

On the Taxonomy of the Lesser Spotted Eagle *Aquila pomarina* and Greater Spotted Eagle *A. clanga*

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INTRODUCTION

The identification of the Lesser Spotted Eagle and the Greater Spotted Eagle is very difficult or sometimes even impossible. The distribution and taxonomic status of these two very similar and closely related Palearctic eagles still remain rather uncertain.

The main aim of this paper is to ascertain the taxonomy of both species as well as to offer recommendation on their separation by means of mathematical methods. For the first time, quantitative morphological variables have been analysed on the basis of abundant empirical material.

MATERIAL AND METHODS

In total, 411 specimens (281 Greater Spotted and 130 Lesser Spotted Eagles) were measured and described including five living birds; the remainder were specimens from the largest museums in Latvia, Estonia, Moscow, and St. Petersburg. Eight measurements were taken:

- 1) bill height in front of cere (BH)
- 2) height of upper mandible in front of cere (HUM)
- 3) bill length from cere to tip (BL)
- 4) distance between 7th primary and wing tip (DPW)
- 5) length of notch in outer vane of 7th primary (NP)
- 6) length of spots on the upperwing median coverts (LS) of juveniles and subadults
- 7) width of spots on the upperwing median coverts (WS) of juveniles and subadults (largest spots measured)
- 8) length of middle toe without talon (LT)

All data were statistically processed. As a result, frequency histograms have been obtained where all eight morphological variables of both species were compared in different combinations. For each of them, reliability was tested according to "Hypothesis Test Hø". For all variables "Principal Component Analysis" (PCA) was done. PCA was used to investigate the degree of differentiation between the Lesser Spotted and Greater Spotted Eagles. Only those specimens (n=194) were chosen for

PCA which had the same number of measurements (morphological variables). The following morphological measurements were used in the analysis: BH, HUM, BL, DPW, LT. Components PC1 and PC2 contain 78% and 13% of the total variation in the data matrix respectively.

Frequency histograms were used to investigate:

- 1) degree of sexual dimorphism of both species
- 2) degree of difference between both species
- 3) most diagnostic characters of both species according to the degree of sympatry of samples.

The following comparisons were made within each of 8 morphological variables:

- 1) between males and females of both species
- 2) between males of both species
- 3) between females of both species
- 4) between birds of both species independently from sexes

As a result, 30 different combinations were obtained and, for each of them, significance of differences was tested according to "Hypothesis test for HO"

RESULTS

Sexual dimorphism was not found to be significant, and all histograms are based on combined data pooling both sexes. Significant differences (at significance level = 0.05) between both species were found for all 8 morphological variables (Figs. 2-9). For statistical interpretation of morphological variables, see Table 1 (variable DPW is not included as it shows no significant difference between both species and is not for practical use in identification). Table 1 differs from that published earlier by me (Bergmanis 1989) due to more complete mathematical treatment of the data. One must combine all parameters represented in Table 1 to identify the birds in the hand. For field identification, there are numerous other publications (Svensson 1975; Cramp & Simmons 1978; Glutz *et al.* 1979; Forsman 1991, etc.) covering different aspects of field identification.

DISCUSSION

In all recent handbooks and field guides, Lesser Spotted and Greater Spotted Eagles are considered to be two very similar species. According to some authors, these species represent an intermediate position between species and semispecies with an allopatric distribution (Dementjev 1951; Zhezhherin 1969). As evidence of separate species status, a light coloured nape patch and canism of juveniles is mentioned for Lesser Spotted Eagle by W. Baumgart (1980). According to B.-U. Meyburg (1974), only additional investigation on distribution would be helpful to solve the problem of whether Lesser Spotted and Greater Spotted Eagles are sympatric twin species, allopatric semispecies, or two subspecies of some species.

Table 1. Summary statistics for morphological variables in Lesser Spotted Eagle and Greater Spotted Eagle(measurements in mm)

Variables	<i>Aquila clanga</i>				SD	<i>Aquila pomarina</i>				SDS	species specific measurements
	N	min.	max.			Species specific measurements	N	min.	max.		
Height of upper mandible, HUM	259	15.5	19.5		0.8	(>17.0)	123	12.5	17.0	0.7	(<15.5)
Bill length, BL	248	28.0	41.0		1.9	(>35.5)	113	23.5	35.5	1.7	(<28.0)
Bill height, BH	204	19.0	31.5		1.2	(>20.0)	105	15.5	20.0	0.9	(<19.0)
Notch in outer vane of 7th primary, NP	223	50.0	135.0		16.6	(>82.0)	64	43.0	82.0	10.2	(<50.0)
Width of spots on the upperwing median coverts, WS	90	3.0	28.0		5.1	(>13.0)	45	1.0	13.0	3.4	(<3.0)
Length of spots on the upperwing median coverts, LS	90	16.0	45.0		5.9	(>29.0)	45	3.0	29.0	6.0	(<16.0)
Length of middle toe without talon LT	233	45.0	63.0		2.6	(>54.0)	90	41.0	54.0	2.4	(<45.0)

