



ON CAINISM IN THE LESSER SPOTTED EAGLE (*AQUILA POMARINA*) AND A POSSIBLE EXPLANATION FOR THE PHENOMENON IN THIS AND OTHER EAGLE SPECIES

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ABSTRACT. – Detailed observations were made of Cainism (fatal Cain-and-Abel struggle) in a Lesser Spotted Eagle's (LSE; *Aquila pomarina*) nest in Slovakia from a hide in which the second chick could be closely observed from hatching to death. At a second eyrie in Germany a remote-controlled video camera was used to record on tape the events leading up to the death of the second chick. In a third case in which the strife between the siblings was studied, both chicks had clearly passed the age at which the second chick has usually perished. Here observations were conducted for several days from a blind.

The strife between Cain and Abel generally leads to the death of the second chick a few days after hatching. The food supply plays no part in this. At this time the nest contains an ample supply of prey. The following factors are responsible for Cainism in the LSE:

1. The time lapse of several days between the hatching of the two chicks, giving the first-born (Cain or C1) a more or less considerable developmental advantage.
2. Cain's greater weight at the time of hatching. It usually also hatches from the larger egg.
3. The aggressiveness of the chicks towards each other.
4. The acceptance of intimidation by the inferior chick, even when there is virtually no difference in weight (e.g. in translocation experiments), to the extent that this chick hardly ventures to take part in feedings.
5. The scant attention paid by the female to the second chick, given its smaller size and, above all, its greater clumsiness in taking food due to its retarded development, shows that it holds a waning power of attraction.

Up to now there has been much disagreement over the meaning of second-egg laying, leading as a rule to the fledging of only one young, and over the significance of Cainism within the framework of evolution in this and other eagle species. None of the attempts to explain it so far published is really convincing. One possible explanation for the phenomenon of Cainism may well be that the species is at an evolutionarily intermediate stage of transition from two-egg to one-egg clutches. For unknown reasons, and in contrast to earlier times, the raising of one young per breeding season is today sufficient to maintain the species. At a later stage in the course of its evolution this species, which at present lays a second egg clearly smaller than the first – one could regard this as vestigial – may well confine itself to laying no more than one egg per clutch.

The most interesting phenomenon in the breeding biology of the Lesser Spotted Eagle (LSE; *Aquila pomarina*) is without doubt the premature disappearance of the second chick not long after hatching. This event was first termed Cainism by Wendland (1958a), derived from the Old Testament tale of the murder of Abel by his brother Cain, since the death of the younger sibling is due to the presence of the chick that hatched first. Accordingly the first chick to hatch (C1) will here be designated as Cain and the second (C2) as Abel.

Cainism may be regarded as a special form of fratricide. The term Cainism or fatal Cain and Abel conflict should only be used for those species which practically always hatch two chicks and in which a shortage of food plays no part, or only a very subordinate one, as a cause of the second chick's death (e.g. LSE, Verreaux's or Black Eagle, *A. verreauxii*) as opposed to those species in which the smallest chicks often starve or are killed by their bigger siblings because of lack of food.



In some species (e.g. Golden Eagle, *A. chrysaetos*) it is not always clear whether one should consider such events as Cainism or Fratricide and there is certainly some overlap.

Between 1968 and 1971 I was able to carry out a study of different aspects of the LSE biology in the East Slovakian Carpathians (Meyburg 1970, 1971, Palsthy & Meyburg 1974, Svehlik & Meyburg 1979). With regard to Cainism experiments were first undertaken in order to find a way of preventing the death of the second chick and thereby help to increase population numbers. After this has been found possible (Meyburg 1971) it was attempted to discover as far as possible the reasons that usually lead to the death of the second chick. All developments from hatching to Abel's disappearance were first recorded in one case from a hide in a nearby tree in 1971 (Meyburg 1974q, b).

