both birds and drifted off to the east.

DISCUSSION Hybridization among members of the genus Falco in captivity is easily accomplished by means of artificial insemination (Boyd 1978) and many peregrine/prairie falcon hybrids have been produced in captivity (Bunnell 1986). To my knowledge, however, the only instance of an interspecific pairing between falcons that has resulted in actual copulation and the production of young in captivity was between a saker (F. cherrug) and a peregrine (Morris and Stevens 1971.) This may only reflect the relative rarity of interspecific pairs set up in captivity rather than an actual blockage to interspecific pairing. Suchetet (1896) describes several early records of potential crosses between different species of falcons. Because of uncertainty in the species status or lack of documentation regarding the success of the pairings, only the cross between a European kestrel (F. tinnunculus) and a Merlin (F. columbarius) which apparently resulted in four young, seems credible. A peregrine pairing with a Saker in the wild in the early 1970s in Bulgaria has been reported (Saar et al. 1984) but no young were found [WD1] * . Vern Siefert (pers.comm.) observed an incubating female prairie falcon in Colorado in 1949 with a tiercel peregrine being the only other falcon seen nearby. The site was not revisited to confirm this pairing. The only other recent case of hybrid young being produced by a natural mating of two species of falcons that I am aware of was in Utah in 1986, again a male peregrine and female prairie falcon at an artificial site (C.M. White, pers. comm.) The prairie falcon was trapped and removed and the eggs sent to the World Center for Birds of Prey in Boise where all five hatched. The male peregrine subsequently mated with a female peregrine and produced young later the same year.

In retrospect the potential for occasional pairing of peregrines and prairie falcons might have been predicted. The peregrine overlaps the entire range of the prairie falcon, often nesting in close proximity (Salt and Wilk 1966, Porter and White 1973) or even in the same eyrie in alternate years (W. Spofford, pers. comm.) They are essentially the same size with extremely similar courtship behaviour and vocalisations. A recent study of the karyotype of these two species showed them to be indistinguishable at current levels of discrimination and suggests they may be more closely related than previously thought (Schmutz and Oliphant 1987).

An additional factor that may have facilitated the formation of the interspecific pairing in Saskatchewan was the fact that three eyass Gyrfalcons (F. rusticolus) and a female prairie falcon were released in the same vicinity as the peregrines in 1980 (Oliphant and Thompson 1988) Although never in contact with the other species until after fledging, the young peregrines often interacted with the Gyrfalcons and the prairie falcons as well as wild prairie falcons in the area. The absence of aggressive parents, which under normal circumstances, would have driven away these other large falcons, may have encouraged acceptance of members of the other falcon species even though sexual imprinting on another species, as we currently understand it in falcons, should not have occurred at such a late stage of development.

Wild prairie falcons have sometimes been used to cross-foster captive-bred peregrines in reintroduction efforts. Over 60 peregrines have been fostered by prairie falcons during the past decade in the Rocky Mountains, California and southern Alberta. Gyrfalcons have also been used as surrogate parents for peregrines in the Yukon. At least some of these cross-fostered peregrines have mated successfully with their own species (B. Walton, pers. comm.) Although the biological significance of the infrequent occurrence of hybridization is probably minimal (Cade 1983), the potential for some gene flow between these two species of falcons in the wild has been demonstrated and should be taken into consideration in any management scheme. Documentation of the fertility of these falcons (which appears to be low in many crosses) and their ability to form viable pairs in the wild would be needed to assess the potential for gene flow.

With respect to the occurrences from 1986 to 1990, I can only offer conjecture. My interpretation of the events is that in 1986 and 1987 the same female prairie falcon returned to the site, successfully paired with a male prairie falcon and laid a clutch of eggs prior to the peregrine returning. The nesting dates in 1986 and 1987 were about 2 weeks advanced over that in 1985, which I suspect was the first year this female laid eggs. Although never observed, the peregrine upon arrival presumably drove the male prairie falcon from the site and successfully took over male duties. I attribute the unsuccessful breeding attempts in 1989 and 1990 to be due to the death of the original female and unsuccessful attempts of the male peregrine to form a strong enough pair bond to result in egg laying with a new female.

If this interpretation is correct, then a number of interesting conclusions may be drawn. First, although the male peregrine was obviously capable of successful breeding and could provide adequately for five young, by age nine he had only produced two hybrid young. Second, it would appear that although a successful pair bond was established with one female prairie falcon, other females of that species were not so inclined. Finally, although circumstantial evidence suggests that the male peregrine was capable of displacing male prairie falcons from its/their established territory (1986 and 1987), he either could not or did not try to take over at closely adjacent site where prairie falcons nested each year. Taken in total, it strongly suggests a relative decrease in breeding potential across species lines, a not too surprising conclusion.

LITERATURE CITED

BOYD, L.L. 1978. Artificial insemination of falcons. Symp. Zool. Soc. Lond. 43:73-80

BUNNELL, S. 1986. Hybrid Falcon overview - 1985. Hawk Chalk 25 (1): 43-47

CADE, T. 1983. Hybridization and gene exchange among birds in relation to conservation. Pages 288-309 in C.M. Schonewald-Cox [ED.], Genetics and conservation. Benjamin Cummings Publishers Co. Inc, Menlo Park, CA.

CADE, T.J., and R. FYFE. 1970. The North American Peregrine Survey, 1970. Canadian Field-Nat. 84:231-245.

CLARK, W.S. and B.K. WHEELER. 1987. A field guide to hawks of North America. Houghton Mifflin Co., Boston, MA.

MAYR, E. 1963 Animal Species and Evolution. Belknap Press of Harvard University Press, Cambridge, MA.

MAYR, E. , and L.L. SHORT. 1970. Species taxa of North American Birds. Publ. Nuttall Ornithol. Club No.9.

MORRIS, J., and R. STEVENS. 1971. Successful cross-breeding of a peregrine tiercel and a Saker falcon. Captive Breeding of Diurnal Birds of Prey 1:5-7.

OLIPHANT, L.W and W.J.P. THOMPSON. 1988. The use of falconry techniques in the reintroduction of the Peregrine Falcon. Pages 611-617 in T. Cade, J. Henderson, C.G. Thelander and C.M. White, [EDS], Peregrine Falcon populations: their management and recovery. The Peregrine Fund Inc., Boise, ID.

PORTER, R.D. and C.M. WHITE. 1973. the Peregrine Falcon in Utah, emphasizing ecology and competition with the prairie falcon. Brigham Young Univ. Science Bull. Biological Series XVIII (1): 1-74.

SAAR, C., D. GERRIETS, P. PAASCH and C. SPAETER. 1984. Die kunstliche Besamung beim Wanderfalken (Falco peregrinus). Jarbuch Deutscher Falkenorden 1984: 14-23.

SALT, W.R. and A.L. WILK. 1966. The birds of Alberta. Hurtig Publ., Edmonton, AB Canada.

SCHMUTZ, S.M. and L.W. OLIPHANT. 1987. Chromosome study of Peregrine, Prairie and Gyrfalcons with implications for hybrids. J. Heredity 78: 388-390.

SUCHETET, A. 1896. Des hybrides a l'etat sauvage. Imprimerie Typographique et Lithographique le Bigot Freres, Lille, France.

e) Peregrine Falco peregrinus female with male Gyr/peregrine F. rusticolus/peregrinus in Germany in 1996. Christian Saar and Walter Bednarek. The female was captive bred and hacked out without parents. The male was an escaped falconer’s bird. Two young were produced in the wild. The male was trapped and the young removed. DNA tests were made by Professor Wink, proving the male gyr/peregrine to be the father.

f) Peregrine Falco peregrinus female with male Gyr/peregrine F. rusticolus/peregrinus in Germany in 1997. Christian Saar and Walter Bednarek. The female was juvenile, unringed. The male had been lost at hack. They paired near Hamburg but the male was trapped without breeding.

g) Unidentified hybrid occupying nest box but not paired up. Belgium 1995 Christian de Coune.

'Two years ago, a big pale coloured hybrid was seen on a cooling tower of an electric power plant occupying a nestbox placed there for peregrines. The ornithos were very upset about that bird and they asked me what to do. The reason they gave me for their anger was not the risk of genetic pollution but the fact that the bird occupied their nestbox and chased the peregrine(s) away; the ornithos did not raise (with me at least) the objection of genetic pollution, but found the bird cumbersome and made birdwatching and raptor identification a bit more challenging.'

Christian de Coune, pers. comm. to the hybrid debate, 03/05/97

h). Female gyr/peregrine paired with wild male anatum peregrine in Colorado 1996. See Steve Sherrod's report. Eggs laid but did not hatch, fertility status unknown.

i). A. Corso and D. Forsman (1997) also cite the following examples of successful hybridisation in wild raptors

- Black Kite Milvus migrans and Common Buzzard Buteo buteo in Rome

- Male Pallid Harrier Circus macrourous and Female Montagus Harrier Circus pygargus Finland 1993

- Golden Eagle Aquila chryseotus and Imperial Eagle Aquila pomarina in Spain

Corso and Forsman also cite the following examples of non-successful breeding attempts:

- Male Pallid harrier Circus macrourous with Female Hen Harrier Circus cyaneus

- Male Pallid harrier Circus macrourous with Female Montagus harrier Circus pygargus

5.2. Of the above examples, one, (b) occurred in 1949 before the advent of captive breeding, and is an example of natural hybridisation, although it was not confirmed. It is probable that peregrines and prairie falcons in this area were nesting in close proximity in 1949. In examples (c), (d) and (e) the pure peregrines had all been hacked out in re-introduction programmes without parents. It is likely therefore that they lacked full parental imprinting. The male gyr/peregrine in (e), the subject of major controversy in Germany, was not (as an escaped falconers' bird) the only factor in this pairing, because the 'wild' female was actually captive bred and hacked out without full parental imprinting. In the second case, (f), the female was juvenile and no breeding took place. It is possible that she was responding to the male as a supplier of food, i.e. as a parent rather than as a mate. In the third case in which a hybrid was involved (g), the bird refused to pair and drove away peregrines. In case (d) Oliphant reported 2 hybrid chicks hatching from a minimum of 5 eggs. When breeding pure chicks the female produced broods of 5 and 3. In h) the eggs did not hatch at all.The little evidence we possess shows that full species are as likely to mispair as hybrids and that inadequate parental imprinting in hacking predisposes birds to mispair. This was a factor in cases (a), (c), (d), (e) - both birds - and (f). Imprinting on saker parents was likely to have been a factor preventing pairing in case (g) but we have been unable to verify this.

5.3. These records represent the total number of global, verifiable attempts that we have traced. [Note, since this was written in 1997, Gene McCarthy has been documenting hybridization of birds for a book due out shortly. It contains long lists of hybrid birds of all taxa that have occurred in the wild, and in captivity, including inter-generic hybrids. It is clear that genetic isolating barriers are by no means as water-tight as previously thought by speciesists and that occasional genetic re-combination through hybridization, although rare, is a normal event in nature.] For raptors, these records are the total known genetic threat despite hundreds of exotic falconers' birds being lost in many countries over the centuries. It is noteworthy that of these case studies, NONE include an exotic falconry species starting to colonise. There have been no nesting attempts between two individuals of the same exotic species. We can confidently say that in the last thirty years there has probably been more intensive monitoring of nesting large falcons than of any other taxon. It is not a case that nobody has been looking. Significant numbers of birds have been lost, but almost none have bred. These are the known facts. The evidence therefore is conclusive: exotic raptors used in falconry are non-invasive in the current situations. We will compare these data with examples of other taxa which are invasive:

6. GENETIC IMPLICATIONS OF HYBRIDS ON WILD GENE POOLS

6.1. Genetic mixing to existing native populations is not necessarily a bad thing. For example, the Welsh population of Red Kites Milvus milvus suffer depressed breeding as a result of genetic impoverishment. Genes contributed by a German kite in the 1960's have provided much-needed genetic vigour. New introductions have since been made of Spanish and Swedish kites and the kites now show improved brood sizes in UK.

6.2. For non-native genes to enter a wild population a number of barriers have to be crossed:

6.3**.a. Behavioural barrier.**

The introduced bird has to be sufficiently close taxonomically to produce viable offspring with a native individual. The more closely related the two birds, the more likely this is to occur. For example, a non-local subspecies of peregrine, such as a Spanish F. p. brookei in the UK, is most likely to interbreed successfully with local F. p. peregrinus peregrines.

Other, full species, are very unlikely to interbreed if they already exist sympatrically somewhere in the world. For example, gyrfalcons and peregrines exist together in many areas of the world and possess mechanisms which stop them even attempting to interbreed. Similarly, sakers and peregrines do not normally attempt to interbreed. However, where gyrs and sakers link in the wild, they do seem to interbreed and form an intermediate form or natural hybrid, the Altai falcon.

This barrier, which prevents breeding attempts, is behavioural. Where two species have only recently become distinct through geographical isolation, such as the red-tailed hawk and the common buzzard, the natural mechanism keeping them genetically distinct is geographical, rather than behavioural. If a red-tail is released into a wild population of common buzzards there appears to be virtually no behavioural or genetic barriers preventing inter-breeding. Having said this, considering the numbers of red-tails lost in UK each year (10+?), there are no authenticated records of inter-breeding except the 1969 record of a failed attempt. There are several sympatric species of Buteo in America and it may be their specific behavioural barriers are quite subtle.

6.4. The mechanisms by which this behavioural barrier operates are not yet fully understood. Calls and displays given by a bird during courtship appear to be of genetic origin, i.e. they are instinctive, 'hard-wired' and unalterable. On the other hand, the image in the bird's mind of what constitutes an appropriate partner to display to is, to a large extent, imprinted during the bird's early life. For example, any species of falcon reared by a peregrine is likely to treat an adult peregrine as a potential mate. Any species of falcon reared by a gyr is likely to treat an adult gyr as a potential mate. Thus, by imprinting a young falcon on a human or any other non-native species, a behavioral barrier is created which reduces the risk of hybridisation with a native species. As humans are unlike any type of raptor, imprinting on humans is a possible way of creating a behavioral barrier against inter-breeding in the wild. Imprinting may also result in reduced survivability in the wild, further decreasing the probability of successful breeding attempts in lost imprint birds (see extract from letter from Bill Burnham, below)

BILL BURNHAM
'A final point on imprints is survivability in the wild should they be lost during use in falconry. Imprints I have seen and personally handled would have a greatly reduced chance of survival in the wild simply because they are so tame and oddly behaviourally directed. Many behavioural imprints which are lost may just as likely beg for food from a human as pursue quarry. The unknowing person who is confronted by a strangely behaving raptor may not react kindly to the bird's flirtations. The chance that an imprinted bird would be shot, hit by an auto, captured, killed by another animal, etc., would certainly be increased several fold over that of a non-imprint.'
Extract from a letter to Robert Tully, Colorado Division of Wildlife, September 7 1983

6.5. This barrier actually goes a step further. For a bird to attempt to breed with another, the mate must not only physically resemble the imprinted image, but must also respond with its own, correct courtship signals to stimulate pairing. Take for example, a gyr reared by a peregrine and lost to the wild. What would happen if it saw a wild peregrine and attempted to court it? The peregrine would be inhibited by the courting gyr through its own behavioural barriers. It would not therefore make courtship signals and copulation would be prevented. However, a gyr/peregrine, reared by a peregrine and later meeting a wild peregrine, might look and behave sufficiently like a peregrine for the peregrine to be stimulated and return its courtship signals, leading to successful copulation.

6.6. **b. Genetic barrier.**

We know that if the behavioural barrier is bypassed through using artificial insemination, these species can produce viable offspring. In other words, there is not a complete genetic barrier. Hybrids can be formed between the three species.

Contrast this with another example, the peregrine and the goshawk. These two species have a behavioural barrier preventing attempted breeding, but also, if one tried artificial insemination, no embryos would develop; there is a genetic barrier.

In our current state of knowledge, it seems likely that all of the species in the genus Falco can be hybridised by artificial insemination to produce first generation young. The close sub-groups in Falco, such as the gyr/saker/lanner complex, or the peregrine complex, appear to form hybrids within their complex which usually show full fertility over indefinite generations. The less closely related species, such as the gyr and peregrine, form hybrids which normally exhibit reduced fertility; the spermatazoa show a high percentage of deformities and some females are completely sterile. A high percentage of them show physical deformities, particularly skeletal and cardiovascular deformities, some of which appear to be fatal in the embryo stage. The result? In the wild gene pool, the genes from hybrids such as these would be diluted out through an inability to compete with pure wild genes.

6.7. Less related hybrids within Falco, such as between peregrine and New Zealand falcon Falco novaseelandiae, are possible, but the embryonic mortality is very high. We have no data yet on second generation fertility. Also, we have no data on the possibilities of inter-generic hybrids in the Falconidae.

6.8. Inter-generic hybrids have been produced between Parabuteo unicinctus and Buteo regalis (harris and ferruginous hawk) and between Parabuteo unicinctus and Accipiter cooperii (harris and coopers hawk). We do not know what is happening at chromosome level in these cases, or about the fertility of such offspring.

6.9. **c. Genetic attrition.**

If the behavioural and genetic barriers are overcome and genes enter the wild gene pool, there is then the question of assessing gene flow and proportions. Although a hybrid individual may show 'hybrid vigour' in terms of energy, genetically hybrids perform less well than pure breds. Hybrid semen shows reduced fertilising capacity, hybrid embryos show reduced viability, hybrid chicks show increased physical defects, adult hybrids have a higher rate of partial or complete sterility. The overall result of this is that when hybrid genes enter the gene pool, not only are they heavily diluted by pure genes, (due to the size of the gene pool and to genetic turnover between generations) but also, they are out-competed. Their performance is not as good as the pure genes and therefore their frequency in the population falls. This dilution rate could be calculated based on numbers and probabilities. Phenotypically too, the hybrid is less well adapted to the local wild conditions than the pure wild type and it will tend to be less well able to support a mate, or show higher mortality, or inappropriate migratory behaviour, to maintain its gene frequency. This is the mechanism by which populations maintain their wild type. For example, the Rock Dove in the UK maintains its wild type in the face of massive genetic challenge from racing and domestic pigeons, through preferential selection.

6.10. Where a local population is already depleted owing to other factors, as is the peregrine in Germany, there may be less intense competition for nest sites and mates. A lost hybrid thus has more chance to be accepted and pair up in these circumstances than in a saturated population as in most parts of Britain.

DR MIKE NICHOLLS

'I feel that the several references to immigrant genes (i.e. genes from other full species or from sub species) being "diluted out" needs to be dealt with systematically. The misconception that a few rare genes can be lost from a population by the sheer weight of numbers of "normal" genes was dispelled long ago by messrs. Hardy and Weinberg. Given certain conditions and the process of recombination (shown even longer ago by Mendel) new genes will remain in a population at the frequency at which they were introduced. Disruption from this equilibrium can happen under certain circumstances - the two important circumstances here appear to be "selection" and "disassortive mating".

Selection - In 6.9 "genetic attrition" great emphasis is made that" the hybrid is less well adapted to the wild conditions than the pure wild type and it will tend to be less well able to support a mate, or shower higher mortality". If this is true then yes, individuals carrying these non-adaptive genes will be selected against and the frequency of the genes will wane. BUT in Section 8.1 great store is given to hybrids being better suited to the "artificial landscapes of modern Europe". Admittedly, this is meant in a falconry context. But if it is argued that pure species are best to carry out falconry against natural quarry in pristine habitats, then surely the same argument holds for free-living birds in disrupted habitats; hybrids (and these are not a single thing) can show greater versatility and therefore adaptation. Selection would therefore favour increase in the adaptive genotype frequency. You cannot argue it both ways!

