Successful Breeding of a Ten-Year-Old Hybrid Spotted Eagle Aquila clanga × A. pomarina Retaining Immature Plumage Characters

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Successful breeding of a ten-year-old hybrid spotted eagle *Aquila clanga* × *A. pomarina* retaining immature plumage characters

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Greater Spotted Eagle *Aquila clanga* and Lesser Spotted Eagle *Aquila pomarina* are hybridising Eurasian raptors, but our knowledge of hybrid fertility is poor. Here, I present a case of interbreeding between a F1 hybrid spotted eagle male and a Lesser Spotted Eagle female in Estonia. The hybrid was first studied and ringed as a nestling in 1999, showing characters of both species. In 2009, the same bird was caught and, surprisingly, this ten-year-old individual had retained several immature characters. Again, characters of both species were recorded in the hybrid, as well as in his backcross-offspring. At the nest site level, the habitat of the hybrid's hatching site was intermediate but its nesting site was typical of *A. pomarina*. At the landscape level hatching and breeding sites resembled habitat typical of *A. clanga* in Estonia.

Key words: Greater Spotted Eagle, Lesser Spotted Eagle, hybridisation, hybrid fertility, introgression

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The ranges of Greater Spotted Eagle *Aquila clanga* and Lesser Spotted Eagle *Aquila pomarina* overlap in Eastern Europe, where interspecific hybridisation has been recorded repeatedly (Bergmanis *et al.* 1997, Lõhmus & Väli 2001, Bergmanis & Strazds 2001, Väli & Lõhmus 2004, Dombrovski 2005, Meyburg *et al.* 2005b, Treinys 2005, Schwanbeck 2008). Although field observations and genetic analyses suggest that at least some hybrids are fertile (Väli & Lõhmus 2004, Dombrovski 2005, Helbig *et al.* 2005, Väli *et al.* 2010b), verified cases with detailed descriptions are lacking. Knowledge on fertility of hybrids is important for both theoretical (e.g. taxonomical) and conservation reasons.

In the current study, I describe a male hybrid spotted eagle, breeding with a female *A. pomarina* in Estonia, as well as his two offspring, backcrosses between hybrid and *A. pomarina*, using a number of species-specific morphological characters proposed by Bergmanis (1996), Forsman (1999), Väli & Lõhmus (2004) and Dombrovski (2006). Measurements were taken following Bergmanis (1989) and Baker (1993). As comparisons of natal and breeding sites of eagles are scarce, I also give detailed descriptions of the two nest sites using the same parameters as in previous papers (Treinys 2004, Väli *et al.* 2004, Lõhmus & Väli 2004, 2005, Mirski 2009).

Results

On 20 July 1999, a spotted eagle nestling was studied and ringed (Estonia Matsalu R7400, hereafter R7400) at its nest in east-central Estonia. According to the DNA-analysis (see for method: Griffiths *et al.* 1998 and Väli 2004), the nestling was a male. In general, its plumage was typical of *A. pomarina*: a large ochre nape patch, brown body colour, few yellowish spots on medium upperwing coverts and contrasting bars on rectrices. However, typical of *A. clanga*, he had rather narrow dark bands on the secondaries (though not as narrow as in most *A. clanga*) and a large bill (Table 1,