In 1974 I was again able to study these events at one nest in Slovakia, the results of which are here presented. Observations concerning this problem at another eyrie in Slovakia are also described. In 1992 developments in connection with Cainism at a LSE nest in Mecklenburg-Vorpommern (Northern Germany) by means of a remote-controlled Video camera were also recorded and analysed.

All statements by other authors to date have merely been based on short observations during nest controls and not on longer direct observation from blinds. (Wendland 1932, 1951, 1958a, b, 1959, Sladek 1959, Gejlikman & Unanyan 1974).

MATERIAL AND METHODS

In 1974, at a nest site in East Slovakia (Nest No. 26), the course of events in connection with cainism was closely observed from a hide, from the second chick's hatching to its disappearance. In a second case (Nest No. 044) in which the strife between the siblings was studied, both chicks had clearly passed the age at which the second chick has usually perished. Here observations were conducted for several days.

In order to avoid any disturbance during the last days before hatching the eggs in nest No. 26 were replaced by dummies and artificially reared in an incubator. After both chicks had hatched they were returned to the nest and during the following days kept under observation from a hide about 80 m distant, using a telescope (20-60 x 80 mm). The hide was situated in a low cliff a little above the nest and provided a good view of the latter's interior. It could be approached and left without the adult at the nest becoming aware. In all, 37 hours were spent in observation.

On 6 July 1974 the second nest (No. 044) was found containing two young. From their weight (on 8 July 1200 and 590 g) and emerging feathers they were estimated to be three weeks old. Hitherto I had never seen a LSE's nest in which C2 had survived for so long. As a rule C2 perishes after about one week. From 7 to 10 July I kept watch for something over 26 hours in all from a hide ca. 70 m distant. The hide was on the ground, on a slope slightly above the nest, so that a good view of the latter was to be had.

Since 1990 a project had been in operation in Mecklenburg-Vorpommern (Northern Germany) to investigate the habitat requirements, migration routes and wintering grounds of the LSE (e.g. Meyburg et al. 1995). Within the scope of this project research was also undertaken in 1991, 1992 and 1993 into its breeding and feeding ecology by means of a remote-controlled video camera. Following an already published general overview of the whole breeding cycle (Scheller & Meyburg 1998), an established case of Cainism is here described in detail. During the 1993 breeding season it was possible to trace the events leading up to the death of the second hatchling.

The studies were carried out on a pair of LSE's in an areas called Mecklenburgische Schweiz which for at least 10 years had occupied a nest on a beech tree. The nest was ca. 20 m high up in a fork of the tree. The camera was installed about 15 m away in a neighbouring tree at a height of ca. 30 m, so that a good view was obtained into the nest hollow.

The video camera, a Panasonic WV-CL 302, in its weatherproof casing, like the microphone attached to it, was firmly fixed to the tree, but its direction could be changed by remote control and it could also be zoomed. The videos were recorded at a receiving station about 600 m distant from



the nest by means of two video recorders. In this way, throughout the whole breeding period the uninterrupted course of each day's events between 4.30 a.m. and 9.30 p.m. (daylight hours) could be recorded on videotape.

RESULTS

Observations at Nest No. 26 in Slovakia. – On 10 June this nest contained two eggs (68.0 x 50.0 mm, 81 g and 62.0 x 49.5 mm, 76 g). On the following day, around 13.00 hrs, the larger egg showed a crack. On 13 June Cain finally hatched around 02.00 hrs. At that time C1 weighed 64 g. In the morning of 14 June Abel began piping its shell and finally emerged the following day around 14.00 hrs, 60 hours after its sibling. Thereafter the following observations were made: 16 June (observations from 10.10 to 18.10 hrs): At the only feeding between 16.22 and 16.38 hrs, both chicks received roughly the same number of bits of meat. The female spent the rest of the time brooding them. There was no sign of aggression between the chicks. The male for his part brought prey to the nest at 13.01, 13.28, 14.30, 15.48 and 16.22 hrs.