Disassortive mating. The Hardy Weinberg principle assumes mating is at random; i.e. birds with hybrid genes and those with none have equal (proportional to their frequency in the population) chances of mating and producing offspring. Two things (other than natural selection mentioned above influence this): intersexual and intrasexual selection, more commonly called mate choice. It is suggested (section 6.9) that hybrids mating with a wild native individual is most common where the wild species is rare. This may be true and I believe that Lynn Oliphant suggested this for the Prairie falcon mating with a Peregrine in Canada a few years ago. However, my understanding of the recent gyr x peregrine hybrid mating with a wild peregrine in Germany shows something different to be happening. I believe in this case the male hybrid outcompeted local wild peregrine males for the possession of the nest site and the female. If it is so, then this is a case of intrasexual selection favouring the hybrid genes and could be very worrying indeed.* It appears that with gyr x peregrines, second generation inviability may act as a failsafe for the exotic genes from spreading further. But what about saker x gyr genes in a saker population, if intrasexual selection gives the hybrid the edge?

Finally, I was curious to read the suggestion of restrictions in the UK of peregrine x merlin hybrids. Surely this is the "safest" hybrid to fly - the two species are not chromosomally or DNA molecularly close; they have existed sympatrically as "good" species for at least 10,000 years and so breeding barriers have had plenty of time to evolve and finally the sheer disparity in size would make it mechanically impossible for an escaped hybrid to mate with either a wild merlin or wild peregrine. I might add here however, that I breed and have flown peregrine x merlin hybrids and so I'm a little biased!

Dr Mike Nicholls, pers. comm, hybrid discussion group, 25/03/97

PROFESSOR TOM CADE

‘First, native species, owing to natural selection operating over many generations, are better adapted to their environments than introduced exotics are; therefore, exotics are nearly always at a competitive disadvantage when placed in a foreign environment with an already naturally occurring ecological counterpart (e.g., lanners attempting to establish in prairie falcon range). Only when there is no close ecological counterpart in the biota is it likely for an exotic species to become established in the wild (e.g., starlings, house sparrows, and feral pigeons in North America). The establishment of exotics under such a circumstance (vacant niche) can even be advantageous from man's point of view (e.g., pheasants and partridges in North America); and I do not accept the purist's view that the deliberate establishment of a species outside its natural range is always a bad thing to be avoided at all costs. If that were true, then most agriculture and horticulture in North America would be non-existent.

There is very little concrete evidence to support the widespread notion among protectionists that exotic bird species have competitively excluded native North American species. Most exotic bird species have become established because of man-created "exotic" environments, including both agricultural and ornamental ones, that provide favourable conditions for the existence of these birds outside their natural ranges. Most native species that have declined or disappeared have done so because of deterioration or loss of the natural habitat on which they depend for survival. South Florida and southern California are now dominated by exotic floras, and to varying degrees so is much of the rest of North America. Very few people complain about the exotic vegetation that man has created. So, what is wrong, really, with an exotic avifauna that is adapted to the exotic flora?

Hybridization in nature and the consequent genetic swamping out of one species by an introduced relative are even less likely to occur than competitive exclusion. Interspecific hybrids are nearly always at a competitive disadvantage compared to their parental species, they have greatly reduced reproductive capacity, and they are rapidly selected against in nature. There are a few poorly documented cases in which well-differentiated island populations of birds have apparently been swamped out by interbreeding with introduced continental forms of the same species; but I know of no such cases on continental land masses, nor do I know of any case in which a full species has interbred so extensively with another full species as to "mongrelize" the forms. In fact, if such hybridization (secondary intergradation) does occur, the two populations are by definition the same species.

People who express fears about hybridization and "mongrelization" of races and about competitive exclusion of native species by introduced exotics simply have no appreciation for natural selection, and it is unfortunate that they cannot all be reassured by reading and understanding the basic facts and principles about speciation as set forth in Emst Mayr's classic book "Animal Species and Evolution."

As far as the use of exotics in falconry is concerned, there are some possible dangers that need to be examined. There is the possibility that exotics escaping in sufficient numbers could become established outside their normal breeding range, and their establishment might have bad effects on native species. The past history of falconry indicates, however, that these possibilities are extremely remote. Since Attila the Hun first introduced falconry into Europe, literally tens of thousands of trained falcons and hawks have escaped all over that continent and its islands for hundreds of years, and yet there is no known or suspected case in which a species has become established outside its natural range as a result of these escapes. There is suggestive evidence that the return of a small number of breeding goshawks in Great Britain has resulted from escaped falconers' birds, but if so, I count that as a plus for falconry. There is also one record of mating in the wild between an escaped red-tailed hawk and a wild common buzzard in Scotland, but the eggs were destroyed before they hatched. Apparently, also, a pair of escaped Harris' Hawks has nested successfully in Florida; but such isolated instances are a far cry from the establishment of a self-perpetuating population.

In a similar manner, races of the once ubiquitous peregrine falcon have been traded and sold back and forth around the world for hundreds of years, and many of them have escaped in foreign lands. Indian shaheens, Barbary falcons, Spanish peregrines, tundra peregrines, Peales' falcons, and other exotic forms have escaped repeatedly in Great Britain since before King Harold fell at Hastings with a Norman arrow through his eye; and yet if any of these foreign peregrines ever succeeded in gaining entrance into the breeding population of the British Isles that fact is totally unascertainable by any phenotypic trait of the British peregrines. The potential for an expression of competitive exclusion or "mongrelization" of races has been well tested in this situation; instead, natural selection has continued to favour those falcons that are best adapted to the British environment, and as a consequence the British peregrines have maintained their locally adaptive phenotypic traits through time in spite of these numerous opportunities for the introduction of exotic genes into their gene pool.

The Harris' Hawk requires some comment too, since it is a species that occurs naturally in New Mexico. This is a species that is basically adapted to arid tropical scrub and desert scrub. Although taxonomic splitters of an older generation divided this species into three "subspecies," it is, in fact, remarkably uniform in its phenotypic traits over a very extensive range from the southwestern United States to southern Argentina, much more so than, say, the populations of red-tailed hawks breeding just in the states of New Mexico, Arizona, and California are. Its habits of hunting and its reproductive biology are unlike any of our temperate zone breeding buteos. Thus, neither its climatic and biotopic affinities nor its niche characteristics make it a likely candidate for establishment much beyond its present range -except possibly in California or in southern Florida - nor is it all likely to be a competitor with other species into whose ranges it might intrude. It is the hawk par excellence for American falconry because of its versatility as a hunter and its tractability for training. There is a large and increasing interest in its use for falconry. Captive propagation can no doubt soon meet most of this demand and relieve the pressure on the wild birds in Arizona, New Mexico, and Texas. If, as a result of escapes, the breeding range of the Harris' Hawk should expand a little in California or in New Mexico, or even into Florida, why should that be considered a problem other than as an interesting phenomenon for scientific study? Indeed, one of the best strategies for survival of a species through time is to increase the geographic distribution of its population as much as possible.

One final point further supports my belief that escaped exotic raptors constitute a minuscule threat to native species as far as competitive exclusion and hybridization are concerned. Falconry trained raptors are treated and handled in ways that strongly socialize them to humans as companions, especially so in the case of birds taken as nestlings (eyasses). A great majority of such birds are partly or completely sexually fixated on humans and consequently do not form sexual bonds with other birds. Any such raptors that escape into the wild are reproductive dead ends. In fact, this is one of the biggest problems we have had to overcome in producing captively propagated peregrines that are suitable for release as potential breeding stock in nature, and abnormal sexual fixation or other abnormalities induced by captivity no doubt also account for the fact that so few escaped falconry birds down through the centuries are known to have mated subsequently in the wild.

For all of these reasons I believe that wildlife administrators need not worry excessively about speculation on the potentially harmful results of exotic raptors escaping into the wild. Situations that may arise and show signs of developing into serious biological problems can easily be controlled without blanket prohibition on the use of exotics or captively produced hybrids.'

Extract from a letter to Mr Harold Olson, Director, Dept. of Game and Fish, New Mexico, June 25 1979

ROBERT SELANDER

January 17 1978

Dear Mr Schreiner,

I have recently read the statement by Professor T. J. Cade entitled "Reasons for Using Non-indigenous and Exotic Peregrines for Release and Establishment in the Eastern United States." As a population geneticist and evolutionary biologist who has had considerable research experience in avian systematics, I was distressed to learn that the Eastern Peregrine Falcon Recovery Plan is in danger of being handicapped through what is essentially a semantic difficulty reflecting a profound misunderstanding of the realities of population structure at the species level. Professor Cade's argument is well thought out and presented; and I endorse it fully. His thinking along lines of population genetics and evolutionary ecology is thoroughly sound.

Is it generally appreciated by those concerned with the problem of the interpretation of the President's Executive Order 11987 and other documents dealing with exotic organisms that the concept of subspecies as taxa has been in large part rejected by leading systematists, ornithological and otherwise, in recent years. As Professor Cade notes, about the only possible justification for the use of subspecific names is for the listing (in shorthand and in a rather unscientific way), of the geographic regions of origin of samples of organisms. Subspecies are in no sense equivalent biologically to species, and their naming is arbitrary. The whole erection and use of the subspecific classification of organisms reflects typological thinking akin to the idea of "pure" breeding lines of species. There is no such thing as a pure breeding line of a species; and, indeed, the whole of evolutionary biology in this century has been directed to the unequivocal demonstration of tremendous genetic diversity within populations and species. Hence, typological thinking is counter to all evidence of populations genetics. The realities of populations structure at the species level are well summarized by Professor Cade, but I will reiterate certain points here. Recent work employing electrophoretically demonstrable marker loci has indicated that a small part of the total genetic information (or variance) carried by a species is distributed geographically.

For example, for the human species on a worldwide basis, Professor Richard Lewontin, of Harvard University, has demonstrated that only about 6% of the total variance can be apportioned between so-called races of man. Local populations of humans contain something on the order of 85% of the total information. What this means is that the total component of diversity that is to be apportioned geographically is a small if not trivial part of the total genetic diversity of the species.

As an example of modern thinking on the severe limitations of the concept of subspecies, I am including a few pages from a review of mine on "Systematics and Speciation in Birds" appearing in Volume I of Avian Biology (edited by Donald S. Farner and James R. King), published in 1971 by Academic Press, New York. This treatment summarizes some of the major arguments against the use of the subspecies system. I know of no leading practitioner of the science of evolutionary biology who seriously considers the subspecies as a unit of sampling for his purposes. Our own extensive work on some dozens of vertebrates in the past few years, utilizing biochemical techniques, has showed that the distribution of genes encoding the primary structure of proteins has no interesting relationship whatsoever to the subspecies ranges outlined in earlier times by morphological taxonomists.

In sum, the typological thinking that was responsible for the introduction of both the concept of the subspecies and the concept of the "pure" breeding line is still apparent in some of the phraseology and thinking of persons responsible for legislative documents. It would be criminal if this sort of semantic difficulty, reflecting an unfortunate ontogenetic phase of evolutionary biology that is now behind us, should significantly affect considerations of the source of stocks for breeding and introduction to the wild as part of the peregrine recovery program. The whole point of the situation is this: The named subspecies of Peregrine Falcon are doubtfully recognizable and biologically inconsequential taxonomic categories for reasons outlined in my paper. If they had not, by chance, been named by typological thinking taxonomists in the past, the problem that we now face would not exist. Subspecies are not units of evolution and have no significant place in the thinking of modern evolutionary biologists and ecologists. They should be eliminated entirely from consideration in the program for the restoration of the Peregrine Falcon populations.

My concern about this matter is profound, particularly as I see a danger of archaic thinking impeding progress in a very important program. I would, therefore, welcome the opportunity to develop my views at greater length, with appropriate documentation if desired, at any time you may see fit.

Sincerely,

Robert K. Selander

Letter to Keith Schreiner, USFWS

HARRISON B. TORDOFF

Dear Warren:

In all the debate about conservation of gene pools, I detect a perspective that, in my opinion, underestimates the power of natural selection. Specifically, the example of introduced Southern Bobwhites allegedly undermining the cold hardiness of northern birds is entirely speculation, so far as I know. The same story was repeated for Michigan, and I looked at specimens taken in the 1960s and found no evidence of genes from southern birds (that is, the 1960 birds were large birds, just as they were a century before.)

The same concern has been expressed concerning mallards, where huge numbers of game-farm birds have been liberated in the Midwest. One result may have been to produce man-tolerant urban populations, but the non-urban populations are not weakened in any way, by any evidence I've heard of.

It's easy to get the feeling that a lot of biologists view ongoing natural selection as unimportant, when in fact it operates with great rigor continuously and effectively to eliminate maladaptive genes. I think Tom Cade's philosophy in regard to eastern U.S. peregrines is entirely sound biologically, and it makes me wince to hear from him that the AOU did his program harm by passing the resolution on gene pools.

Sincerely,

Harrison B. Tordoff

Director, James Ford Bell Museum of Natural History

Letter to Dr Warren King., 7 May 1980

BILL BURNHAM

'Hybridization is an emotional issue, it seems most people begin with a basic prejudice, be it the breeding of people of different ethnic origins, or even religions, or animals. It is important to consider the issue on biological considerations alone. From research on falcons in captivity, both at Fort Collins and by other propagators, I am unaware of a young yet to be produced by a hybrid female (species cross). I personally inseminated a gyr x peregrine hybrid with peregrine semen during two consecutive springs. Six fertile eggs were produced. Embryonic development ceased in each egg about day 17 of development. Other propagators have experienced similar results. I believe it is safe to say hybrid females at least have a reduced reproductive potential. This would suggest that even if a hybrid female (species cross) did breed with a wild peregrine, the chance of that bird doing more than occupying a site would be very remote. Semen from hybrid males have produced a limited number of young. The odd appearance and vocalizations seen in most hybrids may act as a barrier to wild peregrines even accepting such a mate. If the hybrid is reared as a behavioural imprint, as I believe it should be, that would even further reduce any chance of an escapee impacting the wild population. I would also suggest requiring the use of name tags and telemetry on hybrids used in falconry. Doing such would increase the chance of return should birds be lost.

Subspecies crosses are a different question. We know from experience that subspecies crosses in captivity are reproductively viable. The question here seems to be what affect could the loss of single individuals of non-native subspecies of peregrines or subspecies crosses have on the wild population of peregrines in Colorado. In any one year the most peregrines which may be lost would probably be two or three, but let's assume, for this discussion, that four are lost.

Let's also assume they are lost at various stages of training, from just flying to having captured prey. Some individuals are probably very tame and chances of survival reduced. Applying a frequently used mortality rate for peregrines of 50% death from flying to one year old and 25% every year after, by year three, when the falcons are old enough to breed, only one bird would potentially remain. In the peregrine recovery program it normally requires a successful release of ten to fifteen peregrines under excellent conditions to establish a breeding pair. If a surviving falcon were to breed with a wild anatum peregrine it would slightly increase the frequency of certain alleles. As Jim Enderson stated, "At least briefly, there would be a tiny shift in the frequencies of some alleles in the local population." Subspecies crosses with anatums would actually shift the allele frequencies less than pure peregrines of other races. As Tom Cade states (letter enclosed), "Indian shaheens, Barbary falcons, Spanish peregrines, tundra peregrines, Peale's falcons, and other exotic forms have escaped repeatedly in Great Britain since before King Harold fell at Hastings with a Norman arrow through his eye; and yet if any of these foreign peregrines ever succeeded in gaining entrance into the breeding population of the British Isles that fact is totally unascertainable by any phenotypic trait of the British peregrines."

Don Morizots (University of Texas) is currently doing research on biochemical genetics of peregrines. He is processing blood samples from peregrines of known origin from a variety of races. Over eighty samples were obtained from the falcons at Fort Collins. Samples from hundreds of peregrines will have been examined by the completion of this initial research, which should be completed next spring. In a recent telephone call (9/6/83) he told me he has identified five good polymorphic loci in the fifty they have examined. They hope to double the number of loci now examined. He said they can identify blood from at least most hybrids (species crosses), but not peregrines from various geographical populations. Peregrines appear to be very similar genetically. He agrees that occasionally the breeding of non-native peregrines or subspecies crosses would probably have little impact on a population. If the population were extremely small, however, and a hybrid (species cross) were to reproduce, it could impact the genetic make-up.

Should the regulations remain as they are, I am afraid the impact will be negative. Few if any falconers will have falcons surgically sterilized because the bird would probably be useless for falconry and the procedure and risk inhumane, if he or she can find a veterinarian who would attempt the operation. As the regulations read, I suspect the peregrines now in captivity will suddenly shift genetic origin to create "pure" subspecies. The breeding records will be compromised along with the work of many of us who have tried to prevent that over the years. If the regulations carry over into other states, the ultimate result may be the scuttling of "real" pylogenetic records kept by propagators. In addition, the Division of Wildlife will be approached by people wanting wild peregrines, using the new regulations as justification. The current regulations are not a solution or clarification to law enforcement problems. I request that surgical sterilization and the definition of hybridization be reconsidered by the Wildlife Commission.

Extract from a letter to Robert Tully, Colorado Division of Wildlife, September 7 1983

STEVE SHERROD

Generally speaking, the reason why natural hybrids of various bird species do not mongrelize and ultimately destroy the parental species from which they are comprised is that the hybrids are either infertile or are so few in number that their "alien" genes are simply swamped out by the massive number of genes from the pure species with which they associate/attempt to breed. A simple Punnett square can demonstrate that in 4 or 5 generations a hybrid falcon's genes are reduced to essential non-existence if it breeds back with one of the parent species. (A letter by Dr. Clayton White dated 7 Nov. 1997 is attached to provide additional support regarding his feeling about the inconsequential nature of this possibility as a problem in wild populations.) In addition, courtship behaviour and other behaviour (vocalizations, etc.) of hybrids can be intermediate between the two parent species. Such behaviour of hybrids is thought to be "less attractive" to the pure species than the same of other pure species suitors by which they are surrounded in the wild situation, and thus the hybrids are thought to be at a disadvantage when it comes to attracting mates.

To continue on with the scenario of what has changed to cause concern over hybrids since breeding regulations were first initiated in the U.S. and since the veterinarians and biological scientists (see above) first voiced their opinions via letters in 1979-83 about the unlikelihood of threat by hybrids mongrelizing wild raptor populations, there are four substantial factors to consider. These are listed below and examined in the General Discussion section which follows:

1. The captive production of a much larger number of hybrids due to a much greater worldwide demand for these very high-quality falcons.

2. The fact that the demand in some parts of the world is not primarily for imprint hybrids, but for wild-raised hybrids which behave like wild birds, and therefore pose a greater risk of breeding with wild individuals should they be lost or be intentionally released.

3. The fact that there have been instances in both Europe and N.America of hybrid falcons attempting to pair and/or breed with wild falcons.

4. The development of techniques by a limited number of veterinarians to sterilize hybrid falcons in such a manner that it causes absolutely no harm to the birds.

