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The significance for captive breeding programmes of fratricide and cainism in birds of prey

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As in many species, the numbers of bird of prey young which hatch from one clutch are often greater than those which are eventually reared. The youngest nestlings of a brood are often disadvantaged during feeds since, as a result of asynchronous laying, they have often hatched several days later than their oldest sibling and, because of aggression in these older nestlings, they hardly get the opportunity to feed even when the food supply is adequate. This hierarchy does, however, prevent a situation arising in which none of the nestlings receives sufficient food, since only as many young are reared as can be adequately nourished by the available food supply. This corresponds to the classic theory of 'maximum reproduction' (Lack, 1947, 1966).

In a number of species the clutch size is almost invariably of two eggs from which two young hatch, but only rarely do both survive since the older eventually causes the death of the younger. Food shortage is of no importance in such cases. In eagles the terms 'fatal sibling aggression', 'Cain and Abel conflict' and particularly 'cainism' have become established for this particular phenomenon, the most extensive studies of which have been made in the Lesser spotted eagle *Aquila pomarina* (Meyburg, 1970, 1974a, b, 1978a) and Verreaux's eagle *A. verreauxi* (Gargett, 1978, 1982). Cainism is a particular form of fratricide and, as a term, should be used only in cases where food shortage plays no part at all or is of subordinate importance. Apart from

occurring in many eagle species the phenomenon is also found in the Lammergeier *Gypaetus barbatus* (Thaler & Pechlaner, 1980; Thaler, 1981) and various other birds of prey (e.g. Wendland, 1958; Ingram, 1959; Gargett, 1970; Baranov, 1979; Lendrum, 1979; Vasiliev, 1981; Reitherman & Storrer, unpubl.) as well as cranes, gannets (boobies), skuas, penguins, cockatoos, pelicans, shoebill, etc. (e.g. Amadon, 1964; Skutch, 1967; Miller, 1973; Quale, 1976; O'Connor, 1978; Cooper, 1980). In several species, including the Golden eagle *A. chrysaetos* and the White-tailed sea eagle *Haliaeetus albicilla*, it is not possible to distinguish clearly between cainism and fratricide since the second nestling does not always die. It is not certain, therefore, that in these species cainism is occurring in the strict sense or whether food shortage is playing the dominant role (Fiedler, 1968, 1970; Hauri, 1973; Delibes *et al.*, 1975) although it seems likely that both factors are involved.

Although there has been much discussion of the phenomenon in the literature (Meyburg, 1974a; Brown *et al.,* 1977) no satisfactory explanation has yet been found and none of the theories has been generally accepted. It seems most likely that the species concerned are in a transitory stage in the evolution from a two- to a one-egg clutch, an hypothesis which receives possible support from the fact that in species where cainism occurs the second egg is regularly smaller than the first. It is probable that at an earlier stage in their evolution the species required the rearing of both young to maintain their numbers and that this is no longer the case. This idea is in agreement with the hypothesis of 'readjusted reproduction' put forward by Skutch (1967).

The aim of this paper is to discuss to what extent nestlings which would otherwise die prematurely as a result of cainism can be rescued and used in captive breeding programmes, and how this can be done without upsetting the adults' reproductive cycle or reducing the wild population. It is a problem with which the author has been concerned since 1965, with particular regard to two species of eagle, the Spanish subspecies of the Imperial eagle *A. heliaca adalberti* and the Lesser spotted eagle.

The Imperial eagle of Spain is now a seriously endangered form which has a total population of only about 50 pairs, all but one of which are confined to a small area of Spain. It has disappeared completely from Algeria and Morocco and the one pair outside Spain, in Portugal, has had no recorded breeding success. The subspecies is easily separable in both adult and juvenile plumage from its closest relative, the eastern subspecies *A. h. heliaca*, and is considered by some to be a separate species (Hiraldo *et al.,* 1976).