17 June (09.40-16.10 hrs): During the first feeding from 11.50-12.05 hrs C2 only woke up after 12 minutes and even then made no serious attempt to get fed. The feeding over, it was fiercely attacked by C1 but defended itself. During the second feeding from 15.28-15.50 hrs C1 received 14 morsels. C2 completely disregarded the feeding female, which made her first offerings to C1, but continually pecked at the head of C1, which only now and then retaliated. At the end of the feeding the female seemed to be quite helpless in the face of the mutually attacking chicks. The male brought prey at 11.50, 12.01, 12.16 and 15.38 hrs.

18 June (10.35-17.00 hrs): During the first feeding, from 13.08-13.22 hrs, C1 received 19 morsels, C2 only one. The female always presented food to C1 first although it uttered fewer cries than its sibling, and ended the feeding despite the continued strenuous begging of C2. In comparison with its older sibling this begging was quite aimless and at first made with its back to the female. Whilst C1 was poking about with its beak in the bottom of the nest C2 gave its head five vigorous pecks. At the second feeding, from 16.05-16.20 hrs, C1 showed almost no appetite, did not beg and ate only one morsel. C2 received at least 12 pieces of food and constantly pecked C1 which, however, hardly seemed to notice. Although C1 showed no interest, the female had an unmistakable tendency to feed this young first. The male brought prey at 13.28, 13.45 and 16.40 hrs.

19 June (09.10-19.00 hrs): After I had entered the hide, C1 strenuously attacked C2 before the arrival of the female. At the first feeding, 11.55-12.05 hrs, C1 received 38 morsels. C2 made no attempt to take part in the feeding, at the end of which it was vigorously attacked by its older sibling. At 12.35 hrs C1 renewed its pecking of its smaller sibling as the female only brooded them for a short while. At the second feeding, from 14.25-14.36 hrs, only C1 again took part and received 14 morsels. The male brought prey at 10.26, 12.32 and 18.11 hrs. An inspection of the eyrie at the end of observation time revealed eight whole mice with a combined weight of 261 g in the nest. C1 weighed 128 g, its sibling only 46 g, thus 12 g less than four days previously on hatching.

20 June (9.04-13.30 hrs): When the female stood up to feed at 12.54 hrs C1 immediately attacked its sibling that never stirred. The male brought prey at 10.52, 12.54 and 13.27 hrs.

21 June (14.40-16.20 hrs): The female spent the whole time brooding. The male brought a prey at 14.45 hrs.

On 23 June a visit to the nest revealed no trace of C2. Whether, as observed in a previous case (Meyburg 1974 a, b), it was partly eaten by the female and partly fed to Cain could not be ascertained. C1 weighed 266 g; four complete mice in the nest had a combined weight of 111 g.

Observations at Nest No. 044 in Slovakia. – The most important observations are summarised in Table 1. At this nest I was able to determine the interesting fact that the arrival of an adult at the



nest, irrespective of whether or not it brought food, frequently prompted C1 to attack its sibling which, at the first peck, always fled to the edge of the nest – often loudly screeching – and would even clamber onto the branches supporting the nest. These – it was in a wild cherry tree – were very thick and almost horizontal, a circumstance to which C2 probably owed its life. There Abel would remain motionless in a cringing posture with drooping wings and bowed head. The connection between the adult’s arrival and C1’s Aggression meant that C2, at most of an adult’s landings, would make a dash to the edge of the nest, if it was not there already, without C1 having shown any reaction.

Table 1. Summary of observations at Lesser Spotted Eagle eyrie No. 044 in 1974. 1 = Time of arrival of adult bird with out prey, 2 = Arrival of parent bird with prey, 3 = C2 flees, with out having been attacked by C1, 4 = feeding, 5 = Number of pieces of meat consumed by C1 and C2, 6 = C1’s aggressiveness toward its sibling.