General Discussion

Earlier in this presentation we considered how the genes from a lost hybrid attempting to breed with a pure individual of a parent species would be "swamped out" of the population (sustained in letter by C.M.White, 7 Nov. 97) of the parent species within a few generations. Considering points 1. and 2. above, the increased number of hybrids now produced and raised (not as imprints but) as wild-raised individuals makes it possible that several hybrids could enter the wild at the same time. If such did happen in a given area, the probability of genetic swamping could decrease significantly, and it is remotely conceivable that the alien genes might give influence in that region. Although this is not expected to occur in N. America or Europe, the Arabs have made a practice in the past of releasing en masse many of the falcons flown during a given year after that particular hunting season came to a close. At present that practice is generally coming to an end, and the hybrids are being intermewed and flown again in the following year(s). Because there is no natural selection with captive-bred birds (as occurs in the wild state) thereby eliminating unfit individuals, such individuals become a burden just as they do in Europe or the U.S., and they tend to get passed around. Therefore, it is not inconceivable that hybrids which are less than outstanding or are intractable could be released by irresponsible individuals or those just not understanding the importance of this act. It is also possible that several hybrids could be lost in a given area as a result of irresponsible hacking procedures in the U.S. or in Europe. Lastly, although I do not wish to belabor the point, it must be mentioned that exotic species, which are imported and flown in falconry or are hacked in an area outside the range of congenerics must be considered in exactly the same way as hybrid falcons which are released (as in falconry) for any reason outside the range of their parent species. Additionally, hybrids released (as in falconry) within the range of either parent species, and exotics released within the range of congenerics must also be considered in a category together.

7. THE SCALE OF PRODUCTION AND USE OF HYBRIDS

7.1. This is a global situation. Birds bred in Europe or North America may be sold in the Middle East and flown in Asia or North Africa. Birds from Asia are imported into North America. The risk is not necessarily in the country in which the bird is bred, but is in the country where the bird is flown free.

7.2. It may be useful to look at the frequencies of hybrids in captive collections and the reasons for them:

7.3. Hybrids between various buteos and accipiters are infrequently made because they are difficult to produce, have few obvious advantages as hunting birds, are probably sterile, and therefore do not attract much of a market. They will probably remain marginal curiosities, and of no significance to wild populations.

7.4. Hybrids between Gyrfalcon and Saker seem to occur in all gradations both in the wild and in captivity and may not merit the title hybrid as this group appears to be a super-species. In falconry this intermediate form is larger and faster than a typical saker and more heat resistant and disease resistant than a typical gyr. All gradations appear to breed readily and indefinitely in captivity. For details of this group see: Eastham, C.P. 2000. Morphological Studies of the Taxonomy of the Saker Falco cherrug Gray 1833, and other species. PhD thesis, University of Kent at Canterbury, UK.

7.5. Hybrids between Gyrfalcon and Peregrine are popular in Arab falconry because they are large and fast. When lost to the wild in desert areas they do not survive long because there is usually not a sufficient prey base of medium sized birds for their survival and they are slow to adapt to small mammals, having been trained solely for houbara. The falcons are flown sharp and probably have at most only three days of energy reserves in which to make a kill. Those which do not perish often come to humans and are eagerly trapped by locals thinking of reward money. However, they are poorly cared for and without proper resuscitating treatment, also die. When we did deliberate large-scale (80+) releases of health-screened, fat, fit ex-falconry passage pure sakers and peregrines in hunting type habitat e.g. Baluchistan and the Gulf, large numbers died or were re-trapped. We have been more successful by releasing the falcons in Kirghistan where there are more birds and mammals, in April when the spring migrants are returning and the wintering mammals are emerging. The local peregrines tend to be small, desert adapted varieties: Red Shaheens F. p. babylonicus and Barbary Falcons F. pelegrinoides, unlikely to pair with big gyr/peregrines.

Arab falconers have learnt not to release hybrids and we have not heard of any hybrid being ordered to be released since 1995. Instead, Arab falconers have little qualms about having unwanted birds destroyed.

In Europe female gyr/peregrines are used for pheasants, ducks and crows and males for grouse, partridges and rooks. In America they are used for desert grouse and for ducks. In most ways they hunt like large peregrines.

7.6. The peregrine/saker is used primarily in Europe where it combines the speed of the peregrine with the tenacity and willingness to take prey on the ground of the saker. It is thus more suitable for hunting crows than the pure peregrine or saker.

7.7. The National Avian Research Center's monitoring programmes for source breeding populations of Arab falconry peregrines and sakers have not revealed any recognisable captive-bred or hybrid falcons at nests. However, we have discovered two breeding wild calidus peregrines in Siberia wearing Arab jesses.

8. WHY HYBRIDS AND EXOTICS ARE USED

8.1. Unlike wild raptors which may catch any species they wish to attempt, falconry raptors are restricted to certain legal species and seasons. Falconers themselves are restricted to certain hunting areas and these areas are becoming more and more crossed with man-made hazards such as roads, wires and encroaching urbanisation.

The falcon must be closely matched to the prey in order to achieve a successful flight, not only to a species but also to very limited types of habitat. Classic flights thus evolved, such as the peregrine at Red Grouse Lagopus lagopus, partridges Perdix perdix/Alectoris rufa or Rooks Corvus frugilegus, and the Merlin at the Skylark Alauda arvensis, all taking place in very open landscapes.

Most falconers do not live in these open landscapes. They cannot afford a grouse moor, and have to fly in more enclosed land. Many flights are ruined by prey escaping into cover. Therefore, the falconer is looking for a falcon which can hunt in the open but which can also, if need be, catch prey at or in cover at the conclusion of an aerial chase. The falconer also seeks to hunt some quarry which, although legally available pest species, cannot be caught by pure-bred falcons in falconry on a regular basis. In UK the pest list includes the Carrion Crow Corvus corone, the Rook, the Jackdaw Corvus monedula, the Magpie Pica pica, the Collared Dove Streptopelia decaocto, the Feral Pigeon Columba livia, and the Woodpigeon Columba palumbus. Among the smaller birds are the House Sparrow Passer domesticus and the Starling. Among this list, certain hybrids have proven themselves capable of providing quality falconry in circumstances in which pure-bred birds would fail. For example, the peregrine/saker is far more effective at crows and rooks in poor country than a pure peregrine. The New Zealand/peregrine F. novaseelandiae x peregrinus is one of the few falcons which can catch jackdaws, magpies and pigeons consistently in poor country. The peregrine/merlin F. peregrinus x columbarius can take starlings where a pure merlin would fail.

Thus, in the artificial landscapes of modern Europe, hybrids allow falconry to continue in places and at quarry which were previously unfeasible. Bad farming practices now have made such an impact on the UK population of skylarks that traditional flights with merlins are becoming a very rare sight. Access to good partridge or rook hawking ground for peregrines is now so limited that for the falconer in lowland Britain the opportunities for flying a falcon are few, unless he has access to a suitable hybrid.

8.2. As more experience is gained with the different types of hybrids, certain types will establish their potential in falconry and others will be found to confer no additional benefit. The supply of hybrids will mirror the market closely because most are made by artificial insemination and can be changed from year to year.

8.3. In Arabia, large hybrids are in demand because they are larger, faster and more glamorous than pure breds, and because they are less prone to disease, seldom carry internal parasites (such as serratospiculum) and, being less stressed in captivity, moult better. Now that Arabs have learnt to manage them, these birds consistently outperform wildcaught falcons. I do not see this trend in Arab falconry as reversible; many Arabs have set up their own breeding programmes and even if western countries stopped producing hybrids, production would be taken over in Arabia or Pakistan or in the former USSR countries.

Since 1993, as the former USSR opened its borders, trapping pressure on wild sakers in Asia has increased tremendously and the National Avian Research Center in Abu Dhabi has supported local biologists to monitor this species. At present, because of the inbalance of the economies among Asian countries, we do not see any practical means on the ground for reducing this trapping rate. However, captive bred hybrids are now gaining a major share of the Arab falconry market. More than 50% of Sheikh Zayed’s falcons (out of an annual purchase of about 300 birds) are captive bred, mainly hybrids. We also monitor the markets in Pakistan and the Gulf: prices for wild falcons were down at least 50% in 1997 and many birds remained unsold. Thus, captive breeding is the key element at present to reduce the market pressure on Asian wild falcon populations. [Note: in 2004, 40 Sakers in one batch in Pakistan, remaining unsold for falconry, were allegedly killed and stuffed for taxidermy]. At the Consultation on International Trade in Falcons for Falconry, hosted by CITES in UAE in May 2004, it was unanimously agreed that captive breeding should be actively supported in order to offset the trade in wild falcons.

8.4. The Arab market has stimulated large scale commercial production of hybrids which has had both positive and negative effects. While the availability of female hybrids for western falconers has decreased, the males, which are a by-product, are increasingly available and at prices well below production costs. Commerce has stimulated research and development into many aspects of producing birds for falconry, and in ancillary equipment such as radiotelemetry. This has produced spin-off for western falconers and for conservation. In terms of resources, it is more expensive to breed hybrids than to breed pure-breds and it should be borne in mind that the commercial breeder, from the business standpoint, produces hybrids not because he wants to, but as a response to market demand. If falconers did not demand hybrids, breeders would not continue to produce them. In 2003 and 2004, Hunting Falcons International euthanased 10% of its young hybrids, all at 5 days old. These were all small males for which there was no market.

9. THE IDENTIFICATION OF HYBRIDS

9.1. In the case of hybrids between peregrine, gyr or saker; these three species are themselves very variable and there are many specimens from the wild in Asia which cannot be positively identified as being either gyrs or sakers. To identify hybrids on a legal basis is even more difficult. Work on DNA and karyotyping continues but will probably never be definitive. This begs the question as to whether some hybrids between recognised species are actually hybrids or whether we should revise the taxonomic divisions within Falco. Watch this space!

9.2. For specialist interest we have morphometric data on the following birds at the Falcon Facility in Wales, together with colour transparencies and also quite a good collection of study skins of falcon hybrids:

9.3 Table 1. Data on hybrid falcons collected and stored at the Falcon Facility, Wales.

Last updated 14th November 1997. Father is first mentioned species.

Type of hybrid	Sex	Morphometric data	Blood for DNA analysis	Breeding data	Photographs
Gyr / Saker	M F	18 23	17 20	6 3	11 12
Gyr / Peregrine	M F	7 10	7 10	1	4 10
Peregrine / Gyr	F	1	1		1
Peregrine / Saker	M F	12 22	4		8
Barbary / Saker	F	2	2		2
Gyr (1/4) / Saker (3/4)	M F	11 19	7 19	2	2 10
Gyr (5/8) / Saker (3/8)	M F	1 1	1 1		2 1
Gyr (3/4) / Saker (1/4)	M F	2	2		1 1
Gyr (1/4) / Peregrine (3/4)	F	2			2
Gyr / Saker x Peregrine	M F	1 2	2		1
Gyr / Peregrine x Saker	F	1			
Peregrine x Gyr / Saker	M	2	2		
Peregrine x Gyr / Saker x Saker	F	1	1		1
Peregrine / New Zealand falcon	M	1	1		1
Gyr / Peregrine x New Zealand falcon	M	1	1		1
Gyr / Prairie	F				2

10. POLITICAL ISSUES

10.1. There are many pressures on falconry at present, with attempts to ban all fieldsports or to nibble away at them using legal restrictions. As falconers, our first responsibility is to the raptors both in the wild and in captivity. While we naturally desire to do whatever is of biological benefit for the birds, we have to be careful not to over-restrict ourselves and our children for the sake of political correctness, expediency or pressure. German falconry is already subject to heavy restrictions on who may breed and fly birds, what species they may fly and what quarry they may fly. This has resulted in no benefit to falconry in Germany and therefore we should not let similar restrictions be imposed on us. Rather we should fight for the future of falconry and resist political pressures.

10.2. While a restriction on the use of non-native sub-species of peregrine would not be a great loss to falconry, the removal of the redtail from British falconry would be a major blow, and the loss of falcon hybrids would create a much greater loss than most people currently realise. The loss of non-native hybrids, such as the gyr/saker in the UK, would be a major triumph to our opponents and achieve absolutely nothing in conservation terms. If action is deemed necessary it should be targeted at the biological problem rather than a catch-all approach which would do far more harm to falconry than the situation warrants.

CHRISTIAN DE COUNE

What is the problem? Is there really a problem? In the several contacts I have with the conservation circles, I have not yet heard anybody seriously objecting to our use of hybrids. You all know how prone some conservation or protection circles are to criticize what we do, the hybrid issue has not yet come to my ears from them. The only exception, to my knowledge, comes from a German working group on Peregrine protection; I'll revert to that later in my letter. So, I dare to say that so far it is a non-issue; may it last long like that!

The atmosphere is, I think, different in the States and in Europe. In Europe the tendency is to limit the freedom of falconers in various ways: the species or subspecies that may be used, the number of hawks that may be kept, only captive bred hawks, the very limited access to wild populations, etc...

A small example among many other ones of the will to impose unnecessary prohibitions upon us: in Belgium, we succeeded in obtaining special dates for the falconry hunting season: we could start earlier and stop later than the other hunters, the authorities that had given us that "present" said that in exchange of that gift they should prohibit something to us, just to make us pay the gift; they decided to prohibit us to sell the venison of the game we catch outside the shooting season. We of course don't mind, but they "had to" prohibit us something, that "something" was fortunately quite symbolic, but is is alas not always as symbolic as that. It is a bit the "sausage syndrome": thin slice after thin slice, the whole sausage will ultimately be totally gone.

Prohibiting falconers the use of hybrids would be, in the eyes of the antis, a nice slice to cut from the sausage. We must not help them cut that slice, and of course any other slices, in any way.

Does the position of the Germans and the Swiss constitute a potential argument in the hands of the antis illustrating the fact that using hybrids is bad? My position is to say "no". I attended the meeting of the German falconers (DFO) and of the Swiss too when the discussions have taken place. The main reason for their attitude was to keep the good relationship they have with the conservation and protection groups. They felt they had to make that gesture to remain their friends. It must then not necessarily be considered as a recognition of the existence of a danger linked to the use of hybrids for falconry and so it should not be used as an argument by the antis. It was a lovers' present.

An interesting question: Do you need hybrids? Reply: Do you need them to be banned? Explain why.

I would wait very confidently the reply to this last question. I would certainly do nothing to help them by replying "yes" for instance by saying : "falconers, too, are concerned about the risks; the Germans and the Swiss took a decision about it; falconers have organised an International Committee to study the case; I don't like hybrids; these bastards are horrible things; there has been a case in Germany; etc..". I would let them find their own reasons in support of their claims, I think their file would be quite thin. Their file would at least contain the German case, but that alone would not make their file very thick... The file I have myself on that case is very thin... I could even say a bit shallow. Anyway, it is a totally isolated case, as far as I am aware.

In my career as IAF spokesman, I once had to cope with a problem that has rather close relationship with the hybrid issue: The Council of Europe has been preparing for years a resolution on the introduction on non-native organisms in the environment. During the preliminary works, someone quoted falconry as a possible source of such introduction. I immediately reacted and pleaded not-guilty for falconry.

I give you hereafter a free translation of most of the reply that the Council of Europe made to me in French:

"The Secretariat has discussed this matter with Mr de Klemm our consultant...and has sent him your report. He is of the opinion that falconry is a purely anecdotal source of accidental introduction of species in view of the small number of losses of raptors and their unlikely adaptation to the wild life. He did not even consider it necessary to address this topic in his study. We share entirely his view point, but if falconry would happen to be mentioned a source of introduction, we would request our expert to follow the arguments set out in your document"

The last draft of the Resolution indicates univocally in its preamble that it does not relate to the birds of prey used for falconry. One may expect that the attitude of the Council of Europe towards non-native organisms could apply as well to hybrid birds of prey used for falconry. If we want to oppose attempts that would be made to ban the use of hybrids for falconry, we would not lack arguments, whereas the initiators of such an initiative would have a very thin file.

I will always oppose limitations to the freedom of falconers that are not necessary for the conservation of wild populations or for keeping falconry within the limits of wise and sustainable use. So far, I have not seen any scientifically convincing elements that would militate in favour of the renouncement by falconers to use hybrids.

I express the wish that falconers' associations will refrain from taking initiatives that could result in a greater difficulty for the other falconers' associations to defend themselves against attempts to limit their freedom without proven biological necessity, the ban on hybrids is to my eyes typically such an unnecessary measure. At the last general meeting of the IAF, I proposed a resolution on that topic, but the draft having not been distributed long enough before the meeting, it was decided to postpone the discussion on it until the next AGM.

I am thinking of proposing to our members to include in the IAF Code of Conduct a recommendation to use radio tracking. The fewer birds of whatever species we shall lose, the fewer arguments there will be against us.

Together with the 1997 Spring IAF Newsletter, I sent to our members a questionnaire asking how many hybrids are being used for falconry, how many have been lost in the last 3 years and whether they have heard of free-flying hybrids. The questionnaires start slowly to come in. The result will be communicated to you as soon as most of our 21 member clubs have sent their questionnaire back.

In 1995, I sent also a questionnaire to the member associations of the IAF asking them if they were in favour of a ban on the use of hybrids, if they were in favour of member associations imposing themselves a ban on the use of hybrids and if they wished that the IAF would take a position on the hybrid issue; the overwhelming majority of those who replied, said "no" to the three questions. This is one more reason for me to ask the Hybrid Committee not to take a position on the issue of the use of hybrid raptors for falconry.'

Christian de Coune, pers. comm, hybrid discussion group 03/05/97

NICK FOX

I agree with Christian de Coune on this one. I do not accept the emotional use of unscientific public opinion to pressure falconry. We have seen the same tactic on welfare issues (e.g. killing is 'cruel'.) We have to fight with science.

We also have to fight with politics. There are many larger user-groups such as cat-lovers, racing pigeon fanciers, gardeners, farmers, horticulturalists, aquaculturalists, etc. whose entire activity and economy depend on the use of non-native organisms. We put this forcibly to the UK government in September 1998 (in response to a challenge) and this is what we said:

Responses to the Wildlife and Countryside Act in the UK. Most people simply ignore Section 14 of the Act.[3] There are about 9 million domestic cats whose owners flout the Act every day. The cat at No 10 is put out daily to wreak mayhem with the ducklings at St James Park and to disappear for weeks at a time, with the Prime Minister's blessing. A similar situation exists with racing pigeons and ornamental pigeons, as well as with ornamental fowl, waterfowl - and free-range chickens. Many of these have established breeding populations in the wild. There are between 813,000 and 2 million feral domestic cats in Britain, and the Cat Protection League advertises for release sites. There are many millions of feral pigeons which pose a major nuisance and health threat in many towns. The domestic cat interbreeds with the indigenous Scottish Wild Cat and is gradually destroying it by genetic drift [4]. The feral pigeon both outnumbers and interbreeds with the Rock Dove. There have been no prosecutions for these offences.

If the DETR was considering tightening the application of Section 14, the major political implications facing it are the likely reactions of the main user-groups, of which falconers are but a minority. Falconers are prepared to consult, to be reasonable and to follow biological principles. Other groups are unlikely to respond constructively. In short, this is a political hot potato.

Discrimination and political expediency. Falconers protected birds of prey in Britain before democratic government was invented, before the RSPB was formed, and centuries before the Wildlife and Countryside Act was passed. We have always treated raptors responsibly, as a sustainable renewable resource. The problems faced by raptors in the last century were from extreme persecution by shooters, and in this century the major threat to raptor populations have come from government-supported use of misunderstood agricultural chemicals and systems which continues, in differing forms, even today.

Falconers have always been involved in the conservation of raptors. Despite this we have been heavily discriminated against, even though all parties agree that our activities have negligible negative biological impact. Discrimination against falconers appears to have been a means of 'being seen to do something' whilst avoiding addressing the real issues.

