A REVIEW OF CROSS-FOSTERING IN BIRDS OF PREY

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ABSTRACT

Cross-fostering, or the act of fostering one species to another, has been evaluated both in the field, i.e. will raptors accept and care for eggs/young of another species?, and in the laboratory, i.e. what is the effect of cross-fostering on subsequent mate choice? The following combinations are feasible: falcon to accipiter, falcon to falcon, and falcon to buteo. Of 48 nestlings cross-fostered at various ages up to 21 days old, a 40 percent mortality occurred, but was incidental to the technique itself.

In laboratory experimentation with two species of captive kestrel, either species, when wintered with their foster parents, showed a mate preference for the foster parent type. When cross-fostered falcons were wintered in visual isolation, approximately 50 percent of the preferences were in favour of the foster parent type. These findings were substantiated by numerous earlier studies involving non-raptorial species, i.e. at least nine species in the laboratory and four in the field. Hence, cross-fostering is not recommended at present as a technique for releasing nestling raptors into the wild on a large-scale basis. Further testing is being pursued in the field and laboratory.

INTRODUCTION

Cross-fostering, or the act of fostering one species to another, is by no means a novel technique in avian circles, as experimentation in the laboratory and field has included at least nine and four non-raptorial species respectively, as summarized in *Table 1*. Most of this experimentation was aimed at examining imprinting mechanisms. Recently, however, with the advent of captive-breeding and release programmes aimed at restoring endangered species such as the Peregrine (*Falco peregrinus*), cross-fostering has aroused much interest as a potential management tool for releasing captive-bred falcons into the wild. It offers an easy solution to the more expensive, time-consuming hacking techniques by simply allowing wild raptor parents to fledge the young birds as naturally as possible. It also may circumvent any problems with excessive taming due to over-exposure to humans. However, in deciding whether to implement the technique on a large scale, some immediate questions come to mind.

Table 1: A summary of cross-fostering studies in non-raptorial species.

Laboratory
Chickens *vs* turkeys (Schein *et al.* 1962)
White *vs* Brown Leghorns (Lill & Wood-Gush 1965)
Red *vs* Grey Junglefowl (Morejohn 1968)
Zebra *vs* Bengalese Finches (Immelman 1970, Sonneman & Solanders 1972)
Lesser Snow Geese (White *vs* Blue (Cooke *et al.* 1972)
Japanese Quail (Normal *vs* Albino) (Gallagher & Ash 1978)
Mallards (White *vs* Normal) (Klint 1978)
Mallards (Wild *vs* Domesticated) (Cheng *et al.* 1978)
Field
House *vs* Tree Sparrows (Cheke 1969)
Herring *vs* Lesser Black-backed Gulls (Harris 1970)
Herring *vs* Great Black-backed Gulls (Firth 1974)

First, will the parents of one raptor species accept and care for eggs and young of another species in the wild? Second, what will be the effects of cross-fostering on the young in terms of:

(i) physical and physiological quality, e.g. rate of growth, physiological make-up, etc.

(ii) behavioural quality, e.g. future mate choice, future nest type selection, foraging methods and prey type selection, etc.

In order to answer these questions, experiments were undertaken by the authors in both field (W.B., R.W.F.) and laboratory (D.M.B.). Some initial results in cross-fostering captive falcons provided a basis for the field tests.

SPECIES INVOLVED

To date, experiments in the field involving at least eight raptor species (*Table 2*) show that the following were successful: falcon to accipiter, falcon to falcon, and falcon to buteo. Buteo to falcon was initially unsuccessful, as all the young hawks fell to their deaths from a cliff ledge.

Table 2: A summary of cross-fostered raptors in the wild.

Cross-fostered species	Foster parent species	Experimenters
Peregrine Falcons	Prairie Falcons	Cade & Dague (1977)
		Swift & Graham (unpubl. data)
	Goshawks	G. Trommer (unpubl. data)
Prairie Falcons	Red-tailed Hawks	Fyfe *et al.* (1977)
	Swainson's Hawks	Fyfe *et al.* (1977)
	Ferruginous Hawks	Fyfe *et al.* (1977)
Ferruginous Hawks	Prairie Falcons	Fyfe *et al.* (1977)
Lesser Spotted Eagles	Black Kites	Meyburg (1977)
	Common Buzzard	Meyburg (1977)

Table 3: Influence of age at fostering on survival in the wild.

	Falcon to accipiter	Falcon to buteo	Falcon to falcon	Buteo to falcon
Egg stage	3/3	—	2/3*	—
1–5 days	—	4/5	—	0/5
10–14 days	—	14/16	3/3	—
21 days	—	—	7/24	—

Note: * Eggs removed after 16 days; 2 young reared.

Cross-fostering can be achieved at various stages of development ranging from eggs to at least 21-day old young (*Table 3*). Mortality has been inordinately high (40%) but this may not be directly attributed to cross-fostering itself. Of forty-eight nestlings cross-fostered to wild parents, eight were forced from the nest by insect infestations, predators or reasons unknown; three were killed and eaten by predators; three were lost in stormy weather; three succumbed to disease and three disappeared. In no cases were the young rejected by the parents. In summary, the acceptance and care of eggs and young between hetero-specific raptors is not a major problem, facilitating use of cross-fostering in management.