1	2	3	4	5	6
7 July: 13.30-18.00 hrs.					
14.35		14.35			
	15.18				
15.46					
		15.55	15.55-16.10	39	63
	16.15				
16.32					
	16.35	16.35	16.35-16.44	57	1
	17.05				
17.06					
17.35	17.35	17.35	17.35-17.50	37	30
					17.37
8 July: 14.15-18.05 hrs.					
	15.55	15.55			
	16.30				16.30
17.30			17.30-17.40	45	1
17.50					17.30
9 July: 10.50-18.30 hrs.					
	11.10				
	11.43	11.43			
	13.20	13.20	13.20-14.23	175	39
					13.23
	14.55				14.20
15.28		15.28	15.28-16.22	11	111
	15.43				
	16.58				16.58
17.14			17.18-17.28	37	18
					17.14
					17.20
10 July: 08.20-17.25 hrs.					
	08.27	08.27			
	09.58	09.58			
	11.23	11.23			11.24
	12.00				12.00
13.20	13.16		13.20-13.38	58	0
13.40					
	13.45				
13.52			13.52-14.01	53	0
	14.05		14.05-14.20	24	1
15.20		15.20			
15.34					
15.46					16.05

C1’s attacks also occurred when it had a full crop and was no longer inclined to take food. On many occasions C1 pursued its sibling to the edge of the nest and C2 would then flutter to the opposite side. At times it was in this way almost driven to and fro round the nest. On 8 July, around 6.30 hrs, C2 scuttled right under the male, which had just brought in a mouse and thereupon flew off in alarm.

Aggressive behaviour by C1 was also particularly triggered by the start of feeding. While C1 was being fed C2 would stay the whole time with its back to the centre of the nest, loudly begging but not venturing to turn and watch. Its intimidation went so far that many times the female was unable to feed it although with astonishing persistence and patience she would bend down over the chick to offer it pieces of food, particularly when C1 did not want any more. Thus on 8 July at 17.47 hrs the female fed a mouse to C1 on one side of the nest, then turned to a second mouse in the middle of the nest, tore off a piece of flesh and offered this to C2 on the opposite side. C2 was begging loudly but did not dare to take the food. The female thereupon crossed the nest to feed the morsel to C1. After this procedure had been repeated several times the female eventually picked up the rest of the mouse and took it over to C1.

Events at this nest amply confirmed my previously published supposition, hitherto

based solely on observed experiments (Meyburg 1970. 1971 1974 a, b) that the acceptance of intimidation is finally decisive for the death of C2, when this is not already incurred by the other governing factors such as smaller egg size and hence smaller weight on hatching, long lapse of



time to hatch after C1 and hence relatively less skill and persistence in the taking of proffered food, as well as neglect by the female. During the 26 hours of observation C1 consumed 536 proffered pieces of meat, C2 only 264. In addition, on 10 July C1 swallowed a whole mouse and C2 a larger portion of prey.

On 14 July C2 came to grief while J. SVEHLIK was watching from the hide. C1 was fed from 11.00-11.05 hrs, then took no more and attacked C2, already sitting on the rim of the nest, which then fluttered to the opposite side and fell. It survived this fall from a height of 12.4 m without injury. In six days its weight had increased by only 10 g. It was thereafter taken into captivity and by 4 August had reached a weight of 1205 g. Even at this date it still did not dare to eat so long as the other young eagles, taken into captivity at the same time, were visible.

Events at the nest in Germany recorded on video tape

Hatching of the chicks. – C1 emerged from its shell on 12 June 1992 between 14.22 and 15.05 hrs, the second chick 3 1/2 days later between 21.37 hrs on 15 June and 6.07 hrs on 16 June.

During Cain's hatching the female occasionally stood up, turned the egg once and removed all traces of fluid and membrane as they came out of it. The chick worked its way out of the shell entirely on its own; no move to help by the female could be discerned.