We believe that at present the DETR does not fully appreciate the enormous political implications of its ill-advised initiative to restrict the use of exotic raptors. The effect of this applied to other user-groups would cause uproar. As for a unilateral application discriminating against falconers, our legal advice is that if the falconers challenge this in the European Court we would undoubtedly win our case.

2-3 weeks later we received an unreserved apology from the government and on 14 November 1998 the Prime Minister diplomatically found a new home for his cat 'on veterinary advice.' It is essential that we do not handle the issue of exotic and hybrid raptors from our own inside standpoint, but from the viewpoint of outsiders. Raptors are just one group among thousands of species of animals and plants and, while we wish to be responsible, we should not accept being discriminated against as a user group.

We can win this one!

11. POSSIBLE OPTIONS TO REDUCE RISK

11.1 As stated in 4.8, Falconers already:

· Mark their birds.

· Train them to return.

· Supervise them during the release period.

This is more than can be said for many user groups including cat owners, fish stockists, etc. For clubs supporting the use of exotics and hybrids, there are a number of options to reduce risk still further:

11.2 It would not be a major hardship if falconry clubs made it part of their codes of conduct that:

· Any raptor flown free should be marked with its owners' name and telephone number.

· Any exotic or hybrid raptor flown free should carry telemetry.

11.3 In the case of allopatric hybrids it would be advisable for them to be imprinted on the absent parent species: e.g. gyr/peregrines flown in Britain should be imprinted on gyrs or sakers rather than on peregrines; failing that on humans or any other species than peregrines.

Incomplete parental imprinting appears to have been a key factor in most of the case studies. It appears that the future identification of sexual partner depends on exposure to a parent figure, not just during fledging, but also during the flying dependency period. We have found occasionally, when sending hacked falcons to Arabia, that certain individuals started to scream. Analysis discovered that these birds had been reared by peregrines and that they screamed when placed on a perch near an adult peregrine. Those which had been reared by sakers did not scream in the presence of an adult peregrine, or in the presence of an adult saker. Adult sakers do not have a significantly different plumage to juveniles, as peregrines do. There may be something going on here, especially in the imprinting process of peregrines, which would repay more careful study and documentation. We are conducting trials here in UK on imprinting captive bred falcons and the subsequent sexual signals which act as behavioural triggers. This is being done using models.

Bearing in mind that the risks involve not just hybrids, but also exotics, a blanket legal requirement to imprint these groups onto humans is not justifiable. For example, an imprint redtail being flown in a crowded island such as Britain, is a definite safety risk, especially to children. Catch-all solutions are not appropriate; we must look at individual situations.

12. THE TECHNICALITIES OF STERILISATION

Over the past three years we at the National Avian Research Center in Abu Dhabi, and the Middle East Falcon Research Group, have been assessing and discussing whether sterilisation for falcons destined for Arab falconry is both necessary and feasible. The balance at present is that it is not necessary (see discussion 7.5 and 8.3).

Is it feasible? The vets (see items below and Steve Sherrod's paper) consider that, in specialised hands, the operation itself is feasible. But from the practical point of view, how could it be achieved?

If one insisted that birds had to be sterilised before they left the breeder, could this be done consistently and safely before the birds were 45 days old and scheduled to go into the hack box? If so, what effect would this have on their feather development at such a critical stage, and on their mental development? Would they all have to be travelled to a clinic for this to be done? Is this in the bird's welfare interest at this age and would it be legal? What happens about the birds which die or have complications and what follow up would there be to establish that each bird, subsequently, was indeed sterile? From the buyer's point of view, who would want to buy, let alone pay more for such a bird, when non-sterilised birds are available from other countries which anyway have lower labour and production costs? Careful consideration of these questions, particularly with reference to the large Middle East market, concludes that sterilisation is impractical; Arab buyers will set up their own programmes and not sterilise the birds produced. Western falconers will have penalised themselves for little conservation benefit. However, details of techniques are included here for completeness.

MANFRED HEIDENREICH

Birds of Prey: Medicine and Management,

Blackwell science Ltd, Oxford 1997)

13.7.3 Sterilization

As with other animals, birds of prey can, and sometimes should be rendered infertile. This may sound contradictory, since a great deal of effort and knowledge have gone into the breeding of such birds. Captive breeding has been reliably successful for barely two decades, and already there is discussion of surgically intervening to sterilize birds of prey.

Sometimes the breeders of very rare species approach veterinarians with an interest in having birds sterilized. They are probably hoping to maintain their monopoly on the market, preferring to sell infertile animals that cannot be used to found new breeding programs.

A more valid reason for considering sterilization in raptors occurs with production of the many different hybrids possible among birds of prey. Conservation organizations and even local or federal authorities are concerned about possible crossbreeding between such hybrids that might escape to the wild, and natural populations. The introduction of genes from other species or subspecies would be undesirable in natural populations. Such concerns are certainly justified, especially with falcons. Unlike most others hierofalcon subgroup hybrids can be propagated for an indefinite number of generations (Heidenreich et al., 1993). Such concerns have already led to a ban on flying hybrid falcons in the Netherlands. In the United States, such birds must either be imprinted on man or sterilized to avoid possible interbreeding with native falcon populations (Saar, 1993).

There is always the risk that a bird will escape to the wild, especially if it is being used for falconry or otherwise flown free. Nevertheless, this happens only sporadically. The Arab practice of purposely releasing a hawk after the hunting season is completed has a much greater impact on this issue. Hundreds of falconry birds have been exported from the U.S., Canada and Europe to various Arab countries in the last few years. Presumably, these young hybrids have no difficulties joining native wild falcon populations after escaping or being released. Veterinarians with the Middle East Falcon Research Group in Abu Dhabi have recognized this problem and are evaluating the need to sterilize the predominantly female falcon hybrids popular in Middle Eastern countries (Samour, 1995). Sterilization can be achieved in a number of ways.

Neutering

Neutering is a term that can be applied to either sex of an animal and usually pertains to the removal of the gonads, testes in the case of males, or ovaries in females. This procedure used to be common in male chickens (caponizing) because it produced better weight gain in the birds. It was performed in one of two ways. The testes could be removed via a celiotomy approach between the last two ribs (Koenig. 1985), or the birds would be hormonally castrated by administering slow-release feminising hormones under the cervical skin (Schroeder, 1965). Because the surgical technique was impractical on a large scale and hormones in food animals are now tightly controlled, castration in poultry is no longer common.

Neutering male birds of prey by the methods described above is certainly possible, but a number of health concerns make it inadvisable. Cason et al. (1988) and Fennell et al. (1990) were able to prove that removal of the male hormones has a strong negative effect on growth and overall development. Mase and Oishi (1991) found that castrating quail interfered with normal development of the bursa, an organ important in the immune system of birds. Research of this kind has been performed only with domestic birds, and even there, has been relatively limited. The long-term effects of neutering on moulting, for instance, have not been investigated. Castration in male birds of prey should therefore not be considered an option!

Sterilization

The term sterilization is generally used to indicate a method for making an animal infertile without necessarily removing the gonads. In females, this can be done by cutting or tying the oviduct, and in males the same can be done with the ductus deferens. Because these procedures do not interfere with the production of reproductive hormones, birds sterilized in this fashion continue to engage in normal pairing, mating and nesting behaviour. They are infertile, however. Follicles no longer enter the oviduct and sperm are no longer able to travel along the ductus deferens.

These procedures can be performed with laparoscopic techniques in either sex. The bird must be sufficiently mature that its reproductive organs are well developed and easily recognized and manipulated. Hawks should be full-grown, that is, fully feathered and dry (no pin feathers).

Surgical technique for sterilizing the female hawk (from HEIDENREICH, 1994):

The positioning and surgical approach are the same as that described for surgical sexing. The bird is placed in right lateral recumbency with the left hind limb extended backward. The celiotomy incision is made in the left flank area behind the last rib and in front of the left leg. In juvenile birds, the ovary is a small, lumpy white structure located at the cranial pole of the left kidney (Fig. 13.54). The immature oviduct winds its way caudally from the ovary along the renal surface towards the cloaca. At this stage of development, the various anatomic divisions of the oviduct are not yet discernible. There is a ligament, however, that can be seen attached to the infundibulum and inserting on the second to last rib. It serves to support the infundibulum, which captures the ova at ovulation, in its position near the ovary. This ligament is grasped with a fine pair of hemostats (Fig. 13.55) and either transected or pulled from its attachment site on the rib. This releases the threadlike oviduct from its cranial attachment and allows it to retract caudally away from the ovary. The follicles no longer enter the oviduct at ovulation, falling instead into the coelomic cavity where they are presumably resorbed. It is probably easier to grasp the oviduct somewhere along its course and transect it. However, this method carries the risk that the cranial part of the reproductive tract remains intact and capable of at least partially adding albumin and a shell to the ovum. The result would be an ectopic egg and iatrogenic dystocia.

Surgical technique for sterilizing the male hawk (from Heidenreich. 1994):

This procedure is considerably more difficult than the one described for females, especially in young tiercels. Their testes are still very small, lying tucked between the cranial pole of the kidney and the adrenal gland. The ductus deferens, a convoluted white tubule easily seen in mature birds, is so slight in juveniles that its traces can barely be recognized. Both structures are located retroperitoneally. The ductus, like the oviduct in females, runs along the kidney surface and can be dissected free and cut only with great delicacy and care. It is somewhat easier to transect the ductus deferens at its connection to the testis, near the epidydimis. The latter is a barely noticeable cone shaped bump on the medial aspect of the testis. In any case, the peritoneum has to be lifted off the testis before the ductus can he transected. Because the immature reproductive organs in the young tiercel are not heavily vascularized, a ligature is not necessary. The ductus deferens is simply grasped with hemostats and separated from its attachment to the testis. In contrast to the ovary, which is present only on the left side of the bird, this procedure in males must be repeated on the other side for the opposite gonad. It is much easier to sterilize a tiercel during the breeding period. The testes and ductus deferens hypertrophy during this time and are better visualized and manipulated (Fig. 13.56). The approach then need not be repeated on the opposite side. Both the right and left ductus deferens are easily identified in the caudal kidney region and transected from one side.

References and literature of further interest

CASON, J.A., FLETCHER. D.I., and W.H. BURKE (1988): Effects of canonization on broiler growth.

Poultry Science 67, 979-981

FENNELL, M.J., JOHNSON A.L. and C.G. SCANES (1990):

Influence of androgens on plasma concentrations of growth hormone in growing castrated and intact chickens. General and Comparative Endocrinology 77, 466-475

FRANKENHUIS, M.T. and H.J. KAPPERT (1980):

Infertility due to surgery on body cavity in female birds. Causes and prevention.

Verb. Bericht XXII. Int. Symp. Erkr. Zootiere

HEIDENREICH. M. (1994):

Sterilisation volt Falken - Eine Maßnahme zur Verwandtschaftsgrad verscheidener Falkenarten, sowie zum Thema der Faunenverfalschung durch Hybridfalken.

Beitr. Vogelkd. 39, 205 - 226

HEIDENREICH, M., KUSPERT, H.. KUSPERT, H.J. and R. HUISSONG

(1993):

Falkenhybriden. Deren Zucht, zum Verwandtschaftsgrad verschiedener Falkenarten, sowie zum Thema der Faunenverfalschung durch Hybridfalken.

Beitr. Vogelkd. 39, 205-226

JOYNER, K.L. (1994): Theriogenology

in: Ritchie, B.W., G.J. Harrison u. L.R. Harrison (1994): Avian medicine: principles and application Wingers Publishing, Lake Worth, Florida

KONIG, H.E. (1985):

Die Kastiration des Hanchens.

Tierarztl. Praxis 13 307-311

MASE,Y. and T. OISHI (1991):

Effects of castration and testosterone treatment on the development and involution of the bursa Fabricius in Japanese quails.

General Comp. Endocr. 84, 426 433

MILLER. L.E. and L.M. KRISTA (1985):

Effects of caponizisation on body weight. Atherosclerosis in turkey lines.

Poultry Science 64 1002-1014

SAAR, C. (1993):

personal communication

SAMOUR, J, (1995):

The hybrid debate - Discussion on methods for sterilising falcon hybrids.

Falco 2, 8

SHRODER, K. (1965):

Zum Nachweis ostrogenwirksamer Ruckstande in chemisch kapaunisierten Schlachthanchen.

Vet. med. Diss., Munchen

WILSON, S., GLADWELL, C. and R.T. CUNNINGHAM (1990)

Differential responses in castrated cockerels.

J.Endocrinology 125, 139-146

STEVE SHERROD

Although in 1983, several U.S. veterinarians as listed above concluded that surgical sterilization was not a possibility, necessity is the mother of invention. Surgical sterilization of raptors is now possible, although the process is in its infancy. In 1993 Dr. Ken Riddle began exploring this possibility by using endoscopic procedures, and in 1994 he conducted sterilizations on ten female hybrids by placing ligatures around the oviduct. In 1995, 1996, and 1997 he conducted similar numbers of sterilizations on female hybrids by either placing ligatures around the oviduct or by removing short sections of the oviduct. Although fewer in number, several males were also sterilized, but this procedure is much more difficult than in females because the vas deferens leading from the testis and the ureter are not only of miniscule size, but lie on top of each other and are hardly distinguishable especially in young males. It can, however, be accomplished with patience, a steady hand, and knowledge, but there is still room for improvement in the methodology.

None of the falcons, male or female, showed any negative effects from the operation, and all were flown very successfully in either long distance aerial pursuits after bustards in the Middle East or at grouse and ducks in the USA (in other words, as a result of the operations there was no permanent damage to the air sac system as some had speculated). Because the gonads were not removed from the birds, hormones continued to be secreted and there was no sign of sluggishness or obesity as can be associated with capons or poulards. Some are now three, and one half years old, and they are still exhibiting the same vigor of flight as in their first year.

The younger the falcon the more difficult (or more impossible depending on how young) the operation on either sex is to perform. An expert can accomplish this task with some difficulty when large falcons are between six and eight weeks of age. In 1997 Heidenrich published a veterinary book (reviewed in the last Hawk Chalk, Birds of Prey: Medicine and Management) which details the methodology to accomplish surgical sterilization in raptors, and this can be used as a reference in teaching other veterinarians to conduct this surgery. It is not simple, however, and it does take some practice and experience working with an endoscope.

As encouraging as this is, there are still other factors to consider, and there are still questions which require complete answers. For example, if a short section is removed from the oviduct or vas deferens, will these loose ends somehow grow back to reunite?

If a short section of the oviduct is removed, we assume that should such a bird try to breed in the wild, the resulting egg would be shed into the body cavity after reaching the missing section. As different sections of the oviduct play different roles, from secretion of albumin to egg shell formation which are stimulated to occur as the egg passes down the oviduct, it would appear that if sections of the oviduct closer to the ovary are removed in order to accomplish sterilization, a smaller, less developed, shell-less egg would be shed into the body cavity and resorption would be more likely with no harm to the bird. One would assume that females, in which a ligature had been applied around the oviduct, would suffer mortality if and when an egg made its way down that constricted tube. Ironically, death to such a hybrid in the wild would be, I assume, exactly what wildlife regulatory officials would prefer (as is their proper responsibility) so that such a bird, albeit incapable of reproduction, could not take up a breeding territory of a native species as we have already considered.

There is also the possibility of chemical sterilization, but I am afraid I am too ill informed on this subject to comment, and I am also just plain afraid of this (but my mind could be changed).

In short, there are still questions to be answered and additional considerations to ponder about these procedures. We are in the process of trying to arrange for experiments to answer the above questions (about long-term results) with kestrels in the colony held by Dr. David Byrd at McGill University in Quebec. For the present, we have no reason to believe that the techniques described do not work. One thing is for sure: if we do not continue to try, we will never learn.

PROFESSOR TOM. J. CADE

1. Whether or not there are potential biological problems, the "ethical" and conservation issues are not going to go away; they are only going to be exacerbated by the increasing number of hybrids and exotics being produced and used in falconry. Therefore, we should concentrate our attention on finding effective and safe ways to render these birds incapable of reproduction. If this technical problem can be solved, then all other issues become moot or, at least, mooted.

2. Surgical castration may be the least desirable method because (a) it interferes with endocrine functions and (b) it is the most intrusive operation required for sterilization with potential for trauma to other internal structures. Question: when sectioned by surgery or accident, does the membrane wall of an air-sac seal up again? What does injury to an air-sac do to the respiratory capability of a bird? Question: would a neutered falcon actually perform less well as a hunter than an intact bird? Despite Heidenreich's cautions, I am not sure. Neutered bird dogs perform quite well and in some ways are behaviourally "better" than intact dogs. Some careful studies need to be done.

3. Transection of the oviduct or vas deferens as described by Heidenreich sounds like the best surgical procedure. Question: how well does it actually work? Is there potential for regeneration and reconnection of the ducts with the gonads? Question: how much does the procedure cost? These are not procedures that most breeders or falconers can do for themselves, and either the seller or buyer will have to pay the price.

4. Chemical sterilization needs much more investigation. If there is a drug or chemical compound that can be safely used by injection or in the diet, this would be the most preferable method, because breeders or falconers could do the procedure themselves. Cadmium chloride is one chemical that should be investigated. In lab mice and rats, it destroys the germinal tissue without doing permanent damage to the interstitium which produces the sex hormones. The testis is sensitive at low dosages; I am not sure about the ovary. I had a student at Syracuse University who did some trials with parakeets. She got good degeneration of the testis, but as I recall limited effect on ovary. I think there is a fair amount of literature on cadmium, but I have not looked into it for more than 20 years. The big problem with it is that it also has degenerative effects on kidney, adrenals, and liver at higher dosages, but gonadal tissues are the most sensitive; and it might be possible to find a dosage level that destroys reproductive function without doing damage to other organs. Somebody should do controlled experiments on kestrels or other commonly available raptors.

5. Imprinting to humans is safe, virtually irreversible, and works if carried out correctly. (I know of only two cases of imprinted raptors that eventually mated successfully with a member of their own species: Prof. Mendelsohn in Tel Aviv had a lappet-faced vulture that did so, and Ernst Luttger recently told me about his bearded vulture which bred 20 years after having been raised from day one out of the egg.) The one unknown, which needs research, is just how long the

"sensitive period" lasts in falcons and raptors. Since raptors are semi-altricial the end of the sensitive period probably does not occur until sometime in the fledgling stage--several weeks after leaving the nest. For the private breeder who raises only a few birds a year for himself or friends, this is the easiest and best method to follow. The problem with it is that it is time-consuming and labour intensive; therefore, most commercial breeders refuse to imprint their birds or do so in a less than adequate way. Also, imprinting does not allow for hacking in groups, which is a preferred method for conditioning young falcons for future training.

Although human imprinting is required by U.S. law for the free-flying of hybrids, few breeders actually go through the necessary procedure of raising the young in isolation from other birds until they are free-flying and beyond the sensitive period. Also, it is difficult for law-enforcement personnel to determine whether or not a bird has been imprinted on man.

6. Miscellaneous points. (a) The time for rendering captive produced birds sterile must be before they leave the breeder's hands--that is, it should be the responsibility of the seller, not the buyer; but the buyer needs to know how to verify that it has been done. (b) Regarding restrictions on individual freedoms vis a vis hybrids and exotics, what impact will EU regulations have? (c) Perhaps the highest potential risk in North America would be the accidental introduction of European Goshawks and introgression with the North American Gos. There is one reputed case of interbreeding between a German and American Goshawk in the Nevada mountains some years ago.

Tom Cade, pers. comm. hybrid discussion group

NEIL FORBES FRCVS

‘Principally in reply to Tom Cade’s points:

1. I agree, with Tom, that whatever the scientific/genetic arguments, in these conservation times in which we live, I believe our efforts should be towards sterilisation of hybrids before they are flown free.