The Spanish Imperial eagle is typical of the species whose breeding success depends upon the available food supply. One to four eggs are laid all of which generally hatch; in 39 cases of breeding investigated in central Spain the hatching success was as follows: five times, four chicks; 14 times, three; four times, two; ten times, one; six times, none (eggs infertile or embryos perished). Although it is possible for all four hatchlings to fledge marked aggression between them usually leads to the deaths of the smaller siblings during the first two to three weeks, and certainly the youngest is practically always killed. Between 1971 and 1979 it was possible to observe closely the nest of one pair so as to monitor the events leading to the deaths of nestlings. In six out of the seven years in which the nests were checked soon after hatching, three young were known to have emerged; only in 1977 was there a two-egg clutch and in this case both young eventually fledged. In all other years the third young perished in the nest or, in four of the years, would have perished had they not been removed. In 1979 the oldest sibling was seen first to kill the smallest sibling and, two days later, the other. Birds removed from the nest were often lying already chilled on the edge of the nest and would not have lasted through the night; they were found to be significantly smaller than their siblings and clearly had no chance of survival. These birds were placed in the nests of other pairs which had infertile eggs thus considerably increasing the number of fledged young in the wild population, for example by 43% in 1972 (Meyburg & Garzón Heydt, 1973). An alternative to this procedure would be to raise the rescued young in captivity, using them as a basis for captive

breeding programmes and thereby causing no disturbance to the wild population. The prerequisite for such a scheme is a detailed knowledge of the species' biology and habits and, where possible, the habits of individual pairs. In some cases at least one nestling could be removed almost every year without reducing the reproductive output of the pairs concerned.

Our studies in Spain have shown that the breeding success, hatching dates, the number of young hatching, etc. are more or less constant in the individual pairs. For example, two pairs frequently had as many as four young, or at least three, while others invariably produced either one young or eggs which did not hatch. The pairs studied in detail proved to have a constant hatching date with a variation of at most a few days and there was therefore no need to disturb the birds by unnecessary visits. In no case did the few visits made cause any serious agitation or lead to desertion.

The Lesser spotted eagle usually lays two eggs (81·5% of all clutches), less commonly one (16·3%) and only exceptionally three (2·2%) (Meyburg, 1970). Although in most cases both eggs hatch, because of cainism it is extremely rare that both young fledge (Meyburg, 1970, 1974a, b, 1978a). In a well-studied population in the Carpathians of eastern Czechoslovakia 22 (64·7%) successfully incubated clutches produced two young and 12 (35·3%) produced only one (Svehlik & Meyburg, 1979). Cainism caused a nestling mortality of 38%, including those nests with only one young. As the second young to hatch is usually physically fully capable of survival, and will be reared if the older sibling is removed, such birds could be taken for captive breeding purposes without causing any reduction in the wild population. In central Europe most eggs hatch between 4 and 15 June; in about two out of three nests one hatchling could safely be removed. As a general rule one visit to the nest should be enough to remove the nestling but where there is any doubt the nest should be visited sooner rather than later since successful hatching can be achieved without difficulty by placing the second egg in an incubator for the final few days before hatching. The egg can be distinguished from the first to be laid because it is normally the smaller of the two.

Of the other eagle species in which cainism is known to occur the closest relative to the Lesser spotted eagle is the Greater spotted eagle *A. clanga*. It also generally lays two eggs but only exceptionally rears both young; out of 30–40 nests examined only one contained two almost-fledged young (V. M. Galushin, pers. comm.).

In at least 27 of the world's eagle species which usually lay more than one egg the last young to hatch normally dies prematurely in the nest (Meyburg, 1978b). Thus in a large number of birds of prey the second nestling could be removed without harming the wild population, something which could be of great benefit to many of the world's endangered species. The Madagascar fish eagle *Haliaeetus vociferoides*, for example, has a population presently estimated at about a dozen pairs (Meyburg, in press). The few older reports on its breeding biology seemed to indicate that cainism occurs in this species, and confirmation of this has now been received following observations on a nest near Diego Suarez (O. Langrand, pers. comm.). On 2 August 1982 the nest contained a nestling, which was one or two days old, and an already chipped egg; 15 days later there was no trace of the second nestling. It seems possible, therefore, that a captive breeding group could be established using second nestlings provided further confirmation of cainism can be obtained.

There is a certain risk in removing wild young since at least one visit to the nest must be made shortly before or after hatching. So long as the operation is quick because it is carried out with a thorough knowledge of the birds' habits, suitable technical equipment and a degree of physical fitness, the risk is slight. On the other hand, there can be no justification for removing wild young for captive breeding or reintroduction projects, particularly in species where fratricide or cainism occurs, if it is likely that these would later have fledged on their own. This should be borne in mind for projects currently under way such as the reintroduction of the Lammergeier to the Picos de Europa, Spain and of the White-tailed sea eagle to Scotland.

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