Abel's first day. – On their first days of life both chicks were supplied with food. Cain was given its first meal 5 hours after hatching; Abel received its first feed on 16 June at 11.11 hrs. On its second day of life Cain was accurately pecking at the fresh sprigs of beech that the female was constantly introducing to the nest and eating bits of the leaves.

On Abel's first day (16 June) it took part to begin with in the feedings, which were exclusively carried out by the female. Out of a total of 9 feedings supplied during 16 June between 11.11 and 20.37 hrs Cain received food 8 times and Abel only 4. At the following feedings Abel could still take part during its first day of life.

On 16 June 1992 these took place at 11.11-11.15, 12.11-12.22, 18.18-18.28 and 20.33-20.37 hrs and in each case both young were fed parts of a field mouse.

On 16 June at 15.09 hrs Cain was already sitting up during the feeding of its younger sibling and at 16.30 hrs assailed Abel for the first time with blows from its beak. Despite the aggressiveness of the older chick Abel begged even harder to begin with but then evaded the attack by lying flat in the nest hollow. Cain's Aggression thereby seemed to be inhibited, at least at this early stage.

Abel's second day. – On its second day (17 June) Abel still managed once to get fed (11.58-12.01 hrs) while Cain dozed. At this time Cain assaulted Abel with its beak only during feeding times. However, from 14-09 hrs on the clearly larger and stronger older chick began to peck Abel almost continually. The latter at first tried several times to defend itself by pecking back but as it grew weaker finally abandoned the attempt. Cain's aggressive behaviour became increasingly directed at everything in its immediate surroundings (beech twigs, the female's head, its own wings and feet) but was ever more concentrated on Abel.

During feedings Cain would clamber over the now severely weakened Abel so that the latter also had no chance to beg. The female standing by made no move to intervene, nor did she make any attempt to provide the increasingly weakening chick with food. It was now no longer possible for this chick to procure anything to eat.

Abel's last three days. – On its third day of life (18 June) Abel begged for the last time and was instantly attacked by Cain, pushed aside and ceaselessly belaboured with blows from its beak. After three days of almost uninterrupted attacks, partly carried on while being brooded, Abel was so weak that in the evening of its 5th day (20 June) its life was plainly nearing its end. At this time it was virtually smothered by freshly brought sprigs of beech incorporated in the nest hollow and subsequently became invisible.

In the evening of the following day (21 June) the female with her beak plucked the dead chick



out of the depths of the nest hollow at 6.34 hrs and began at once to dismember it and feed it to its surviving sibling. The beak and head were offered first, bit-by-bit. In between the female consumed more and more pieces herself. About 15 minutes later the dead chick had been completely devoured.

DISCUSSION

The interesting phenomenon of Cainism is known to occur in at least 27 of the world's eagle species (Meyburg 1978) and a number of other larger birds of prey, e.g. Bearded Vulture (*Gypaetus barbatus*) (Thaler & Pechlaner 1980). It is also found in species of Crane, Penguin, Cockatoo, Gannet, and Pelican. Regarding the eagles it has been discussed in the literature by various authors (e.g. Meyburg 1974 a, b, Brown et al. 1977, Stinson 1979, Edwards & Collopy 1983, Simmons 1988, 1989, Gargett 1990).

Among the congeners of the LSE, eagles of the genus *Aquila*, this phenomenon is widespread. It is most pronounced in the Black Eagle, where it has been studied in depth by Gargett (1978, 1990), whereas in the Golden Eagle it is not at all unusual for the second young to survive the strife between the siblings. In this species a shortage of food may also play a part.