This has a number of implications; firstly, it will need to be done at a young age, well before sexual maturity, at which stage the organs are small and surgery (if that is the method of choice), is not so easy. Yes, it will need to be done by a vet if it is surgical, and it will have to be certified by the vet as having been done. For the certificate to be legitimate, the bird will have to be identifiable, e.g. identichip.

2. I agree that I currently have a tendency against surgical castration as it might affect rate of muscle development etc. Air sac walls will repair very quickly following surgery. Bob Altman is due to present a paper to the European Association of Avian Vets in London (May 1997), on the radiological sterilisation of pigeons. [...] Essentially, if any testicular material is left behind, it can regenerate. However, in the pigeons on which he operated, post mortem histopathology (carried out 1-5 months later) failed to show any vestigial testicular tissue in 9 birds (including 6 sexually immature birds), whilst four were not successfully castrated. None of the 11 female birds were effectively castrated by this method.

3. Recommended surgery would involve removal of the oviduct (at least 75% of its length, rather than simple transection.) This is a recognised standard procedure, routinely carried out by

experienced avian vets on birds as small as cockatiels. At present, surgery is being carried out via a left caudal celiotomy, but has also been carried out in larger birds (e.g. flamingos) via endoscopy. Endoscopic surgery has major advantages, as there is a smaller area of feather removal, less muscle sectioning, hence quicker healing and less effect on flight training at a young age. It is certainly technically possible. but it would remain a procedure for specialised avian vets to carry out, rather than the street corner cat and dog, or even camel vet.

With respect to male birds, sectioning of the vas deferens is certainly the method of choice. Again, surgery could be done by endoscopy, the main problem that I have experienced to date is finding the vas in a young (non sexually mature) bird. The position of the vas in relation to the caudal lobe of the kidney, and the ureters, does vary with respect to species. No doubt with more practice, we can come up with some more definite recommendations on surgical approach.

The only way of addressing whether the question as to whether castration as opposed to vasectomisation has any effect on flying ability, is to carry out a number of each (at least 6 and probably more), and to assess their ability in a blind trial (i.e. the trainer/falconer would not be aware of which bird had had which procedure carried out.)

As to whether the vas deferens would reconnect, if radio surgery were used (which would be the easiest anyway) and a number of sections were made this is highly unlikely.

Cost - could be a problem as it is a specialist technique, and will have to be carried out at the site of the breeder rather than in a specialist falcon hospital say in the UAE. What may be a greater problem is actually locating enough vets with the necessary equipment, experience and bottle to carry it out.

4. If sex steroids or other chemicals were to be fed, one would have to be certain that the effect was permanent, the same applies to chemical implants. Other chemicals such as cadmium certainly can be studied, but who is going to certify that the bird is sterile, i.e. that the correct amount for the correct period was given? I regret that I feel that there are plenty of breeders who would rather state that they had given the chemical when in fact they had not.

5. Imprinting - again, is variable; if done wrongly can be an absolute disaster, i.e. the effects are not in my mind consistent although apparently reliable if done correctly.

I will investigate the surgical side in greater depth and report back. I will also check with the RCVS to ensure that the procedure would not be termed a ‘mutilation’ (i.e. a surgical procedure not carried out for the animal’s best personal interests) and hence ethically unacceptable in the UK, although I cannot personally see much difference between this and castrating any cat/dog/horse.

NEIL FORBES FRCVS

To all interested parties, copy of Dr Bob Altmans paper on radiosurgical castration of pigeons. Please be aware that this paper is not due for presentation until May 22 1997 and hence is not for general release as yet. Feel free to contact Bob on his E mail if you want to raise any points. The paper does not discuss the safety of the technique utilised.

I personally still feel vasectomy / salpingohysterectomy is the way forward, in time by endoscopic keyhole surgery.

Neil Forbes FRCVS

NEUTERING MALE PSITTACINE BIRDS

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KEY WORDS: Neuter, Castration,Testicle, Radiosurgery, Coagulate

SUMMARY

Radiosurgical ablation of the gonads of 24 pigeons, (Columbia livia), was performed. The ovary or left testicle was harvested from 1 to 5 months after the surgery and examined histologically for residual or regenerated gonadal tissue. Thirteen of the 24 birds were male (6 immature and 7 mature) and 11 were female. Four of the male birds were unsuccessfully neutered but 9 revealed no evidence of residual testicular tissue. Of the 9 successful procedures, 6 were immature (100%) and 3 were mature. All of the female birds (5 immature and 6 mature) revealed residual ovarian tissue upon histological examination.)

INTRODUCTION

There are a number of indications for neutering male or female psittacine caged aviary and pet birds. Male birds can become aggressive and inflict serious to fatal injuries on cage mates and a number of species of ornamental fowl can cause excessive disturbances from loud vocalization. By neutering these birds these problems can be diminished or eliminated.

Female birds, particularly species such as cockatiels (Nymphicus hollandicus) will often become chronic egg layers increasing the potential for egg binding. Female birds can also display aggression towards cage mates as well as human companions. Ovariectomy can resolve these problems. Since current techniques for neutering both male and female birds are difficult and, in many cases, hazardous, the surgical technique of ablation of the gonad by radiosurgical coagulation was attempted.

MATERIALS AND METHODS

Twenty-four feral pigeons (Columbia livia) were used in this study. Of the 13 male birds, 6 were immature and 7 were mature. Of the 11 female pigeons, 5 were immature and 6 were mature. Radiosurgical coagulation of the gonads was accomplished using an Ellman International Surgitron radiosurgical unit (Ellman International Inc., Hewlett, New York, USA). A ball electrode was used for the male birds and a ball and suction electrode was used for the females. A left lateral laparotomy approach offered easy access to the left gonad. The gonad was carefully desiccated until all gonadal tissue was deemed coagulated. Extreme care was taken to ensure the integrity of all surrounding tissue. Testicles and immature ovaries were coagulated with a ball electrode. Mature ovaries with follicle development were coagulated with the suction electrode after the follicular contents were aspirated. Isoflurane was the anaesthetic used. From one to five months after radiosurgical ablation of the gonads, autopsies were performed and tissue remnants of the gonads were harvested, placed in 10% buffered formalin and submitted for histological examination.

RESULT

Surgical success was measured by the lack of evidence of any gonadal tissue after histological examination. Of the 7 mature male birds studied, 3 were successful and 4 were considered failures. All of the 6 immature male birds were successfully castrated. All of the 11 female birds in both age categories were considered failures because of incomplete coagulation or regeneration of ovarian tissue.

DISCUSSION

In immature male pigeons, small testicles are easily ablated. Mature males with hypertrophied, active testicles are more difficult to totally ablate because of the large volume mass of the testicular tissue and complete ablation is not always possible. However, by modifying the surgical technique by debulking the testicle using a loop electrode and then coagulating the remaining tissue, it might be possible to achieve 100% surgical success.

In female birds, the ovary is less accessible increasing the risk of injuring surrounding tissue. However, in females with active ovarian follicles, aspiration of the follicular contents and aggressive coagulation and debulking might be successful though it potentiates a much greater risk.

With modifications in surgical technique, the authors feel that success can be achieved in all female and all adult male birds.

REFERENCES

1. ALTMAN RB (1997) Soft tissue surgical procedures. In: Avian Medicine and Surgery: RB Altman, SL Clubb, GM Dorrestein, K Quesenbury (eds.), W.B. Saunders, Philadelphia p. 712

2. BANNETT RA, and HARRISON GJ (1994) Soft tissue surgery. In: Avian Medicine: Principles and Application: BW Ritchie, GJ Harrison, LR Harrison (eds.), Wingers Publishing, Lake Worth, Florida pp 1128-1131

13 THE LAW IN RELATION TO HYBRIDS AND EXOTICS

13.1 The law in relation to hybrids and exotics, as it applies to the individual falconer, is many-tiered. We have international agreements, such as CITES (Convention on International Trade in Endangered Species), which covers participating countries which are signatories to the Convention. CITES is not enforced evenly across the countries and in many third world countries it will never have the level of control and enforcement applied by Management Authorities in Western countries. CITES is primarily aimed at trade and movement, but also tries to define terms such as 'captive bred' and 'commercial purposes' which tend to set precedents of definition for national legislation.

Countries, or groups of countries such as the European Union, also adhere to other agreements such as the 'Bern Convention.' These are listed below.

13.1.2 INTERNATIONAL LEGISLATION AND GUIDANCE CONCERNING RELEASES OF NON-NATIVE SPECIES

13.1.3 The Bern Convention

A4.1. The Convention on the Conservation of European Wildlife and Natural Habitats (the "Bern Convention"), adopted by the Council of Europe on 19 September 1979, aims to conserve wild flora and fauna and their natural habitats, especially those species and habitats whose conservation requires the co-operation of several States, and to promote such cooperation. Particular emphasis is given to endangered and vulnerable species, including endangered and vulnerable migratory species. Article 11(2) of the Convention requires that:

"Each Contracting Party undertakes:

a) to encourage the reintroduction of native species of wild flora and fauna when this would contribute to the conservation of an endangered species, provided that a study is first made in the light of experiences of other Contracting Parties to establish that such reintroduction would be effective and acceptable;

b) to strictly control the introduction of non-native species." (note: this applies to ALL exotic forms, including hybrids)

The Bern Convention forms the basis for the Council Directive 92/43/EEC, the "Habitats Directive" (see A4.3. below).

A4.2. Further to this Convention, the Committee of Ministers to Member States have made Recommendations concerning the introduction of non-native species [5] and on the reintroduction of wildlife species [6]. These recommendations state that the introduction of non-native species into the natural environment be prohibited where adverse effects on the ecosystem may occur. However, certain exceptions to prohibitions may be authorised on the condition that the possible consequences are assessed beforehand.

Where reintroductions are considered, they should only be undertaken after carrying out research and implemented under scientific supervision. It is recommended that interested parties be informed of such reintroductions. Also, collecting stock for reintroductions should be prohibited from populations which would be threatened as a result.

13.1.4. Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora

A4.3. The "Habitats Directive", adopted by Member States on 21 May 1992, also aims to conserve wild flora and fauna and their natural habitats and is based on the Bern Convention. Article 22(b) states that, in implementing the provisions of this Directive, Member States shall:

"ensure that the deliberate introduction into the wild of any species which is not native to their territory is regulated so as not to prejudice natural habitats within their natural range or the wild native fauna and flora and, if they consider it necessary, prohibit such introduction. The results of the assessment undertaken shall be forwarded to the committee for information."

13.1.5. Council Directive 79/409/EEC on the Conservation of Wild Birds

A4.4. The "Birds Directive" aim to protect wild bird species and their habitats. Article 11 states that:

"Member States shall see that any introduction of species of bird which does not occur naturally in the wild state in the European territory of the Member States does not prejudice the local flora and fauna. In this connection they shall consult the (European) Commission".

13.1.6. Convention on Biological Diversity

A4.5. The Convention on Biological Diversity was opened for signature on 5 June 1992 at the United Nations Conference on Environment and Development at Rio de Janeiro, after adoption on 22 May 1992 at the Nairobi Conference for the Adoption of the Agreed Text of the Convention on Biological Diversity. The Convention entered into force on 29 December 1993. The objectives of this Convention are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

The Convention specifically addresses the introduction of non-native species. Article 8(h) states that:

"Each Contracting Party shall, as far as possible and as appropriate:

(h) prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species.

13.1.7. IUCN Position Statement on Translocation of Living Organisms: Introduction, Re-introductions and Re-stocking.

A4.7. The World Conservation Union (IUCN) position, published in 1987, is that introductions should only occur if there are clear and well-defined benefits and if no suitable native species are available. It sets out general principles for determining the desirability of intentional introductions in natural, seminatural and human-made habitats, discouraging accidental introductions, undertaking eradication measures and administering introductions in national and trans-boundary contexts.

See also Shine, C., N. Williams and L. Gundling. 2000. A Guide to Designing Legal and Institutional Frameworks on Alien Invasive Species. IUCN Environmental Policy and Law Paper No 40.

13.1.8. FAO Code of Conduct for the Import and Release of Exotic Biological Control Agents

A4.8. The United Nations Food and Agriculture Organisation's Code of Conduct, published in February 1996, sets out the responsibilities of Government authorities, exporters and importers of biological control agents capable of self-replication (parasitoids, predators, parasites, phytophagous arthropods and pathogens) used in research and for environmental release, and describes three responsibility phases; pre-export, pre-import and post-import.

13.1.9. ICES Code of Practice on the Introductions and Transfers of Marine Organisms 1994

A4.9. This Code of Practice, adopted by the International Council for Exploration of the Sea in September 1994, recommends practices and procedures to diminish risks of detrimental effects from the introduction and transfer of marine organisms. It provides recommendations for new intentional introductions and suggests that member countries submit proposals to ICES for an opinion on a proposed introduction.

13.2 NATIONAL LEGISLATION AND GUIDANCE CONCERNING RELEASES OF NON-NATIVE SPECIES.

We then have group legislation such as the European Community Birds Directive. This is applied in each European country as national legislation, therefore differing in each place, and in Britain at least (in the form of the Wildlife and Countryside Act 1981 and the Import/Export Act) tends to be stricter. In the US there is a Federal, and a State level of legislation. Below the national legislation, we have voluntary codes of conduct such as those applied by the IAF and by falconry organisations such as NAFA, the Hawk Board, DFO, BFC, etc.

Note: In the USA the legislation is USFWS: 50CFR21:30. The UK legislation is as follows:

The UK is governed by Section 14 of the Wildlife and Countryside Act 1981 as a legal framework for the application of the 'Bern Convention':

With respect to the release of animal species, Section 14(1) of the Act states that:

'Subject to the provisions of this Part, if any person releases or allows to escape into the wild any animal which -

(a) is of a kind which is not ordinarily resident in and is not a regular visitor to Great Britain in a wild state;

or

(b) is included in Part I of Schedule 9, he shall be guilty of an offence.

With respect to the release of non-native plant species **Section 14(2)** of the Act states:

"Subject to the provisions of this Part, if any person plants or otherwise causes to grow in the wild any plant which is included in Part II of Schedule 9, he shall be guilty of an offence."

Thus, **sections 14(1)** and **(2)** of the Act respectively prohibit the release of all non-native animal species (see paragraphs 2.2 - 2.5 below) and certain plant species (see paragraphs 2.6 - 2.7 below). There are certain groups of organisms to which the Act does not apply which are listed in paragraph 2.8 below.

Non-native animals

2.2. **Section 14(1)** of the Act prohibits the release of any non-native animal into the environment, no matter what its purpose or circumstances. In addition to direct releases to the open environment, including natural and semi-natural habitats, it is considered that ***"releases or allows to escape into the wild"*** includes semi-confined situations such as gardens and glasshouses. This is because animals will escape into the wider environment via available routes such as vents in commercial glasshouses, or via removal of soil or plant matter in which they may shelter or feed. Similarly, the keeping of non-native aquatic animals in cages or pens floating in lakes, sea lochs and coastal regions is also considered as a **release**, because non-native freshwater or marine fish and invertebrates are likely to escape in these situations.

2.3. **Section 14** applies to *"any animal"*. It is considered that this is any species that is currently accepted by scientists to fulfil the criteria of the Kingdom Animalia. This includes all nematodes (including microscopic species), mites, insects and all other invertebrates, in addition to all vertebrates (fish, amphibians, reptiles, birds and mammals). The *"kind"* of animal may be specified down to the sub-species level, and includes hybrids between native and non-native species. It is also important to note that all life-cycle stages of the non-native animal are controlled. Thus, the Act applies, where appropriate, to eggs, semen, embryos, larvae, pupae and adult stages.

Query: **14 (1) (a).... is of a kind which is not ordinarily resident in and is not a regular visitor to Great Britain in a wild state.** 'Kind' refers not to species, but to an individual which could be distinguishable phenotypically, but be taxonomically identical. For example, the Racing Pigeon, Town or Feral Pigeon and the various fancy pigeons, are all the same taxonomically as the native Rock Dove, i.e. they are all Columba Livia. But obviously they are phenotypically different because they are of different 'kinds'.

However, most Schedules to the Act maintain that common names shall not apply, only scientific names: in other words, phenotypic differences will be ignored in favour of taxonomic differences. So, what is a 'kind'? As far as human introductions are concerned, the criterion for entry is at species level - Homo sapiens - and does not discriminate against non-indigenous races or phenotypes: indeed, it is illegal to do so!

2.4. I**n section 14,** a non-native animal is one that is ***"not ordinarily resident in and is not a regular visitor to Great Britain in a wild state".*** This includes all species of animals which, according to scientific records, do not naturally occur in Great Britain. In order to be **resident**, it is considered that a species must be breeding in the wild and producing young which reach maturity without the deliberate assistance of man, ie: under natural environmental conditions. **Section 14** does not extend to non-native animals that regularly visit Great Britain in a wild state, for example migratory birds and some species of insects which, as an established behavioural trait, seasonally migrate either for the summer or winter months to utilize environmental resources for feeding and reproduction.

Query: And rather than or, indicates that the animal must be of a kind which is neither a resident nor a visitor in a wild state. For example, the domestic cat is not ordinarily resident in a wild state, although feral cats do breed in the UK, nor are cat's regular visitors to Britain because they cannot swim the Channel. It is therefore illegal to release domestic cats on both counts. Gyrfalcons on the other hand, although they visit Britain, are not ordinarily resident and therefore only fulfil one of the two mandatory requirements. It is therefore legal to release them.

Regular refers to the even spacing of the visits and has been misused here. Regular could mean once every ten minutes or once a century. What was intended was some measure of frequency.

In a wild state refers here not to a place, but to a condition of the 'kind' of animal which already resides or visits Britain (ie. not the individual being released). It may mean that the 'kind' is independent of man in terms of food supply, nest sites or breeding; it may mean that the species is 'mentally wild', in the sense of unapproachable, or genetically wild type rather than a feral domestic type. It cannot mean a place - because the animal could not visit and take the wild place with it.

2.5. **Section 14(1)(b)** prohibits releases of animal species into the wild which are specifically listed in **Part I of Schedule 9** of the Act (see Annex 1), which is referred to in section 14(1)(b). In practice, most of the animals listed are those known to be established in the wild in Great Britain and causing damage to the environment.

Non-native plant species

2.6. Section 14(2) of the Act only prohibits the release of the non-native plants specifically listed in **Part 11 of Schedule 9** of the Act. These are plant and algal species which have become established in habitats in Great Britain and have been specifically listed because of the damage they are causing to the natural environment (see Annex 1).

2.7. The Act states that any person who ***"plants or otherwise causes to grow in the wild"*** the listed plant species shall be guilty of an offence. It is considered that this includes the deliberate planting of these species in the wild. It also includes the cultivation of these species in confined situations but allowing the removal or transfer of plant material to where it may become established in the wild. All life cycle stages and parts of these listed species which are capable of dispersal, regeneration growth and reproduction are controlled: including, where appropriate, reproductive and dispersal structures, seeds and live vegetative or root material capable of regenerating, for example rhizomes of Japanese knotweed (Fallopia japonica).

Query: Whereas subsection (1) essentially covers the introduction of new exotic animal species, subsection (2) does not make the same provision for exotic plant species. Provided one does not introduce any of the four plants in Schedule 9, two of which are seaweeds, there are no controls on exotic plants under this Act.