Results of our studies found sufficient differentiation between Lesser Spotted and Greater Spotted Eagles to suggest they are two separate species. Only one Greater Spotted Eagle had atypical measurements with bill and middle toe quite different from other specimens measured (Fig. 1). Evidently it was so young that its measurement caused this bird to be placed so far in a plot of Lesser Eagle ($PC_2 = 0.84/PC_1 = -2.36$).

Looking at histograms, one can conclude that most diagnostic are variables of bill, middle toe, and upperwing coverts (especially HUM and BH which show a minimal standard deviations). Due to moulting, the measurement DPW may be too variable to be always diagnostic.

The notch in outer vane of 7th primary was not highly distinct, nevertheless measurable for 64 Lesser Spotted Eagles (60%; $n = 107$), more or less distinct for only 11 (10%), and for the remainder of the 43 birds instead of a notch there was only unmeasurable contraction. On the other hand, the notch was found in all Greater Spotted Eagles ($n = 223$), and only 17 (8%) of them had it comparatively indistinct but measurable.

Variables WS and LS are also diagnostic. Spots occur on all upperwing coverts of Greater Spotted juveniles while frequently only on greater and middle coverts of Lesser Spotted juveniles. One of the most diagnostic measurements was LT.

Figure 1. Plot of both species along the first two principal components of five external measurements.

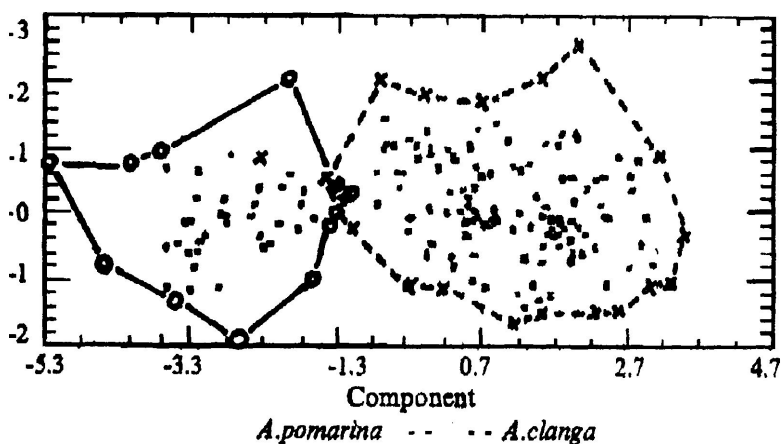


Figure 2. Greater Spotted Eagle vs. Lesser Spotted Eagle Height of Upper Mandible.

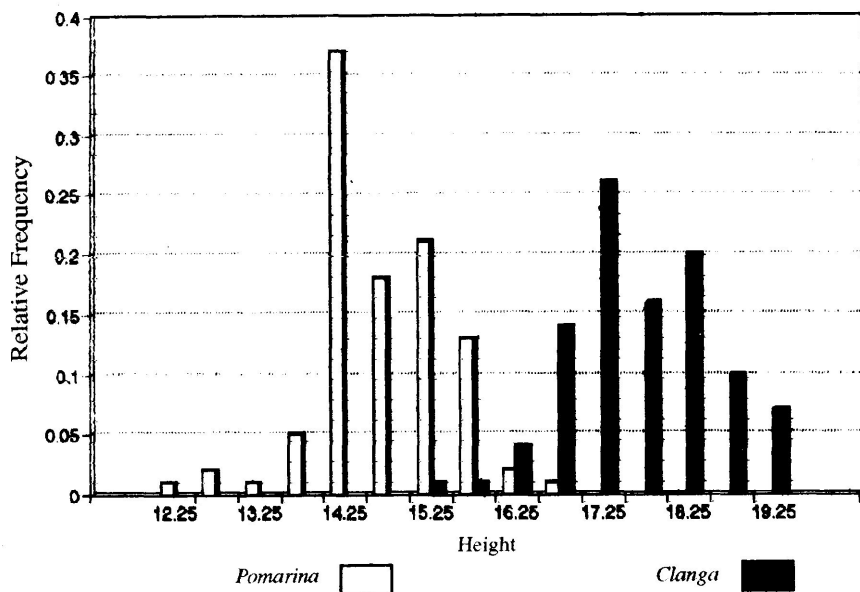


Figure 3. Greater Spotted Eagle vs. Lesser Spotted Eagle Bill Length.