OFFSPRING QUALITY

We now examine evidence concerning the influence of cross-fostering on the quality of the offspring. Before discussing sexual imprinting problems, some comments on diet and nest type selection in cross-fostered raptors are warranted. The adequacy of the diet would seem to be relatively important in terms of both behavioural and nutritional implications. Peregrines raised by Prairie Falcons (*Falco mexicanus*) at locations where mammals and reptiles were predominantly fed appeared thin, implying malnourishment. One cannot really evaluate the extent of this problem until data become available on the nutritional importance of various diets to raptors, as well as relative differences in parental feeding behaviour on growth rates of cross-fostered young. Behaviourally speaking, it would seem ludicrous to cross-foster one raptor species to another where the physiological tools necessary to catch, eat and digest a particular food item favoured by the foster parent were not available to the cross-fostered young. Whether fledged young actually imprint on the food types eaten at the nestling stage is not yet known. Similarly, it would seem ridiculous to cross-foster kestrels to eagle-sized birds, although kestrels have been reared by buzzards (Cupper & Cupper 1981) and Peregrines (Ratcliffe 1980) in the wild.

In some cases, efforts to cross-foster young to unlikely nest types, e.g. cliff-nesting falcons into buteo tree nests, have been deliberate (R.W.F., Trommer, unpubl. data) in order to imprint cross-fostered raptors on abundant nest types, thus maximizing nest site availability. Whether raptors actually imprint on the nest type they were raised in remains to be further investigated.

Potentially detrimental to the practical application of cross-fostering is the possibility that the young may select their foster parent type as a mate, perhaps hybridize with it or simply develop as behaviourally sterile individuals. Unfortunately, high mortality among wild falcons, and the number of variables involved, has prevented any answers to this major question. In most cases in *Table 1*, the young did imprint on the foster parent type. This was particularly evident in

Table 4: Mate preferences of two species of cross-fostered kestrels after winter isolation. Categories in column one are as follows: AK = American kestrel; 1 = 0 to 4 days; N = no sibling; EK = European kestrel; 4 = 16 to 24 days; S = one sibling.

	Definite choice		Preference	
Categories	Foster	Conspecific	Foster	Conspecific
AK ♂ 1 S	1	0	0	0
AK ♂ 4 S	2	0	0	1
AK ♂ 1 N	0	1	0	0
AK ♀ 1 S	0	0	0	1
AK ♀ 4 S	0	1	0	0
EK ♂ 1 S	0	1	2	2
EK ♂ 4 S	0	3	0	0
EK ♂ 1 N	0	1	1	0
EK ♀ 1 S	1	0	1	0

No data for: AK ♂ 4 N
AK ♀ 1 N
AK ♀ 4 N
EK ♂ 4 N
EK ♀ 4 S
EK ♂ 1 N
EK ♀ 4 N

Harris' (1970) work where wild gull species cross-fostered to one another hybridized and also showed abnormal migration patterns.

In an effort to provide some answers to this question, cross-fostering experiments with two species of captive kestrel, *Falco sparverius* and *F. tinnunculus*, were undertaken by D.M.B. at McGill University in 1978. Even in controlled laboratory conditions, the number of variables are many, i.e. genotype, sex, number and genotype of siblings, age at fostering, length of exposure, wintering conditions, test conditions, onset and length of testing, and reversibility of imprinting.

The techniques for cross-fostering and subsequent mate selection tests have been described earlier (Bird & Goldblatt 1981). Generally, members of each species were fostered to the other at either 0–4 days or 16–24 days of age, and either with or without a single sibling. In contrast to the birds being kept together as a family unit throughout winter (Bird & Goldblatt 1981), all test birds were isolated during the winter months from members of either species in an effort to naturalize their situation. Mate choice tests were conducted the following spring since both species are able to breed at this age (some exceptions occur with *F. tinnunculus*). Each test bird was simultaneously exposed to American kestrel (AK) and European kestrel (EK), choice birds tethered and separated by an opaque divider and supplied with a nest box.

The test birds which were wintered with their foster family unit, both males and females, generally showed a preference for the foster parent type at various ages of cross-fostering. Although testing is continuing in 1982, *Table 4* gives an update of the choices and preferences of members of both species cross-fostered and isolated in winter in 1980 and tested in 1981, and indicates the categories for which data are not yet available. *Table 5* summarizes the 1981 findings with respect to the role of species, sex, age at fostering and sibling presence on the mate preference

Table 5: Role of species, sex, age at fostering, and sibling presence on subsequent mate preference in two species of cross-fostered kestrels.

		Foster	Conspecific
Species	AK	3	4
	EK	5	7
Sex	male	7	8
	female	2	2
Age at fostering	0 to 4 days	6	6
	16 to 24 days	2	5
Sibling presence	none	1	2
	one	7	9

of both species. So far, no distinct pattern has emerged, but one thing has become quite obvious. Approximately 50 percent of the preferences were in favour of the foster parent type, suggesting a 50:50 risk involved with cross-fostering one raptor species to another with or without sibling and whether at one day or three weeks of age. Whether these findings will be altered to some degree with increased sample sizes or by increasing the number of siblings in the nest remains to be investigated. Several birds cross-fostered in 1979 and tested in both 1980 and 1981 did change their preference from the foster parent type to their conspecific type in the latter year. Whether this is a result of rejection by the former is not known.

To summarize the field and laboratory tests performed to date, cross-fostering of eggs and young from one raptor species to another can be achieved in spite of some heavy losses of young incidental to the technique itself. However, in view of the high risk of producing abnormal mate choices, as has been observed in many non-raptorial species and also shown for two captive kestrel species, we are somewhat reluctant at this time to recommend the large-scale use of cross-fostering as a means of releasing nestling raptors into the wild. Temporary cross-fostering of young, as was done by Meyburg (1977) to alleviate sibling rivalry, may not have any serious effects on later mate choices, but this was not tested. Further examination of this question is being pursued with respect to physical/physiological quality of the young, nest type and prey type selection, mate choice experiments with large falcons and, finally, mate choice tests with small falcons in the field.

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