Species not covered by section 14 of the Act

2.8. Species in the following groups of organisms are not controlled by section 14 of the Act:

- *Monera (including viruses and prokaryotic microorganisms, including all bacteria);*
- *Protista (including all protozoa and eukaryotic algae, including seaweeds), except those listed in **Part II of Schedule 9** (listed in Annex 1);*
- *Fungi (including lichens);*
- *Plants (including mosses, liverworts, horsetails, ferns, gymnosperms and angiosperms) except those listed in **Part II of Schedule 9** (listed in Annex 1).*

Re-introductions of animal species endangered or extinct in Great Britain

2.9. Where native animal species are declining or have become extinct from areas of Great Britain, there may be attempts to reintroduce populations using non-native stock from outside Great Britain. These releases are also prohibited by **section 14** of the Act, if the non-native stock consists of a sub-species which is not native to Great Britain. It is considered that the non-native sub-species of the animal from another country may be genotypically and phenotypically significantly different from the original native populations, and thus may behave differently in the environment after release. Re-introductions should be planned within the context of UK Biodiversity Action Plans[7], and applications for licences will be considered with existing plans and policies in mind. Further information regarding Species Action Programmes may be obtained from English Nature, Scottish Natural Heritage, the Countryside Council for Wales or the joint Nature Conservation Committee (addresses at Annex 6).

Population studies of animal species listed in Part I of Schedule 9 of the Act

2.10. Where field studies are being carried out with populations of species listed in **Part I of Schedule 9** of the Act which are established in Great Britain, it may be necessary to apply for a licence. This would apply where, in the course of a study, individuals of the list species are captured, tagged or otherwise labelled for identification purposes, and re-released. In the event of re-release, an offence shall have been committed unless a licence had been granted to the person or persons responsible for the study.

Penalties for an offence under section 14 of the Act

2.11. **Section 21 (4)** of the Act states:

"A person guilty of an offence under section 14 shall be liable-

(a) on summary conviction, to a fine not exceeding the statutory maximum;

(b) on conviction on indictment, to a fine.

With respect to **section 21(4)(a),** the maximum statutory fine, arising from a summary conviction in either a sheriff or a magistrates court is presently £5000. With respect to **section 21(4)(b)**, the fine arising from a conviction on indictment in the High or Crown court is potentially unlimited.

2.12. If an offence is committed under section 14(1) (for releasing or for allowing the escape of non-native animals without a licence) or section 14(2) (for planting or otherwise causing to grow in the wild the plants listed in **Part 11 of Schedule 9** without a licence), under **section 14(3)** of the Act it shall be a defence to a charge of committing an offence to prove that all reasonable steps were taken and all due diligence exercised to avoid committing an offence.

Summary of Section 2

The Act prohibits the release of all non-native animal species and sub-species into the wild in Great Britain. This includes semi-confined situations where the animals will escape into the wild.

- The Act also prohibits the release of specifically named animal species which are established in Great Britain.
- The Act also prohibits the release of specifically named plant species which are established in Great Britain.
- The penalty on a conviction for releasing non-native animals or the listed plants without a licence may be an unlimited fine.

CONCLUSION:

STEVE SHERROD (US Co-chair)

1. This document evidences the miniscule threat that exists from introduced falcons to native falcon inhabitants. Nevertheless, hybrids comprised of at least one native species do impose a certain risk factor. Regardless of that fact, I believe that the requirements in the current USFWS regulations (50CFR21.30) regarding breeding and raising hybrid falcons are totally adequate to prevent any significant problems with these birds in wild populations **as long as** those regulations are followed as written.

2. In addition, working radio telemetry should be required to be used on any hybrid falcons flown or hacked, and;

3. a name tag with phone number should also be required on these birds always when flying freely. NAFA Members should be willing to help state authorities trap (and if not possible, remove by any means necessary, ultimately including shooting) any hybrid or exotic falcon which takes up residence at eyries. The methods of sterilization which are now being used and further developed will have to be learned by more avian veterinarians, and they will have to be available to the falconry/breeder community at reasonable costs. The owner of any such hybrid falcon will have to be held responsible

for the sexual orientation (imprinted/wild raised) and reproductive state (sterilized/non-sterilized) of his/her own bird. Ultimately, I believe most falconers will deal with this matter responsibly if the operation is available to them. Some, however, might not.

There has been discussion that the owners of all hybrids might be required to provide documentation regarding how their individual hybrid was raised, and to have available for inspection a certificate of sterilization signed by a licensed veterinarian for any non-imprints. This would not be acceptable because of the varying shades of gray or loopholes which exist, and therefore would be very difficult to enforce. When matters are not black and white, and when they become unenforceable, law enforcement officials react by eliminating the problem in its entirety (i.e. hybrids).

Although the problem is in reality quite small, concern is real and not totally unfounded; the perception of a much greater problem than probably actually exists as well as some individuals' failure to abide by the reasonable regulations we already have, could well result in restrictions which eliminate this bird from American falconry.

SUMMARY: WE MUST BE WILLING TO FOLLOW THE RULES WE ALREADY HAVE.

CONCLUSION: NICK FOX (UK Co-chair)

I agree with Steve Sherrod's three points, with the addition of the following:

1. The 'wild' hacking of exotic or hybrid species which have not been sterilised or which are not closely monitored by radio-telemetry, and which result in individuals becoming 'hacked back' to the wild should be discouraged. This has been the root of the problem in Germany.

2. Falconers should be strongly encouraged not to shoot themselves in the foot over this issue. Look around you at how totally dependent we are on non-native organisms, in our food, our gardens, in our landscape. Are we prepared to get rid of our dogs and keep wolves instead?

14 ACKNOWLEDGEMENTS

The chairman would like to personally thank all the members of the Hybrid Discussion Group for their contributions; Helen Macdonald, who created and moderated the list and provided valuable editorial assistance with this document; and finally, we are indebted to all those who have previously tackled this issue for NAFA and other organisations. We have not been able to include all of their work due to the fact that much of the scientific data and technical information (eg on sterilisation) have been superseded. Their work has been crucial to the tenets and scope of this document.

Special thanks are due to Mr Mohamed Al Bowardi, Managing Director of the National Avian Research Center, part of the Environmental Research and Wildlife Development Agency, Abu Dhabi, for his continuing initiative in tackling conservation issues related to Arab falconry, including support in the preparation of this document.

APPENDIX 1

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APPENDIX 2

EXTRACTS FROM 'THE REGULATION AND CONTROL OF THE RELEASE OF NON-NATIVE ANIMALS AND PLANTS INTO THE WILD IN GREAT BRITAIN', DEPARTMENT OF THE ENVIRONMENT 1997

1. Introduction

1.1. Numerous non-native animal and plant species from other countries have been introduced into Great Britain for a number of reasons in historical times. Some introductions may have been accidental, others to provide different sources of food, sport or for ornamental purposes. Many non-native species have become well established as part of Great Britain's fauna and flora, interacting with native species. Their success depends on their ability to adapt to the environmental conditions experienced in Great Britain, and on their biological interaction with native species.

1.2. In some cases, non-native species can adapt and invade natural communities. Often, this is because they have not evolved over a long period of time with the native species with which they interact, so environmental pressures to limit their spread, such as pathogens, predators or defence adaptations are absent. Some naturalised introductions may be relatively benign, while others may be damaging to the environment, including native flora and fauna, or to human interests such as agriculture and forestry. Changes in land use may exacerbate spread, because environmental conditions and the species balance are altered, giving the non-native species a competitive advantage. There are many examples worldwide of damage to the physical environment or native fauna and flora occurring as a result of non-native species introductions. In Great Britain examples include the grey squirrel (Sciurus carolinensis), the New Zealand flatworm (Artioposthia triangulates) and Japanese knotweed (Fallopia japonica). It is therefore important to control and regulate releases of non-native species to ensure that further damage to the environment does not occur.

International controls on releases of non-native species

1.3. The introduction of non-native species is controlled by international and European legislation, particularly Article 11 (2) (b) of the Convention on the Conservation of European Wildlife and Natural Habitats (the "Bern Convention"), Article 22(b) of Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora, Article II of Council Directive 79/409/EEC on the Conservation of Wild Birds, and Article 8(h) of the Convention on Biological Diversity. Codes of Practice have also been drawn up by international organisations, for example the Food and Agriculture Organisation (FAO) International Standards for Phytosanitary Measures "Code of Conduct for the Import and Release of Biological Control Agents", the International Council for Exploration of the Sea (ICES) "1994 Code of Practice on the Introductions and Transfers of Marine Organisms", and the International Union for Conservation of Nature (IUCN) "Translocation of Living Organisms" (1987). Further details on this legislation and guidance are provided in Annex 4 to this guidance note.

Controls of releases of non-native species in Great Britain

1.4. The release into the wild of animal species which are not native to Great Britain, whatever their proposed use, is prohibited by section 14 of the Wildlife and Countryside Act 1981 ("the Act"). The release of certain animals and plants which are already established in the wild in Great Britain is also prohibited by **section 14** of the Act. **Section 16** of the Act gives the Secretary of State and the Minister of Agriculture, Fisheries and Food powers to grant licences for releases so that **section 14** does not apply. Releases of non-native animals may therefore be licensed under the Act for specific purposes, for example to authorize their use for the control of pests on commercial crops.

APPENDIX 3

NORTH AMERICAN FALCONERS ASSOCIATION POLICY ON RAPTOR HYBRIDIZATION

A. N.A.F.A. encourages the captive-breeding of the raptors used in falconry under the terms of those laws/regulations currently (Nov. '77) in effect. N.A.F.A. is opposed to any captive breeding attempts undertaken without appropriate permits.

B. Although encouraging captive-breeding of "pure strains" of raptors (i.e. subspecies with like subspecies), N.A.F.A. approves of intraspecific hybridization when accomplished in accordance with Item A, above.

C. N.A.F.A. similarly approves of interspecific hybridization when conducted in accordance with appropriate permits. Recognizing that much interspecific hybridization to date has occurred only because of a lack of "matched" pairs of birds or a lack of semen to match the species/subspecies of laying females, N.A.F.A. encourages those of its members participating in captive-breeding to exchange birds or semen (within appropriate legal restrictions) to facilitate "pure" breeding and to refrain from such cooperation with anyone attempting to breed without appropriate permits.

D. N.A.F.A. concurs in principle with the present federal restrictions placed on interspecific hybridization (i.e. that birds so produced be surgically sterilized or totally imprinted on humans), but supports such restrictions ONLY for birds to be used in falconry. In view of the fact that surgical sterilization is a procedure of considerable technical difficulty', N.A.F.A. highly recommends that interspecific hybrids to be used in falconry be imprinted.

E. Although the possibility of hybrid "contamination" of wild raptor populations is virtually infinitesimal, N.A.F.A. strongly urges that falconers flying hybrids utilize telemetry to reduce thus possibility of their loss.

F. The N.A.F.A. urges that individuals engaged in any captive raptor breeding keep scrupulously accurate records and participate fully and without reservation in the North American Peregrine Foundation Raptor Registry and Stud Book so as to develop maximum knowledge from all captive raptor breeding.

'NAFA calls to the attention of all captive breeders the problem - and potential subsequent over-reaction and likely over-restriction - that could come about as a result of 'flaunting' hybrids of any type or the subject of captive hybridization before unknowledgeable non-falconers and other raptor breeders. The NAFA strongly recommends the utmost discretion be used in any public statements etc., concerning the subject.'

1978

APPENDIX 4

FALCONRY POSITION STATEMENT OF THE RAPTOR RESEARCH FOUNDATION, INC.

INTRODUCTION

Birds of prey have received considerable conservation attention in recent years due to marked declines in some populations, notably of those species vulnerable to environmental pollutants. As a result of these declines, and because reliable data on population status were often unavailable, protection of raptor species became a conservation priority, including strict regulation of the sport of falconry. In 1977, the Conservation Committee of the Wilson Ornithological Society (WOS) reported on falconry in North America (Braun et al. 1977), concluding that falconry is a legitimate art but that monitoring of raptor populations was needed. Recommendations were made that falconry regulations be adopted by all states, that a practical marking system be developed for permanent identification of individual raptors, that properly marked falconry birds be allowed to be transported freely between states, and that captive bred raptors of any species be allowed for falconry. At the time of the WOS committee report, newly promulgated federal regulations controlling the practice of falconry were being implemented in the United States which have served as the basis, with minor changes, for regulating the sport in 42 states. Similar rules have been promulgated by several provinces in Canada.

Since 1977, substantial data have become available on the status of most raptor species suitable for falconry, and depressed raptor populations have generally recovered in North America and Europe. Most of the recommendations of the WOS Conservation Committee have been achieved in the United States and Canada, and the contributions of falconers to raptor management and conservation education have been widely recognized. Yet regulation of falconry still causes controversy in some countries.

The purpose of the Falconry Position Statement by the Raptor Research Foundation, Inc., is to provide current and additional expert opinion based on available biological data on issues relating to the regulation and practice of falconry. This statement neither affirms nor disaffirms the philosophical question of the legitimacy of the sport of falconry.

DEFINITION OF ISSUES

Harvest of wild populations -- The removal of young birds from wild populations reduces productivity (directly, and perhaps indirectly through disturbance during the nesting season). However, raptors are a renewable resource, and thus the game management principle of 'sustainable yield' may be appropriately applied to harvest of individuals from healthy populations.

Captive Propagation -- Captive propagation of raptors has increased dramatically in recent years, and the release of captive-bred progeny has been valuable for re-establishing some endangered species. Captive breeding provides birds for falconry, but may also be used to conceal illegally acquired birds unless parentage can be proven.

Hybridization and Introductions -- The production of hybrids, especially among large falcons, has raised questions concerning the release of such birds to the wild. Genetic theory predicts that, at normal population levels, hybrids between sympatric or parapatric species would be eliminated by natural selection. Similarly, non-native species from within the same super-continent (Americas, Eurasia) are unlikely to establish themselves in the wild as introduced aliens. However, trains from hybrids between allopatric species might establish in native stocks, and species from other super-continents might become accidentally introduced if used in large numbers for falconry.

Identification of Individual Birds and Parentage -- To effectively enforce falconry regulations, individual birds must be reliably identified. Leg bands which cannot be refastened after removal would be a convenient method, but bands currently used are not entirely reliable. Alternatives include biochemical parentage tests, which should soon become available for raptors, and foot scute patterns which are expected to provide unique 'fingerprints' for individual identification.

Regulation and Enforcement of Falconry --Controls are desirable; however, the intensity of regulations and their enforcement should be consonant with the risk to raptor populations.

POSITION

1. The position of the Raptor Research Foundation, Inc., with regard to the above stated issues relating to Falconry is:
2. North American raptors used in falconry have stable or increasing populations throughout most or all of their range. This is also generally true of European countries where falconry is practiced.
3. Evidence indicates that large and stable or increasing raptor populations can sustain an annual harvest of at least 10% of nestlings.
4. Any harvest of raptors from small and unstable or declining populations should be evaluated, in each instance, on a biological (e.g. population and productivity data) basis.
5. The annual harvest of wild raptors by falconers in the United States is well below 5% for any species and below 1% for most species. Percentages are not adjusted for return to wild stocks of released and escaped birds.
6. Final development of biochemical parentage tests and the use of foot scute patterns for individual identification should be encouraged as tools for regulation and enforcement.
7. Escape of sympatric and parapatric species or their hybrids is unlikely to pose any significant threat to wild populations. However, we recommend that hybrids between allopatric species should not be bred for falconry, and that other hybrids or species at risk of accidental

introduction between super-continents should be imprinted on humans before being used in falconry.

8. Licensing individual falconers on merit is effective for regulating falconry, especially when combined with individual markers for raptors of special management concern (e.g., endangered species.) There is little conservation justification for the administrative costs of marking common raptors individually, and future consideration should be given to modification of this practice.
9. Many resources now being directed towards the control of falconry in the United States and elsewhere could be redirected to raptor population monitoring, habitat conservation, education and preventing the killing of wild raptors.
10. Government agencies should be more responsive to the changing status of species, both by imposing protection when necessary and by removing restrictions on use when biological data indicate such is warranted.
11. International standards for the practice and regulation of falconry are encouraged.

1997

APPENDIX 5

LETTER FROM ROBERT A. WITZEMAN, M.D. of the MARICOPA AUDUBON SOCIETY TO HAROLD OLSON, NEW MEXICO DEPT. OF GAME AND FISH.

September 6 1982

Dear Mr Olson,

The New Mexico Department of Game and Fish is to be congratulated for recognizing the importance in limiting potential introductions of exotic wildlife which may constitute a threat to native populations and their ecosystems as well.

Historically unthinking and unplanned actions by man have led to the destruction of native wildlife populations or their habitats or both. A few examples should be mentioned:

1. European starlings here in the Southwest appear to have competed with, and crowded out many native cavity-nesting species such as Elf Owls, Gila Woodpeckers, Gilded Flickers and Purple Martins. This may have major untoward implications for the entire Saguaro-Palo Verde vegetative and wildlife community.

2. Rainbow trout in Arizona have interbred and genetically swamped Arizona's native Apache trout, requiring extensive rescue and restoration efforts. Brown trout also introduced in the area have competed for the food supply and preyed upon the Apache trout.

3. Rio Grande Cutthroat Trout likewise have been genetically diluted by Rainbow trout and exotic subspecies of Cutthroat trout in New Mexico.

4. The Red Wolf has reached near extinction for many reasons, and the few remaining have been genetically destroyed through interbreeding with the Coyote and dog in Texas and Louisiana.

5. The re-stocking of depleted North-eastern US Bobwhite populations with genetically distinct Texas and Mexican Bobwhite populations has produced an individual which may biologists believe is less

capable of wintering-over successfully in the northern ecosystem (Our Wildlife Legacy, Durward Allen, 1954.)

6. Gambusia introduced into the Southwest have competed for food and also preyed directly upon the native, endangered Gila Topminnow populations. Reintroduction of Topminnows has succeeded primarily where Gambusia have been entirely removed-- at great commitments in time and cost.

7. The Masked Bobwhite subspecies of Bobwhite Quail was reintroduced into Arizona with great care to preserve the genetic purity of the introduced population. Guardian (Texas subspecies) surrogate (male) Bobwhite parents released with the Masked population were carefully sterilized to prevent genetic mixing of the highly-esteemed indigenous Masked Bobwhite population (formerly found in Arizona until past overgrazing excesses eliminated it).

Many people do not realize the small size of our native southwestern raptor populations. There are but a few dozen pairs of Peregrine Falcons - the native breeding population - in New Mexico and Arizona. The flying of non-native Peregrines here in the Southwest, which have origins, whether from far-flung parts of the world or other adjacent North American populations, tempts disaster. The various world-wide subspecies or populations of Peregrines are not just subtle taxonomic differences. They may vary greatly from each other in size, appearance, behaviour, blood chemistry or migration patterns. Each population represents hundreds of years of evolution - to enable that race to thrive best in its own ecosystem.

The ability of exotic falcon populations to provide the genetic makeup to cope with our southwestern ecosystem is unknown and when a key species such as the Peregrine Falcon is at stake, how can such chances be taken? The Department is to be congratulated for the September 25 regulations which will ensure the integrity and survival of the Peregrine and other native raptor populations from potential jeopardy by exotics.

It should also be noted that the use of Peregrines from the 'eastern" Cornell mixed stock should not be flown and represent an unwarranted risk. They are composed of a highly crossbred mix containing the genes of several different Peregrine subspecies-- Including many arctic tundra birds, birds from heavily forested wet Pacific coastal areas and even European stock. This "polyglot" population has never had the benefit of centuries of adaptation to the rigors of survival In the New Mexican ecosystem. The native New Mexican subspecies, which has had the benefit of years of the natural selection process has already shown it is capable of coping with the Southwest environment.