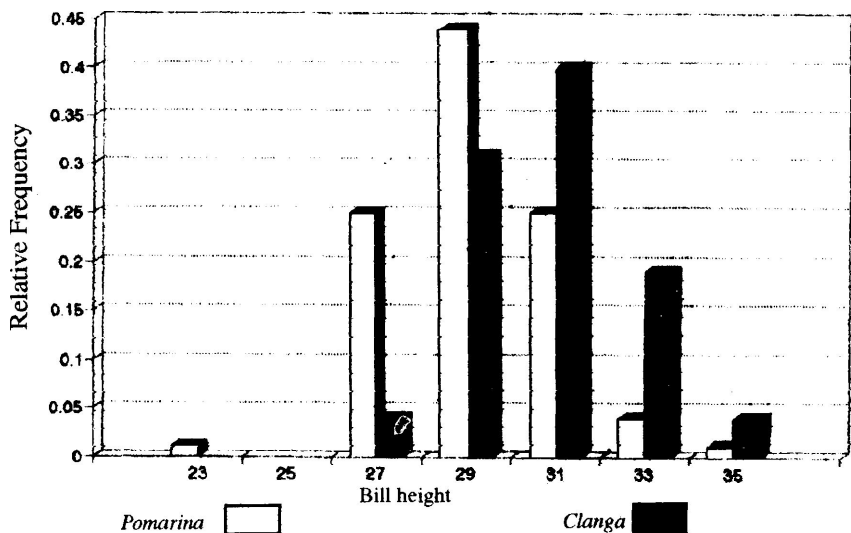


Figure 4. greater Spotted Eagle vs. Lesser Spotted Eagle Bill Height.

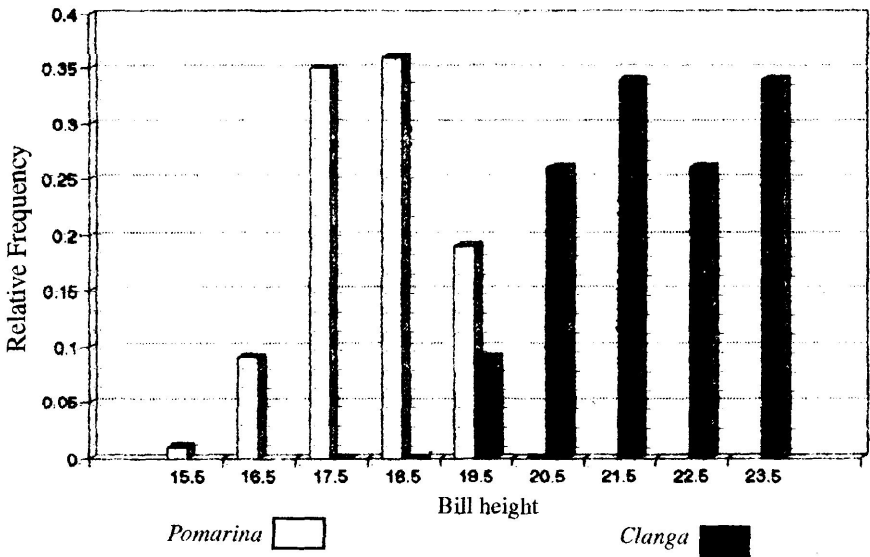


Figure 5. Greater Spotted Eagle vs. Lesser Spotted Eagle Distance Between 7th Primary and Wing Tip.