Comparatively little is known about Cainism in the Greater Spotted Eagle (*A. clanga*; GSE), the closest relative of the LSE. The relatively large number of accounts of the fledging of two young – V. Wendland in Glutz von Blotzheim (1971) cites 13 recorded cases – has at times been regarded as a fundamental distinction between the two species (Baumgart 1980). Manifestly the fledging of two young in the GSE represents a rare exception. V. Galushin (pers. comm.), one of the best authorities on the species, who has studied 40 nests in the Oka Nature Reserve south-east of Moscow, found two young fledged only once. Also during my own studies at numerous nests in East Poland I confirmed Cainism three times, whereas I encountered no case of two young fledging (Meyburg & Pielowski 1991 and unpubl.).

Glutow (1959) described in detail the events at two GSE nests from hatching to death of the second chick during nest control. Accordingly the procedure must be very similar in both Spotted Eagles. So far there has been no sustained direct observation of this species.

In the last decades a few instances have been known of the fledging of two young by LSEs unaided by humans. Bergmanis et al. (1999) reckoned the percentage of successful broods with two fledglings in Latvia to be 2.5% (N=118). On present-day viewing it can be asserted that both species can now and then rear two young to fledging so that this does not represent any distinguishing characteristic between the two.

Edwards & Collopy (1983) distinguish between obligatory and optional Cainism in eagles, namely species in which the second chick unflinchingly or only at times meets with a premature death in the nest. They endeavour to explain this by the time lapse and different weight at hatching, e.g. the difference in weight of the two eggs in the clutch, factors which have already been pointed out in the Lesser Spotted and other eagle species (Meyburg 1970, 1974b, 1983).

Different theories have been propounded in the literature as to the reasons for the premature death of Abel in the LSE. Based on his observations during nest control Wendland (1951) concluded "that the reason for the death of the smaller chick in the LSE lies in its being overwhelmed by the older chick". Sladek (1959) observed how Cain belaboured Abel with blows from its beak and concluded that, on account of these attacks, the latter during its short life could above all obtain no food and so starved to death, a supposition confirmed by Meyburg (1974 a, b) from a directly observed case. Indeed in this case Abel, weak from the start, was dead only 28 hours after hatching. Moreover Cain was already 6 days old when Abel hatched, resulting in a considerable difference in size.

There has never been any confirmation of the supposition by Gentz (1965) that death could also be occasioned by the fact that Abel, during its first and perhaps second day of life, needed mashed-up food whereas the female was already feeding pieces of meat to Cain.



Observations at the nest and also experiments by Meyburg (1970, 1971, 1974 a, b) led to a far-reaching clarification of the causes of the Cainism phenomenon whereby the prime cause lies in the mutual aggressiveness of the chicks, leading to the weaker chick being intimidated to such a degree that eventually it no longer dares to take part in feedings, a view confirmed by later observations and experiments by Haraszthy et al. (1996). This aggressiveness and intimidation, at all events, nearly always lead to Abel's death when other effective factors such as the different dates of hatching and Abel's smaller weight at hatching do not of themselves bring this about.

The in all three studies of Abel from hatching to death show that Cainism in the LSE can take very different courses. Whereas in some cases Abel, during its brief life, can procure no food, in others an increase in its size is evident. More broods need to be studied and, if possible, the chicks investigated daily regarding their food intake, body weight and measurements, so as to gain understanding of the whole complex process in all its variations.

I assume that the events at nest No. 26 are fairly typical of many, if not most, broods: Abel is in fact well equipped to live but due to its later hatching is severely handicapped by its delayed development in comparison with Cain, so less adroit and persistent at feeding times. This is further strengthened by the lack of attention paid to it by the female as compared to Cain. On top of this comes Cain's Aggression. In 1971 I observed a fully analogous case in an African Hawk Eagle (*Hieraaetus spilogaster*) (Meyburg 1974 a). How long Abel survives seems above all to depend on the length of time between hatchings. In species in which in a number of cases Abel is reared, this is perhaps the decisive factor, but it needs to be confirmed by direct observation.

The first decisive factor in Cainism must be the considerable difference in size between the first and second egg. From measurements of 46 clutches this averages 2.3 mm in length and 1.8 mm in width and it is assumed, of course, that the larger egg is always the first one to be laid (Meyburg 1970).