Peale's Peregrines from the extremely humid Pacific Northwest coastal areas of Canada have eggshells of increased porosity to accommodate the transpiration of water concurrent with embryonic metabolic processes. Such genes would suggest disaster for our southwestern Peregrine population.

Because Arizona has a Peregrine Population which interacts closely with and shares the genes of those birds in New Mexico, we are especially gratified that the new regulations address this concern.

New Mexico and Arizona both have the good fortune of possessing other unusual and exciting raptor populations which are relatively small in numbers and could be adversely impacted by exotic raptor introductions:

1. The Harris' Hawk subspecies of South America is different from the Harris' Hawk population found in New Mexico or the one found in Arizona. The latter two populations are separated from each other by the Sierra Madre and Rocky Mountain continental divide. The inadvertent or unthinking release of a non-native race into any of these three populations would be a disservice to the

centuries of natural selection which made each population fit to cope with its respective ecosystem. Harris' Hawks obtained in Arizona or Western Mexico should not be flown by falconers in New Mexico nor should New Mexico-Texas birds be flown in Arizona.

2. Arizona and New Mexico may both point with pride to their Apache Goshawk population. It is to be commended that the proposed regulations prevent this southern population from being placed in jeopardy by (smaller) northern Goshawk populations of the US and Canada or by any of the half dozen other exotic populations of Goshawks which are found throughout the northern hemisphere in the old and new world.

The use of hybrid species, as permitted in the proposed regulations, is unwise even with transmitters. Such equipment is far from foolproof and costly. Species which some biologists have believed to be sterile-as-mules have not always turned out that way. The supposedly sterile Grass-Carp (White Amur-Bigmouth Carp cross) was an unpleasant surprise to a great many biologists.

A host of 'hybrids' of widely varying lineage have been used for falconry in the US involving Gyrfalcons, Peregrines, Prairie falcons, Lanner, Saker and many other allied and peregrine-like taxa (forms). The taxonomy and genetic isolation of many of these forms is unknown to biologists today. One glance at wolf, dog and coyote interbreeding or duck fancier breeding efforts leads one to a healthy respect for the destructive potential which such so-called hybrids could hold for our native southwestern raptor populations.

In conclusion, the Department is to be congratulated on its drafting of falconry regulations which reduce the potential for introduction of exotic wildlife. We have also commented upon the telemetrized use of hybrid species and why it is unwarranted. Thank you for this opportunity to present this commentary.

Sincerely,

Robert A. Witzeman, M.D.

Editor

APPENDIX 6

D) extract from: RECOMMENDATIONS OF THE COLORADO WILDLIFE FEDERATION TASK FORCE ON RAPTOR LAW AND REGULATION

Submitted to the Colorado Wildlife Commission

4 January 1984

The Colorado Wildlife Federation established the Task Force on Raptor Law and Regulation in September 1983 based on our concern that there had not been full and complete discussion on several raptor regulation issues and the fact that new information had become available on key issues. The Task Force members are listed below. The Task Force identified key issues, met formally four times, and has made the following recommendations. These recommendations were reviewed and approved by the Board of Directors of the Colorado Wildlife Federation on December 10, 1983. Colorado Wildlife Federation appreciates the responsiveness of the Commission to the work of our Task Force. Colorado has historically been a national leader in the development of raptor management. We believe these recommendations provide Colorado and the Colorado Wildlife Commission with the opportunity to continue this leadership role in a very positive and constructive fashion. References made in the following recommendation discussion are to the Chapter 6 Commission regulations approved in August, 1983.

1. **Hybridization**. The Task Force is convinced that truly negative biological effects to wild populations resulting from the occasional loss of individual intra-specific (sub-species) crosses are remote. To discourage sub-species crossing by requiring such crosses to be surgically sterilized or imprinted is over-regulation which could result in net deleterious rather than beneficial effects. Sterilization or imprinting should be required of inter-specific (species) hybrids only. To further guard against impacts on wild populations, all crosses of, and non-native, Falconidae should be flown free only with identification and telemetry.

Recommendations:

A. Delete "sub-species" and "cross-breeding" from definition of "hybridization" (p. 19, #600 e.);

B. Allow hybridization (inter-specific) in accordance with federal regulations, i.e. require surgical sterilization or imprinting of produced hybrids, and prohibit hybridizing threatened or endangered species (p. 14, #625 a.2.); and

C. Require any sub-species cross or hybrid of the Family Falconidae, and any species or sub-species of the Family Falconidae not native to Colorado, to have an owner identification tag and adequate telemetry equipment when flown free (p. 10, #611 C., under Death, Escape, or Release of a Raptor, and p. 14, #625 a.z., Hybridization).

2. **Sale**. The sale of captive bred raptors under federal regulations became legal on August 8, 1983. The U.S. Fish and Wildlife Service, in making sales legal, argues that breeding and selling (especially rare) raptors under the federal guidelines will benefit wild populations and serve to increase their numbers by providing a cost recovery incentive to individuals for successful propagation programs. The Service argues further that sale will alleviate human pressures on wild populations by meeting demand with captive produced birds and maintains that sale will increase the genetic diversity in captive populations by encouraging production and providing an incentive to exchange valuable breeding stock. The Task Force was disappointed to find the federal regulations to be less than clear in many cases and sometimes internally inconsistent.

The Task Force is generally very wary of commercializing Colorado's raptor resources, particularly the rarer species. The creation of new incentives, namely maximizing profit, for removing young birds or eggs from the wild, incentives which are not related to the bird's biological welfare, is contrary to the sound husbandry of a very special part of Colorado's Wildlife heritage. Serious concern was also expressed about the creation of fly-by-night or non-serious propogator intending only to make money. Yet some aspects of the Service's arguments make sense. The Task Force was relieved to discover that the Service's long-heralded seamless bands do exist and seem to have some promise of effectiveness. Reports of extremely high prices for certain raptors, especially in foreign markets, appear, however, to be accurate. Moreover, the Task Force is concerned about the possible development of bird dealers whose only goal is maximizing profit in brokering desirable birds of prey.

APPENDIX 7

THE USE OF EXOTIC PEREGRINES TO REPOPULATE LOST RANGE

By Tom J. Cade, Cornell University, 10 August 1980.

"...I believe that conservation should mean the keeping or putting in the landscape of the greatest possible ecological variety--in the world, in every continent or island, and so far, as practicable in every district. And provided the native species have their place, I see no reason why the reconstitution of committees to make them rich and interesting and stable should not include a careful selection of exotic forms ...” (ELTON, 1958)

After a lapse of 25 years, peregrine falcons are again nesting in the eastern United States. They are not descendants of the "duck hawks" that Archie Hagar, Joe Hickey, Dick Herbert, Walter Spofford, and other falcon watchers once knew, for that population of peregrines was totally extirpated by DDT poisoning. Nor are they nesting on the rocky crags overlooking the Connecticut, Hudson, and Susquehanna rivers as the duck hawks once did. Instead, they are nesting on special towers in coastal salt marshes and on buildings in cities. They are, nonetheless, bona-fide peregrines of the species Falco peregrinus, produced in captivity by parents taken from various geographic populations extraneous to the eastern United States.

From its beginning in 1970, everyone involved in the eastern peregrine recovery effort has clearly understood that restoration of a nesting population of peregrines in the East would depend upon the introduction of falcons drawn from non-indigenous sources. The issues involved were thoroughly discussed at a conference sponsored by the National Audubon Society in 1972 (Clement, 1974). They were further reviewed in great detail by the Eastern Peregrine Falcon Recovery Team in preparing the official recovery plan for the U.S. Fish and Wildlife Service (Bollengier et al., 1979), and the Office of Endangered Species conducted its own internal review of the matter in 1977 of exotic organisms (E. 0. 1987, May 24, 1977).

The Service then issued official policy statement supporting the use of non-indigenous peregrines release in the eastern U. S.., a policy that is still in force today.

Since the propriety of releasing non-indigenous or exotic falcons into the "natural ecosystem" of the eastern states continues to be questioned by sme people, and since the A.O.U. committee on resolutions specifically addressed the subject in a resolution passed last year and widely publicized, I would like to recapitulate, once more, the salient and, I believe, justifiable reasons for the course of action we have undertaken. My reasons are based on the following views about the conservation of biological diversity.

First, the Endangered Species Act rightly focuses on the species as the taxon of fundamental importance for preservation. It is not the "endangered subspecies act" or the "endangered deme act" for sound biological reasons. Species are populations the members of which freely interbreed and exchange genes in nature, or that have the potential for doing so, but that are reproductively isolated from all other populations of similar organism. Reproductive isolation is the key to the definition of species and also to the scope of the need for preservation, because all members of a species, regardless of how widespread or how nmy populations have been described by taxonomists as "subspecies," share a closed, cohesive,.cdadapted gene pool and a conmn epigenetic system of phenotypic development (Mayr,1963; Selander, 1971). To be sure, a wide-ranging species such as the peregrine falconlis likely to consist of a number of "ecotypes" that are to some degree specially adapted to local enviroments, but if the work of Corbin (1977) and others who have been studying "genetic distance" among avian taxa applies to falcons, then probably as mch as 90 to 95 per cent of the total genetic diversity of the peregrine falcon is shared in conmn by all local breeding populations. This estimate of similarity led Corbin (op. cit.) to conlude that "It is likely that coadapted gene pools of birds differ somewhat among geographic areas. However, the genetic identity data suggest that for management purposes the origin of individuals being used to repopulate areas following local extinctions need not be a major concern of the program."

Second, the primary purpose of work under the ESA is to restore species, as far as possible, to their original density and distribution prior to their endangerment; or if that goal is not possible, at least to secure a free-living population in some suitable range. The purpose is not necessarily or only to preserve local genotypes but to maintain the species as a population of ecologically adapted individuals and to increase their numbers in geographic regions where they have declined or disappeared.

Approximately 2.5 million square kilometres of former nesting range for peregrines now lies vacant east of the Rocky Mountains. As far as we know, the original breeding population has been totally extirpated for about 20 years. Any peregrines that become re-established as breeders within this vast range will be in some sense exotic or non-indigenous, whether they come in naturally or by human intervention.

The chances for natural re-establishment on this range are remote. The Great Plains constitute a partial barrier against dispersal frm a sparse, poorly reproducing population in the western states, and northern breeders show no proclivity to settle and nest in mid-latitude habitats over which they migrate. Thus, the situation is totally unlike that in Great Britain, where a resident population reduced to about 44 per cent of its original numbers has shown a dramatic recovery since 1963 (D. Ratcliffe, in press).

There are three ways to go about establishing a new population.

A. We can try to discover the existing peregrine population with the greatest number of genetic similarities to the extinct duck hawk and use that stock for our introductions, in the expectation that such falcons will have the maximum possible fitness for establishment in the East. Based on geographic proximity (since we know nothing about the actual gene pools), peregrines from Labrador might the closest ones; based on morphological similarities, those from northern Alberta might be. Unfortunately, all such potential candidates are themselves severely endangered, and the removal of individuals from these populations for use in an eastern recovery program would meet strong resistance.

B. We can look for peregrines that are the closest ecological counterparts of the former eastern birds and try them. None of the existing North American populations really qualifies as well as, say, French or German peregrines do. But they are exotics, and moreover they are also severely endangered.

C. A third possibility put forth by William Drury (1974) and Ian Nisbet (see Clement, 1974) represents a refreshing counter to the objections often raised about "exotics" and "mongrelization" of races. They suggest that breeders of captive peregrines should deliberately mix their stocks to achieve the greatest possible degree of genetic variability in the genotypes and then to release these "hybridized" individuals into the vacant breeding range and let natural selection pick those individuals that are fit for the present environment of the East. Such a procedure recognizes our inability to determine a priori which kinds of peregrines are adapted for survival and reproduction in the current eastern environment and also comprehends the severe problems of inbreeding that often occur in small populations of animals, captive and wild (Ralls et al. 1979). (It is worth calling attention here to the elaborate ways in which birds have evolved social behaviours that prevent inbreeding; see Koenig and Pitelka, 1979).

Following Drury's lead, our basic working assumption has been that if we can release enough individual peregrines with some degree of fitness for the eastern environment, then natural selection will have a chance to work toward optimum fitness for the eastern environment, so that after several generations a well-adapted population of peregrines will emerge. If the same selective forces that produced the original duck hawks are still operative, then it is reasonable to predict that the new population will converge genetically and phenotypically on the old; if, as seems more likely, new and different selective forces are now associated with the much altered eastern environment, then a somewhat different peregrine will result. The difference will not be noticeable to 99.9 per cent of the people who watch peregrines, and the new population will still belong to the closed gene pool that is represented by individuals of the species Falco peregrinus.

Since 1975 we have released 272 peregrines in the eastern United States. They represent genotypes derived from breeding populations in Spain, Scotland, Chile, the Canadian tundra and taiga, the Alaskan tundra and taiga, the Aleutian Islands, the Queen Charlotte Islands, and California. Many of these released peregrines have not only managed to survive in the eastern states but have also returned as adults to the environs where they were first established. Five pairs have formed, two have successfully produced young of their own this year, and a third has reared fostered young. In addition, one female has paired with a wild male at an eyrie in southern Quebec, and she produced two young in 1980.

The genetic backgrounds of these successfully established birds are as follows. The female in Baltimore is a "half -breed" between a California male and a Chilean female; she is mated with a male of Nearctic tundra-taiga origins. The breeding pair in Brigantine NWR consists of a female derived from the Queen Charlotte Islands (Peale's falcon) and another half-breed male of California-Chilean extraction. The Manahawkin breeding pair consists of an Alaskan tundra-taiga male and a female of mixed Alaskan tundra-Queen Charlotte Island parentage. The Sedge Island male is Spanish, the female, Nearctic tundra. The new birds in Atlantic City have not yet been individually identified. The female in Quebec is either of tundra origin or a tundra-taiga mixture; she has not been individually identified either.

Despite their diverse genetic backgrounds, these successfully established peregrines have converged remarkably close in their main biological habits to the former duck hawks. First of all, they are not highly migratory-- some are quite sedentary-- despite the fact that many of them derive from populations that are highly migratory in their natural ranges. Our most southerly reports so far are one bird seen in the Florida Keys and another that was trapped illegally by a gang of Germans on the Mexican Gulf coast. By contrast, the Canadians, who have been releasing peregrines in northern Alberta and other northern locales, have had several of their birds reported from as far away as Mexico City and Belize south into northern South America (R. Pyfe, in litt.), exactly where one would expect them to go, following the natural migratory habits of the populations into which they have been introduced. Our most distant summer returns have been in southwestern Saskatchewan and, possibly, the west side of James Bay just south of Churchill.

So far, based on five nestings by three females, the timing of reproduction corresponds closely to the late March-April period of egg-laying that characterized the breeding season of the former duck hawks. Response to photoperiod and other seasonal timers of reproduction does not seem to be precisely influenced by genetic background, and earlier concerns about the complexity of the natural photoperiods experienced by the Arctic migratory peregrines, for example, have proved to be groundless.

The released peregrines have adopted trophic relations virtually identical to those of the old duck hawks, too. Around their nests they feed heavily on blue jays and other small woodland birds and on feral pigeons and mourning doves. In coastal environments, especially in late summer, fall, and winter, they feed on a wide variety of shorebirds and on some ducks, as well as on pigeons.

The peregrine is a well-known generalist and opportunist, and it appears that there is sufficient behavioural and physiological plasticity built into the phenotype, so that adaptive adjustments to specific environmental conditions can be made regardless of the precise allelic composition of the genotype. This plasticity should make it much easier to establish a founding population from exogenous sources than would be the case were the genotypes highly selected to fit specific environmental configurations.

When possible, it probably is wisest to release only birds from indigenous stock, assuming that a large enough sample exists to avoid problems of inbreeding, as we are doing in our Rocky Mountain peregrine program. This rule can be carried to gross and unnatural extremes, however, when, for example, people insist that only peregrines from New Mexico should be released in New Mexico, or only Alberta birds in Alberta, Swedish birds in Sweden, and, of course, only Falco peregrinus germanicus in Germany--as though these political boundaries have some deep biological significance to peregrines. It could be that only falcons from western montane habitat should be released in the mountains of Colorado, or only coastal dwelling peregrines on the sea-cliffs of California; but even this ecotypic principle appears to have exceptions, judging from our experience in releasing a variety of ecotypes in the eastern states.

Ornithologists and conservationists mzt learn to deal with the world the way it really is. It is man-dominated, and it will only become more so. There is no such thing as a "natural ecosystem," if by that term one means an ecosystem unaffected by man's activities and by the introduction of exotic plants and animals. Many forms of life face extinction in the next two decades. In our efforts to maintain the maximum possible diversity of living things, we should not exclude the intelligently considered and careful introduction of exotica into new areas, as Charles Elton (1958) recognized same time ago in his little book on the invasions of animals and plants. The natural world is not the way it was in Britain before the arrival of civilized man; but there is still an out-of-doors full of a variety of plants and animals. The English experience with the naturalization of about 80 species of exotic vertebrates (Lever, 1977) shows that there are many benign benefits from their presence in the fauna, as well as some problems. If the California condor can only survive in the out-of-doors through introduction onto Santa Cruz Island, for example, or the Mauritius kestrel, on Reunion, those compromises are more acceptable, it seems to me, than extinction.

The notion that "endangered gene pools" of local populations are somehow pure and sacrosanct, and should be protected against gene exchange with other populations of the species, needs to be weighed carefully against the well-known problems of inbreeding depression encountered by small, relict populations and the known benefits of increased heterozygosity and heterosis from outbreeding. What are we to do about the "gene pool" of the dusky seaside sparrow, which apparently is now represented only by male genotypes? It might be saved and reconstituted by natural selection if females from some other seaside sparrow population were introduced into the Dusky's habitat, assuming that the habitat can still support a breeding population.

REFERENCES.

Bollengier, R. M., Jr., et. al. 1979. Eastern peregrine falcon recovery plan. U. S. Fish and Wildlife-Service. Mimeographed. 147 pp.
Clement, R. C. (ed.) 1974. Peregrine falcon recovery--proceedings. Audubon Conservation Report no. 4:1-36.
Corbin, K. W. 1977. Genetic diversity in avian populations. Pp. 291-302 in Endangered birds edited by S. A. Temple. University of Wisconsin Press.
Drury, W. H. 1974. Rare species. Biological Conservation 6(3):162-169.
Elton, C. 1958. The ecology of invasions by animals and plants. London: Methuen & Co., Ltd. 181 pp.
Lever, C. 1977. The naturalized animals of the British rsles. London: Hutchinson & Co. 600 pp.
Koenig, W. D., and Pitelka, F. A. 1979. Relatedness and inbreeding avoidance: Counterploys in the

communally nesting acorn woodpecker. Science 206:1103-1105.
Mayr, E. 1963. Animal species and evolution. Harvard University Press. 797 pp.
Ralls, K., Brugger, K., and Ballou, J. 1979. Inbreeding and juvenile mortality in small populations of ungulates. Science 206:1101-1103.
Selander, R. K. 1971. Systematics and speciation in birds. Pp. 57-147 in Avian biology, vol. 1 edited by D. A. Farner and J. R. King. Academic Press.

APPENDIX 8

Giving some idea of the issues as they are perceived by the parrot-keeping community.