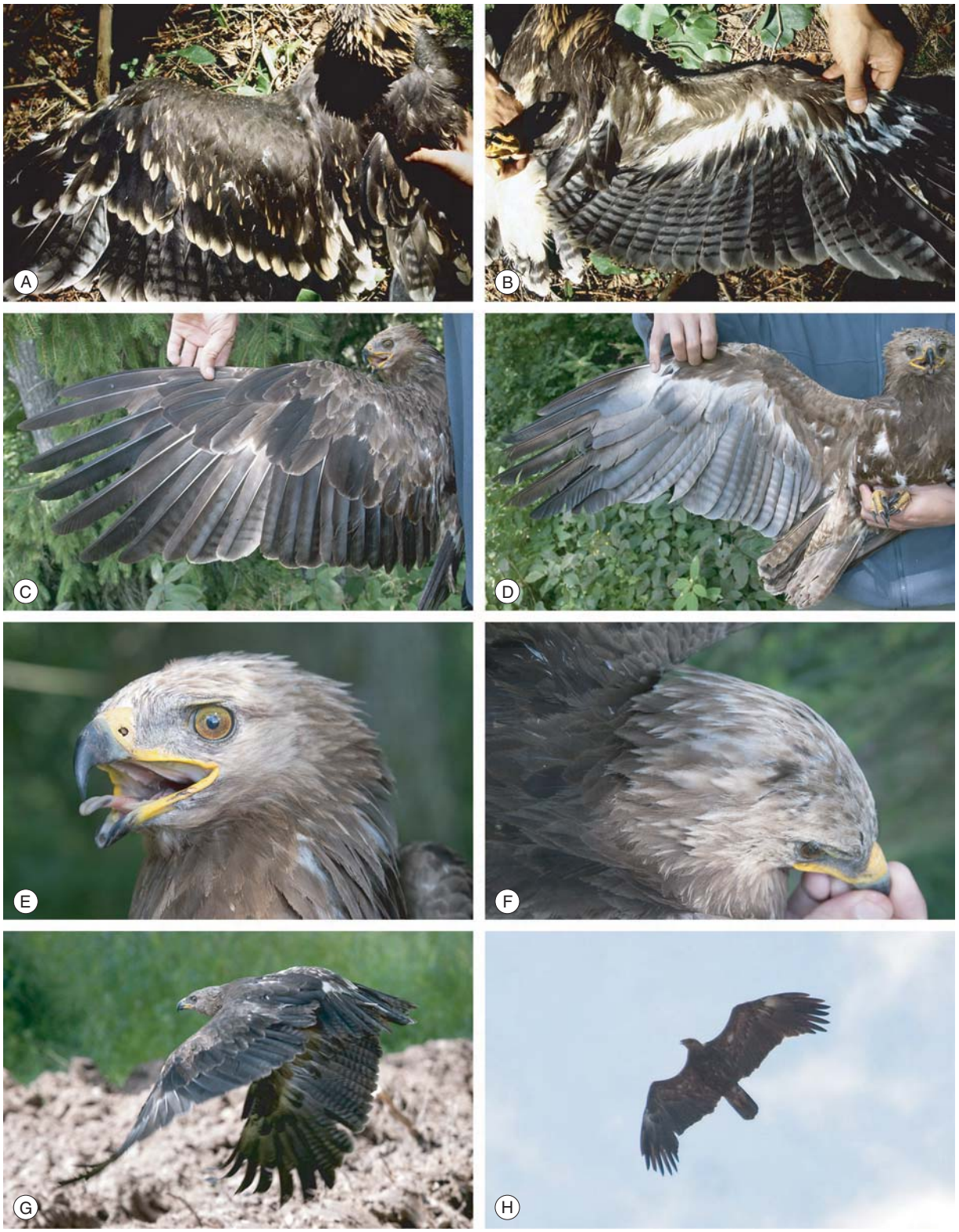

Figure 1. Hybrid spotted eagle R7400 as a nestling on 20 July 1999 (A–B), and as an adult on 28 July 2009 (C–F).

Figs 1 A, B). The DNA-analysis (for details, see Väli *et al.* 2010a) confirmed that the bird is an F1 hybrid between the two species. Field observations indicated that his father had been *A. pomarina*, his mother *A. clanga*. The latter was also confirmed by DNA-analysis of feathers collected at the nest. Two years later, a moulted feather of the male *A. pomarina* was found at the same nest site and sharing of alleles at all studied loci suggested that this bird had sired nestling R7400 in 1999.

Ten years later, on 28 July 2009, hybrid R7400 was caught close to his nest, 9.4 km away from his natal site, where he was breeding with a female *A. pomarina*. Some of his morphological characters, such as overall dark colour, single prominent carpal crescent and large bill resembled those of *A. clanga*. Other characters, such as rather short and narrow wings, and banded rectrices, would have suggested *A. pomarina*. Some characters, such as a yellow-brown iris (which, however, looked dark from a distance) and medium length of the notch on the 4th primary, were intermediate (Table 1, Figs 1 C–H). Surprisingly, several immature characters (see Forsman 1999) had been retained: some fresh medium upperwing-coverts had whitish tips, there were yellowish spots on the back and light edges to some of the feathers on the breast and on the belly (forming spots from a distance), the undertail coverts had whitish tips and bars which together formed a pale area, the secondaries were contrastingly barred and the fresh nape feathers had rufous tips. The bird also showed white edges on the greater underwing coverts, a character pronounced in juveniles and immatures (forming spots), but also present in adult spotted eagles (Forsman 1999, Ü. Väli & A. Nurmla, unpubl. data). At the same time, the bird had several simultaneously ongoing moult waves of remiges (primaries P and secondaries S, numbered respectively descendantly and ascendantly): fresh P2, P4, P5, P7, P8, S2, S3, S6, S7, S8, S10, S12 on the left wing, and fresh P2, P4, P5, P7, P9, S2, S3, S6, S7, S9, S11 on the right wing), suggesting an advanced age of the bird.