In 1972 J. Svehlik (pers. comm.) established in one case that the first chick hatched out of the smaller egg. This measured 63.7 x 51.4 mm (weight 88.5 g on 30.5.1972, the second egg being 65.5 x 51.9 mm (90.5 g). C1 hatched on 13 June and weighed 63 g; its sibling, which hatched only 65 hours later, weighed 4 g more. Further studies will show whether this was an exceptional occurrence or whether C1 does not so regularly hatch from the larger egg as has been hitherto believed. Perhaps it is similar instances which lead to the fledging of both young.

The next factor is the time lapse between hatching. It can be assumed that the lapse of two and a half days at Nest No. 26 and of three and a half days at the video recorded nest allows Abel to obtain food for several days at least. The lapse of six days observed in the first case studied (Meyburg 1974 a, b) gave Abel no chance at all.

Taken together, the following factors are responsible for Cainism in the LSE:

1. The time lapse between the hatching of the two chicks, giving Cain a more or less considerable advantage of several days' growth.
2. Cain's greater weight at hatching. As a rule it seems to hatch from the larger egg.
3. The mutual aggressiveness of the chicks.
4. The acceptance of intimidation by the inferior chick, even when there is virtually no difference in size (e. g. transfer experiments), resulting in the chick's inability to take part in feedings
5. The diminished amount of attention paid to C2 by the female on account of its smaller size and above all its greater clumsiness in taking food.

A shortage of food plays no part in all this. Indeed at this time the nest is amply provided with prey.

There is still considerable disagreement over why a second egg is laid when as a rule only one young is reared to fledging in this and other eagle species and the significance of Cainism within the evolutionary process (Meyburg 1974 b, Brown et al. 1977, Gargett 1990). According to Brown et al. (1977) none of the attempts to explain it so far published is really convincing. Sometimes it is suggested that the LSE is possibly not in a position to raise two young to be sufficiently fit to undertake the long migration on their own. Since it lives on relatively small prey, which must be



brought individually to the nest, the cost in energy is too high. Cainism thus provides a significant regulatory mechanism which is activated before Cain is faced with a shortage of food (Baumgart 1980). This hypothesis, however, does nothing to explain why only one egg is not laid, as in many raptor species. It also fails to explain Cainism in species such as the Black Eagle, which take large prey.

This theory is also disproved by all experiments, which have shown that with human help both chicks can be reared to fledging (Meyburg 1971, Haraszthy et al. 1996, M. Stubbe pers. comm.). In more fully studied cases it was found that also after fledging both young were amply provided with food. This was clearly observed, for example, by D. Hummel (pers. comm.) in the Hakel (Sachsen-Anhalt, Germany). Both young eagles were often so sated that they would take no prey brought by their parents. In the Hakel, in several instances, both young eagles fledged with the help of M. Stubbe and fellow-workers. In Hungary, in one case, a pair had to feed three young because one Abel could not be replaced in its own nest. Observations during the post-fledging dependence period showed that the adults so intensified the rate of feeding that all three young were fully satisfied (Haraszthy 1996).

Against Baumgart's (1980) views, finally, remains the existence of Cainism in large species such as the Black Eagle, which preys on large mammals and which does not migrate. It could also be proved with *A. verreauxii* that the adults had no problem conveying sufficient food when Abel had survived the critical stage with human help (Gargett 1978, 1990).

One possible explanation for the phenomenon of Cainism may be that this species is at an intermediate stage in its evolution, of changing to the laying of one egg instead of two. For unknown reasons, in contrast to earlier times, the rearing of one young per breeding season is sufficient to maintain the species. In the course of time this species, in which the second egg is plainly smaller than the first – one might regard it as a sort of vestigial – will come to have only one egg per brood. In both categories, species laying only one egg and those with two eggs which usually manage to rear both, there are a number of examples among the eagles.

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