HYBRID BIRDS: SHOULD THEY BE CREATED ON PURPOSE? SOLD?
Catherine Quinones

From the WWW 1997

'This is one topic that can generate incredibly heated arguments. The issue is whether hybrid birds (the result of the breeding of parents that belong to two different species) should be 'made' and if so, should they be sold to the public. I don't claim to have covered all the points of this discussion, by the way.

For starters, lets agree on the definition of a species. A species is defined as a group of individuals that are more related to each other than they are to other such groups, and this has come about because of genetic (reproductive) isolation. This is to say that a set of individuals (a population) have been breeding amongst themselves, and in doing so, natural selection, mutation and chance have caused each population to become genetically different from other populations (if there is migration among populations, that will have a certain effect in mixing things up.) By 'different' I mean that genetically, each population will eventually develop distinct, characteristic frequencies of alleles, with allelles being the different 'versions' of given genes. One key reason those populations remain genetically distinct is that the populations do NOT intermingle, and if they do, they trade genetic material at a very low rate (this level is arbitrarily set).

At least part of the confusion comes from Mayr's biological species concept, which spells out that the offspring of a mating among individuals belonging to different species is sterile; this DOES happen is some cases. Unfortunately, in using that definition, people often stick 'to the letter of the law' and fail to see 'the spirit of the law.' In such cases, the fertile hybrid is then seen as the 'missing link' that proves the unity of two otherwise discrete populations and the sterile individual is seen as the culmination of a series of genetic steps, the ultimate proof of true separation between the two populations. Yet, equally thorough genetic isolation can happen well before there is the production of infertile young. As long as the populations don't mate, whether that is due to behavioural, physical or geographical reasons is irrelevant: genetic exchange doesn't happen: period! Genetic isolation among populations is THE effective parameter in this discussion, as long as people are willing to define the species involved according to their behaviour and geographical range in their natural, UNDISTURBED habitats.

When we take up the discussion of whether two individuals capable of mating and producing viable, non-sterile offspring are the same species or not, we must decide WHY WE CARE about the outcome of the argument. To some people, the relevance hails to their belief that allowing a mating in captivity that would never happen in the wild IS doing a disservice to the evolutionary trajectory of each species/population in question. Alternatively, others argue that the fact that the breeding animals are no longer in their natural habitat already introduced a very chaotic factor into the population's genetic futures, and that anything else that may happen in captivity and which doesn't directly involve the wild populations is irrelevant to the future of the wild populations. Obviously, the people that support the first interpretation oppose hybridisation in captivity, while the others don't. I am not trying to convince anyone that hybridisation in captivity is good or evil; I'm here simply trying to summarise the arguments offered by both sides.

There are some incontrovertible facts that also affect this discussion: many populations of wild birds are in imment danger of extinction due to the loss of their habitat. Even if sufficient habitat was secured and a population was established, population genetics models predict that, unless the population is sufficiently large, it will eventually become extinct due to inbreeding (which accelerates the expression of inheritable characteristics, whether they are good or bad.) Another fact is that there are representatives of at least some of these species being kept in captivity, and that some or most of these individuals are capable of breeding.

The following are arguments commonly offered by people who oppose the creation and sale of hybrids in captivity:

- Each bird that is bred to an individual of another species COULD have been breeding with a member of its own species and creating young that can help maintain genetic variability. (Remember that birds must form a bond with their mate: this takes time and is different from the more 'casual' mating rituals of other species).
- Each non-hybridised individual we have is a vessel that stores valuable genetic information. This genetic information may be used in the future to help natural populations recover from the damage that has been done by human intrusion (in the form of hunting, capturing birds for the pet trade, and destruction of habitat).
- 'Pure' (non-hybrid) birds are more beautiful that any hybrids anybody can create. Hybrids are aberrations that were not 'meant to be.'
- If hybridisation doesn't occur in the wild, it shouldn't be allowed to occur in captivity.
- We still don't know a lot about breeding birds in captivity, in particular about the nutritional requirements of baby birds, and we may be using nutritionally incomplete formulae. Hybrid birds may have different requirements from what non-hybrids of either parent species are believed to need, and because of our ignorance we may not properly nurture hybrid offspring.
- There is no way to ENSURE that a hybrid bird will not be bred. Even if the owner swears, they won't breed the bird, unforeseen circumstances may come into play. Ask any breeder and they will tell you that many of their breeding birds were formerly pets: that means a lot of birds DO get passed on to others. The same thing may happen with a hybrid, and the new owner may not be as careful about upholding the promise not to breed the bird.
- The reports of hybrid parrots occurring in nature are rare. Many such matings may have occurred due to human intervention, or disturbance of natural habitats, or to people facilitating the mating of animals that would otherwise prefer to mate with their own species. May such reports are anecdotal and unverified. Also, hybrids are rare and only occur in the zone where the geographic boundaries of two species meet. Hybridisation s NOT a common occurrence nor is it part of the 'natural scheme of things' in particular when the species involved DO NOT have overlapping geographical ranges!

People who don't think creating hybrids is a problem offer the following counterarguments (numbered in correspondence to the item they dispute):

- Not all birds kept in captivity are capable of breeding. Hand-fed birds in particular seem to have a high incidence of showing no interest in bonding with members of their own species. Even if they were capable of breeding, their owners may not be interested in allowing them to be bred. Because of these variables, it is not truthful to say that each pet bird counts in this conservation effort.
- There is no unified program controlling the matings that take place in captivity. For the most part, no records were kept of where the initial breeding stock originated, so for all practical purposes we may have lots of hybrids in the pet trade that are believed to be 'pure' representatives of one species or another. If the anti-hybridisation people don't feel those distinctions are important, then they should be just as happy with repopulating the habitats with whatever parrots can be had, regardless of their species or of whether they are hybrids.
- Beauty is in the eye of the beholder, and some people DO like the colouration of some hybrids. For instance, there are many colour mutations in some species of captive birds (e.g. budgerigars) that, although they didn't originate from hybridisation, are very beautiful in their own right. Hybridisation (mixing of genetic material from two distinct groups or species) has had a place in the domestication of every grain we eat and also played its part in the domestication of most or all of our farm and companion animals. Hybridisation has been a key part in the domestication process and perhaps it will help us create pet birds that are more comfortable and happier in a human home.
- There are lots of things that don't occur in the wild, like having a veterinarian care for the animals, and offering a balanced diet, and keeping the birds in human homes. Or keeping birds in cages and clipping their wings. Captivity IS an unnatural circumstance, and whatever birds are bred in captivity are NOT 'playing by the rules' that regulate the lives of wild birds. Because of this, we may in fact be breeding birds that won't have what it takes to survive in the wild.
- Hybrid chicks seem to be doing just fine. If they weren't, they wouldn't be for sale, and we wouldn't be having this discussion, right?
- Hybrids occur in nature. Hybridisation is natural. Don't accuse me of failing to care for my bird for the length of its lifespan, or of providing for its care if I can't do so, you don't know me, blah blah blah etc.
- There aren't very many hybrids being created, therefore their numbers don't pose a threat to any 'domestic breeding for future repopulation' efforts. Besides, there will be no return to the natural world as it was, so we must start talking about modern evolution, which happens when humans intervene.

The counter-counter argument to that is something along the lines of 'fine, even if all that is true, AND the world is going to hell in a hand-basket, AND there is a hole in the ozone, AND the rainforests are gone, not creating hybrids AT LEAST DOESN'T COMPOUND ON THE PROBLEM and COULD help preserve species as we know them.'

As it stands, making, selling, nor owning hybrids is illegal. I think most rational people can see that there ARE arguments for both 'pro' and 'con.' Ultimately, as long as there is a market for hybrids, there will be hybrids. As is, I can't imagine domestic breeders as a whole 'saving' any wild populations via their breeding stock because of point #2 above. As long as there is no agreed, encompassing course of action, all we have is a bunch of people running their own breeding and domestication programs (programs that may include inbreeding, hybridisation, breeding of unsuitable or unhealthy birds, dubious record keeping...) Which is to say, the great majority of breeders (and the birds they own and produce) are NOT (and probably CAN'T be) part of pro-conservation army, because more likely than not they are breeding PETS for the pet TRADE, or at worst, are just pumping out a commodity the market demands. Most certainly they are not breeding wild birds meant to be the basis of a re-release program.

With that said, I hope people think about these issues before they buy a hybrid bird strictly on its appearance. As is the case with other purchases, people need to decide if they are OK with being part of the pro-hybridisation crowd because whenever a hybrid is purchased, the buyer IS supporting hybridisation in general. Likewise, let us all remember that the birds are NOT to blame for what is going on. Hybrids deserve as much loving care and respect as any other animal. Their owners likewise don't deserve to be ostracized because (1) they may have NOT been informed that they were buying a hybrid (both ignorance and false advertisement can be to blame on this one), or (2) they may have rescued the animal - meaning they were not directly, deliberately contributing to the demand for hybrids - and (3) because, after all, the impact of domestic hybridisation on parrot conservation hasn't been assessed.

APPENDIX 9

SOME SPECIES DEFINITIONS

From notes by

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1, 'No one definition has as yet satisfied all naturalists; yet every naturalist knows vaguely what he means when he speaks of a species' (Darwin 1859).

2. 'A species is a set of populations capable of combining with each other but not with other similar sets of populations on the basis of affinity and co-direction in ecological speciation.' (Shaposhnikov 1966: 13)

3. 'A species is a group of organisms not itself divisible by phenetic gaps resulting from concordant differences in character states (except for morphs such as those resulting from sex, caste, or age differences), but separated by such phenetic gaps from other such groups.' (Michener 1970: 28)

4. 'We may regard as a species (a) the smallest (most homogeneous) cluster that can be recognised upon some given criterion as being distinct from other such clusters, or (b) a phenetic group of a diversity somewhat below the subgenus category, whether or not it contains distinct sub clusters.' (Sneath and Sokal 1973: 365)

5. 'Somit ist die Art als das Kollektiv von Lebewesen zu bestimmen, das gemeinsam eine okologische Nische behauptet.' (von Wahlert 1973: 249)

6. 'Species may then be defined as groups of phonetically similar populations that have the capability to interbreed, and share similar ecological characteristics.' (Doyen and Slobodchikolf 1974: 240)

7. ‘Species, then, are the most extensive units in the natural economy such that reproductive competition occurs among their parts." (Ghiselin 1975: 538)

8. ‘A species is a lineage (or a closely related set of lineages) which occupies an adaptive zone minimally different from any other lineage in its range and which evolves separately from all lineages outside its range.’ (Van Valen 1976: 233)

9. 'Species are the smallest groups that are consistently and persistently distinct, and distinguishable by ordinary means.' (Cronquist 1978: 15)

10. ‘A species is a single lineage of ancestral descendant populations of organisms which maintains its identity from other such lineages and which has its own evolutionary tendencies and historical fate." (Wiley 1978: 18)

11. ‘A ‘species’ is merely a population or group of populations defined by one or more apomorphous features, it is also the smallest natural aggregation of individuals with a specifiable geographic integrity that can be defined by any current set of analytical techniques.' (Rosen 1979: 277)

12. ‘A species is a group of animals or plants all of which are similar enough in form to be considered as minor variations of the same organism. Members of the group normally interbreed and reproduce their own kind over considerable periods of time.' (Trueman 1979: 764)

13. 'A species is a diagnosable cluster of individuals within which there is a parental pattern of ancestry and descent, beyond which there is not, and which exhibits a pattern of phylogenetic ancestry and descent among units of like kind.' (Eldredge and Cracraft 1980: 92)

14. ‘Species are simply the smallest detected samples of self-perpetuating organisms that have unique sets of characters.' (Nelson and Platnick 1981: 12)

15. ‘Each species is an internally similar part of a phylogenetic tree." (Willis 1981: 84)

16. 'We can, therefore, regard as a species that most inclusive population of individual biparental organisms which share a conunon fertilization system." (Paterson 1985: 25)

17. ‘An ‘evolutionary species’ is a single lineage of ancestor-descendant populations which maintains its identity from other such lineages and which has its own evolutionary tendencies and historical fate.’ (Wiley 1978: modified from Simpson 1961)

18. ‘A species is what a good taxonomist says it is.' (anon.)

19. ‘At the outset I confess a disbelief in species, as that word is commonly understood to refer to the basic taxonomic unit or to the taxonomic unit of evolution... There seem to be no basic taxonomic units and no particular taxonomic unit of evolution... and as Agassiz said in 1859 'species do not exist in nature in a different way from the higher groups’ (Nelson 1989).

20. '... species as the most inclusive group of organisms having the potential for genetic and/or demographic exchangeability' (Templeton (1989).

2I. ' a species is 'the smallest aggregation of populations (sexual) or lineages (asexual) diagnosable by a unique combination of character states in comparable individuals (semaphoronts)’ (Nixon and Wheeler 1990).

22. Species 'refer to groups of actually or potentially interbreeding populations isolated by intrinsic reproductive barriers from other such groups. Evidence for reproductive barriers will involve concordant genetic differences among the populations involved [...] Subspecies are groups of

actually or potentially interbreeding populations phylogenetically distinguishable from, but reproductively compatible with, other such groups, Importantly, the evidence for phylogpnetic distinction must normally come from the concordant distributions of multiple, independent, genetically based traits' (Avise and Ball 1990).

23. ‘Species are groups of actually or potentially interbreeding natural populations, which are reproductively isolated from other such groups' (Mayr 1942).

24. 'A species is a reproductive community of populations (reproductively isolated from others) that occupies a specific niche in nature' (Mayr 1982).

25. 'A species is the smallest diagnosable cluster of individual organisms within which there is a parental pattern of ancestry and descent' (Cracraft 1983).

26. ‘Species are "lineages whose components (if distinguishable) are not incontrovertibly on different phylogenetic trajectories (i.e., sublineages, if distinguishable, are reproductively compatible), as long as these sublineages do not form a paraphyletic group in recovered history. [...] The species category ... would represent the largest entities that have evolved whose parts, if distinguishable, are not likely to be on dilterent phylogenetic trajectories' (Frost and Hillis 1990).

27. 'if a given historical group of hybridogens is persistent and is not affecting the evolutionary trajectory of its Mendelian ancestor (as indicated by biogeography, habitat preferences, or genetic divergence), it should be considered a separate species' (Echelle 1990).

28. ‘A species is the 'smallest recognizable monophyletic or unresolved unit’’ (Donoghue 1985). [see also de Quciroz, K. & M. J. Donoghue. 1988]

29. 'Phylogenetic species can be delimited by a procedure (population aggregation analysis) that involves a search for fixed differences among local populations, followed by successive rounds of aggregation of populations and previously aggregated population groups that are not distinct from each other [...] descent relationships among [phylogenetic species] must be hierarchic'. (Davis and Nixon 1992).

30. See # 1.

References

Avise, J. C., & R. M. Ball. 1990. Principles of genealogical concordance in species concepts and biological taxonomy. Oxford Surveys Evol. Biol. 7:45-67.

Cronquist, A. 1978. Once Again, What is a Species? In: Biosystematics in Agriculture. Ed. by Romberger, J. A. pp. 3-20.

Cracraft, J. 1983. Species concepts and speciation analysis. Current Ornithology 1: 159-187.

Darwin, C. 1859. On the origin of species. London: John Murray.

Davis, J. I. & K. C. Nixon. 1992. Populations, genetic variation, and the delimitation of phylogenetic species. Syst. Biol. 41:412-435.

de Queiroz, K. & M. J. Donoghue. 1988, Phylogenetic systematics and the species problem. Cladistics 4:317-338.

Donoghue, M. J. 1985. A critique of the biological species concept and recommendations for a phylogenctic alternative. The Bryologist 88:172181.

Doyen, J. T., & C. N. Slobodchikoff. 1974. An operational approach to species classification. Syst. Zool. 23:239-247.

Echelle, A. A. 1990. In defense of the phylogenetic species concept and the ontological status of hybtidogenetic taxa. Herpetologica 46:109-113.

Eldredge, N. & J. Cracraft. 1980. Phylogenetic Patterns and the Evolutionary Process. New York. Columbia Univ. Press.

Frost, D. R, & D. M. Hillis. 1990. Species in concept and practice: herpetological applications. Herpetologica 46:87-104.

Ghiselin, M. T. 1975. A radical solution to the species problem. Syst. Zool. 23:536-544.

Mayr, E. 1942. Systematics and the Origin of Species. Columbia Univ. Press.

Mayr, E. 1982. The Growth of Biological Thought. BelknapPress, Harvard University.

Michener, C. D. 1970. Diverse Approaches to Systematics. Evolut. Biol. 4: 1 38.

Nelson, G. 1989. Species and taxa: systematics and evolution. Pp. 60-84 in D. Otte and J. A. Endler (eds.), Speciation and its consequences. Sinauer Assoc. Inc., Sunderland, Mass.

Nelson, G. & N. Platnick. 1981. Systematics and Biogeography. New York. Columbia Univ. Press.

Nixon, K. C., & Q. D. Wheeler. 1990. An amplification of the phylogenctic species concept. Cladistics 6: 211-223.

Paterson, H. E. H. 1985. The Recognition Concept of Species. In: Species and Speciation. Ed. by Vrba, E. S. olt. cit pp. 21-29.

Rosen, D. E. 1979. Fishes from the uplands and intennontane basins of Guatemala: revisionary studies aid comparative geography. Bull. Am. Mus. Nat. Hist. 162:267-376.

Shaposhnikov, G. Ch. 1966. The origin and the breakdown of reproductive isolation and the species criterion. Entomol. Rev. 45:1-18.

Sneath, P. H. A., & R. R. Sokal. 1973. Numerical Taxonomy. San Francisco. W. H. Freeman.

Templeton, A. R. 1989. The meaning of species and speciation: a genetic perspective. Pp. 3-27 in D. Otte and J. A. Endler (eds.), Speciation and its consequences. Sinauer Assoc. Inc., Sunderland, Mass.

Trueman, E. R. 1979. Species concept. In: The Encyclopedia of Paleontology. Ed. by Fairbridge, R. W.; Jablonski, D., Stroudsburg, Pa.: Dowden, Hutchinson & Ross. pp. 764-767.

Vaten, L. van. 1976. Ecological species, multispecies, and oaks. Taxon 25:233-239.

Wahlert, G. von. 1973. Phylogenie als okologischer Proecls. Naturwiss. Rundschau 26:247-254.

Wiley, E. 0. 1978. The evolutionary species concept reconsidered. Syst. Zool. 27:17-26.

1981. Phylogenetics-The Theory and Practice of Phylogenetic Systematics. New York. J. Wiley.

Willis, E. 0. 1981. Is a species an interbreeding unit, or an internally similar part of a phylogenetic tree? Syst. Zool. 30:84-85.

[1] Heywood, 'Invasions by terrestrial plants', 40; US Congress, Harmful Non-indigenous Species, 95. See also Drake, J. A. et al. 1989. Biological Invasions: A Global Perspective. SCOPE Report 37, John Wiley, New York.

[2] Ebenhard, T. 1988. Introduced Birds and Mammals and their Ecological Effects. Viltrevy 13 (4): 3-76; see also Long, J.L. 1981. Introduced Birds of the World, David and Charles, London.

* Note: Saar's 1994 report refers to hybridisation in captivity, not in the wild. (Bednarek, pers. comm.))

* Note: see case history of the female (Ed).

[3] See section 13

[4]Lever, C. 1977. The naturalised animals of the British Isles. Hutchinson, London

[5] Recommendation No. R(84)14 adopted on 21 June 1984

[6] Recommendation No. R(85)15 adopted on 23 September 1985

[7] Biodiversity: The UK Steering Group Report

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