The offspring of R7400 (a backcross F1 × *A. pomarina*; Table 1, Appendix 1) was ringed and studied on 15 July 2009. The nestling had several characters of *A. pomarina*, such as overall brown coloration in upper-

Table 1. Morphological characteristics of the spotted eagle R7400 (F1 hybrid between *A. clanga* and *A. pomarina*) in 1999 (nestling, 20 July) and in 2009 (adult, 28 July), and his two offspring (backcrosses between F1 hybrid and *A. pomarina*) in 2006 (25 July) and 2009 (15 July). All birds were described by the author.

	R7400		Offspring in 2006	Offspring in 2009
	1999	2009		
Wing length (maximum wing chord; mm)	355	470	326	257
Upper mandible (mm)	15.2	15.7[a]	13.7	14.6
Bill depth (mm)	20.2	21.2	19.0	19.7
Bill length to cere (mm)	30.2	33.0	26.6	28.9
Length of the notch on the 4th primary (mm)	55	75	40	At least 65
Max length of the spots on upperwing medium coverts (mm)	23		25	28
Max width of the spots on upperwing medium coverts (mm)	12		25	21
Upperwing contrast	Weak	Weak	Weak	Weak
Underwing contrast	Clear	Clear	Weak	Clear
Width of dark bars on secondaries in relation to light bars	Narrower	Equal	Narrower	Narrower
Nape patch	Rufous feathers form the nape patch, rufous tips cover rest of the head	Whitish feather tips cover all the head, few fresh feathers have dark rufous tips	Rufous feathers cover all the head	Rufous feathers in the middle on nape, rufous tips cover rest of the head
Rectrices	Dark above, banded below		Dark with contrasting light bands on the tip	Dark with two contrasting light band on the tip

[a]Measured perpendicularly (90°) to the bill. In earlier studies of adult museum specimens the same measurement have been taken with an angle (from the edge of the mandible), which gives about 1 mm larger values (Ü. Väli, unpubl. data).

parts, large ochre nape patch (albeit larger than in most *A. pomarina* nestlings), dark rectrices with light bands to the tip, as well as several characters of *A. clanga*, such as large bill (relative to wing length), narrow bands on secondaries and very large spots on medium coverts, which were much more prominent than shown by its father in his nestling stage. Its light-coloured breast was also more typical of *A. clanga*, although it may occur in some *A. pomarina* as well (Forsman 1999). Probably, R7400 had been present already in 2006, since a ringed adult male spotted eagle with identical field characters was then breeding at the same nest with a female *A. pomarina* and the genotype of the nestling in 2006 suggested R7400 having been the probable father. The 2006-nestling was very similar in appearance to the chick in 2009, although the rufous areas in its plumage (underbody, nape, spots on coverts) were much larger, and its bill was smaller (Table 1, Appendix 1).

Discussion

Earlier records of birds with intermediate or mixed characters (Forsman 1999, Lõhmus & Väli 2001 and references therein, Gutiérrez & Villa 2002, Dombrovski 2005, Treinys 2005) all suggested the viability of hybrid spotted eagles. Moreover, breeding of such birds (Dombrovski 2005, Treinys 2005, Ü. Väli unpubl. data) indicates hybrids to be potentially fertile. Although intermediate appearences can sometimes be explained by morphological variation, which is very large in both species (Forsman 1999), recent genetic studies have confirmed that at least some hybrids are fertile, as backcrossing and introgression of genes from one species to another have been recorded (Väli & Lõhmus 2004, Helbig *et al.* 2005, Väli *et al.* 2010b). As far as I know, this is the first case when the hybrid origin of an adult has been confirmed by a ringing record.

Surprisingly, I found several immature characters in the ten-year-old adult bird. According to Forsman (1999: 325, 340), spotted eagles are supposed to attain adult plumage in their fourth or fifth calendar-year, although subadult plumages may then still persist. However, data backing up this opinion are scarce. In *A. pomarina*, breeding of a four-year-old male with retained juvenile plumage characters has been recorded, whereas – on the other hand – a four-year-old female and a five-year-old female had already attained full adult plumage (Meyburg *et al.* 2005a). Therefore, Meyburg *et al.* (2005a) suspected that males attain adult plumage one year later than females, in the fifth year. The data presented here indicate that spotted eagles could retain immature characters until much later, perhaps even close to the average age of an adult spotted eagle (c. 11 years; Meyburg *et al.* 2005a). Meyburg *et al.* (1997) reported the breeding of an *A. clanga* in partial juvenile plumage, but the actual age of the bird was not known. Hybrid origin has been suspected to affect the development of adult plumage characters in spotted eagles (Dombrovski 2005), but it does not necessarily have to since immature characters could be retained throughout life also in other long-lived species that do not hybridise (e.g. Common Gull *Larus canus* (Olsen & Larsson 2003: 73, K. Rattiste & L. Saks, unpubl. data). Whatever the reason, proper ageing of eagles in the field is difficult; hence, some records of birds breeding at an unusually young age might be erroneous if not confirmed with other data, such as ringing or repeated DNA-analysis.

The hatching and breeding site of R7400 were very close to one another. This is not surprising, as eagles are known for their philopatry (Ferrer 1993, Wood 2009). However, in *A. pomarina* previously recorded distances between hatching and nesting sites varied between 0.13 and 550 km (Danko & Maderič 2008). At the nest level, the hatching site can be considered as intermediate but the nesting site was typical of *A. pomarina* – a patch of old-growth spruce forest (Appendix 2). At the landscape level, both sites closely resembled the habitat of *A. clanga* in Estonia, with large water bodies surrounded by wetland nearby. This is in concordance with other nest sites of mixed pairs in Estonia and supports the idea that mixed pairs have settled in former territories of *A. clanga* (Lõhmus & Väli 2005), and that hybridisation is an intermediate step in the extinction process of *A. clanga* populations (Väli *et al.* 2010b). Indeed, this region of east-central Estonia has been known for formerly harbouring several pairs of *A. clanga* while only one mixed pair (mother of R7400 still breeding with a male *A. pomarina*) and the backcrossing pair described in this paper have remained today. Moreover, the current breeding territory of R7400 was earlier occupied by an *A. clanga* pair in 1997–2001 (nesting only 200 m, 340 m and 820 m from the R7400 nest) and by an *A. clanga* × *A. pomarina* pair in 1993–1994 (nest site 1510 m away) and in 2002–2004 (340 m away).

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Samenvatting

Hybridisatie tussen Schreeuwarend *Aquila pomarina* en Bastaardarend *A. clanga* komt in Europa veel voor. Er is echter weinig bekend over de vruchtbaarheid van de daaruit voortvloeiende nakomelingen. Hier wordt een vogel beschreven die in 2009 bij zijn nest in Estland werd gevangen en als nestjong in 1999 bleek te zijn geringd. Hij was gepaard met een Schreeuwarend, en was vermoedelijk dezelfde vogel die in 2006 op hetzelfde nest een jong had grootgebracht met een Schreeuwarend als partner. De gevangen vogel had een Schreeuwarend als vader en een Bastaardarend als moeder, iets wat uit zowel veldkenmerken als DNA-analyse naar voren kwam. Hoewel dit mannetje inmiddels tien jaar oud was, bevatte zijn verenkleed nog tal van kenmerken van een onvolwassen vogel. Dit verklaart misschien de meldingen van arenden broedend op een ongebruikelijk jonge leeftijd: de kans is groot dat

dit volwassen hybride vogels zijn geweest met veerpartijen die deden denken aan die van een onvolwassen vogel (iets wat onder hybriden vaker voorkomt dan bij zuivere vogels). De beide jongen van dit mannetje hadden kenmerken van zowel Schreeuw- als Bastaardarend. Hij is het levende bewijs dat – althans sommige – hybriden van Schreeuw- en Bastaardarenden vruchtbaar zijn. Het mannetje broedde op slechts 9,4 km van zijn geboorteplaats. De nestplaats in een opstand oude Fijnspar *Picea abies* was kenmerkend voor Schreeuwarend, maar op landschapsschaal was de broedplaats typisch voor Bastaardarend: moerassen met grote waterpartijen. In Estland worden deze bastaardarendhabitats in toenemende mate door mengparen in gebruik genomen. Hybridisatie zou dan een tussenstap kunnen zijn in het uitstervingsproces van de lokale populatie Bastaardarenden. (RGB)

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Appendix 1. Offspring of R7400 (backcrosses between F1 hybrid male and *A. pomarina* female) on 25 July 2006 (A–C) and on 15 July 2009 (D–E).

Appendix 2. Nest site characteristics of the hybrid spotted eagle R7400.

	Hatching site in 1999	Breeding site in 2009
Nest site		
Nest tree (age, height)	Spruce (86 yr, 22.5 m)	Spruce (70 yr, 26 m)
Nest height (m)	15.5	20
Nest location	On side branches	On the broken top
Canopy coverage	85%	50%
Forest type	Mixed (birch, aspen, pine)	Coniferous (Spruce)
Home range		
Distance to nearest river	1700 m	1100 m
Distance to nearest road	585 m	840 m
Distance to nearest house	385 m	470 m
Distance to nearest field	300 m	270 m
Distance to nearest meadow	30 m	310 m
Area of CORINE land cover types in 2 km radius		
Decideous forest	208 ha	311 ha
Coniferous forest	120 ha	–
Mixed forest	394 ha	144 ha
Non-irrigated arable land	237 ha	181 ha
Pastures	100 ha	302 ha
Complex cultivation	59 ha	–
Natural grassland	2 ha	–
Lake	–	36 ha
Shrub	25 ha	28 ha
Marsh	–	39 ha