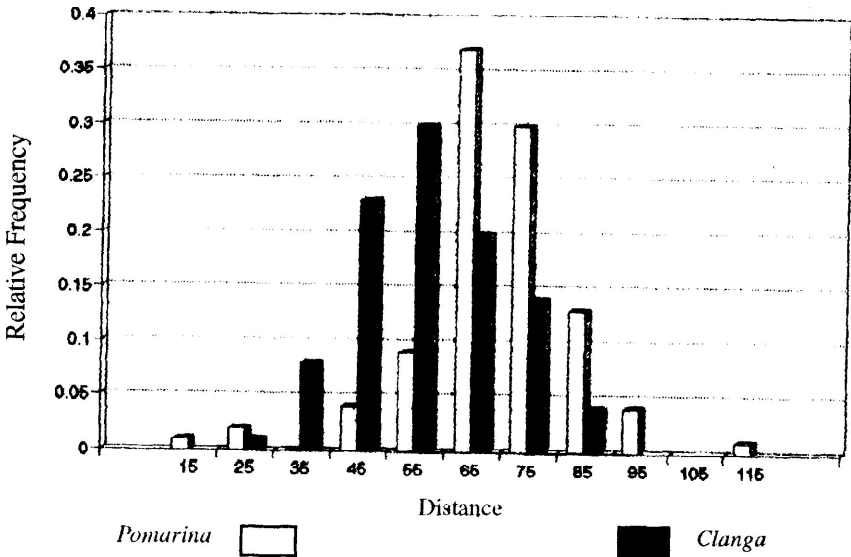


Figure 6. Greater Spotted Eagle vs. Lesser Spotted Eagle Notch in outer vane of 7th Primary.

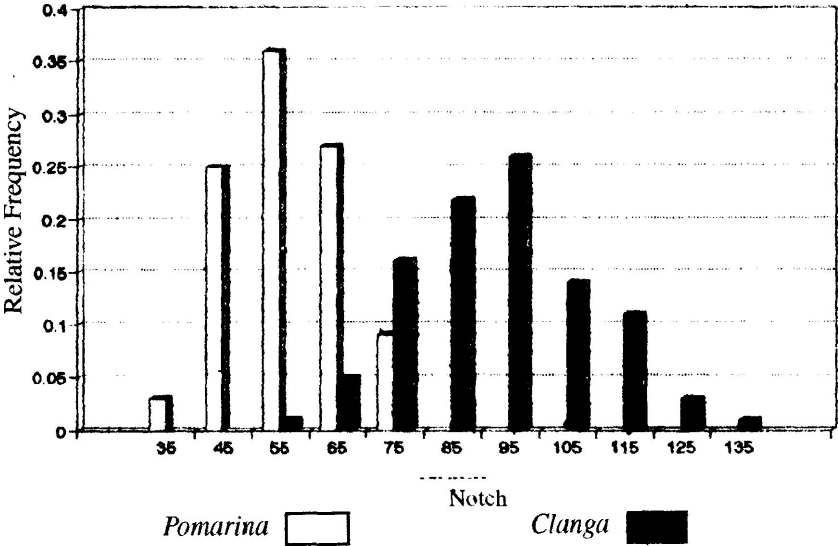


Figure 7. Greater Spotted Eagle vs. Lesser Spotted Eagle Width of Spots on the Upperwing Median Coverts.

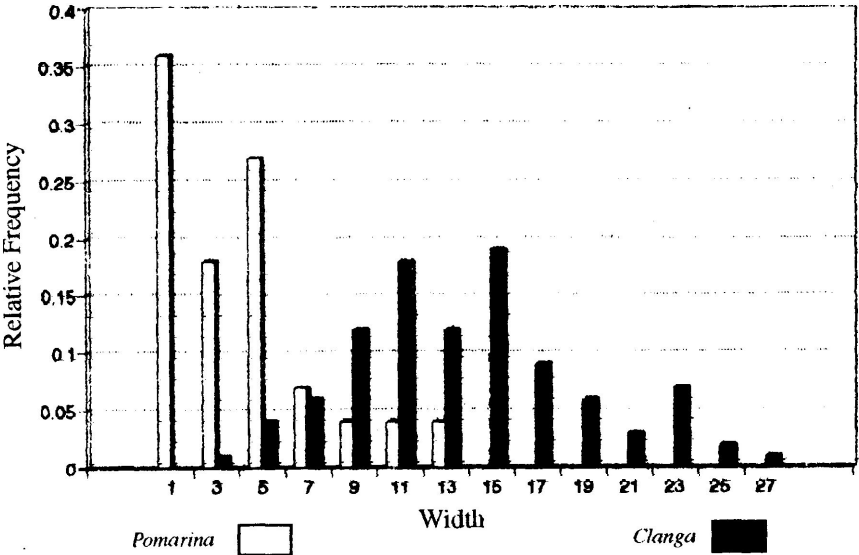


Figure 8. Greater Spotted Eagle vs. Lesser Spotted Eagle Length of Spots on the Upperwing Median Coverts.

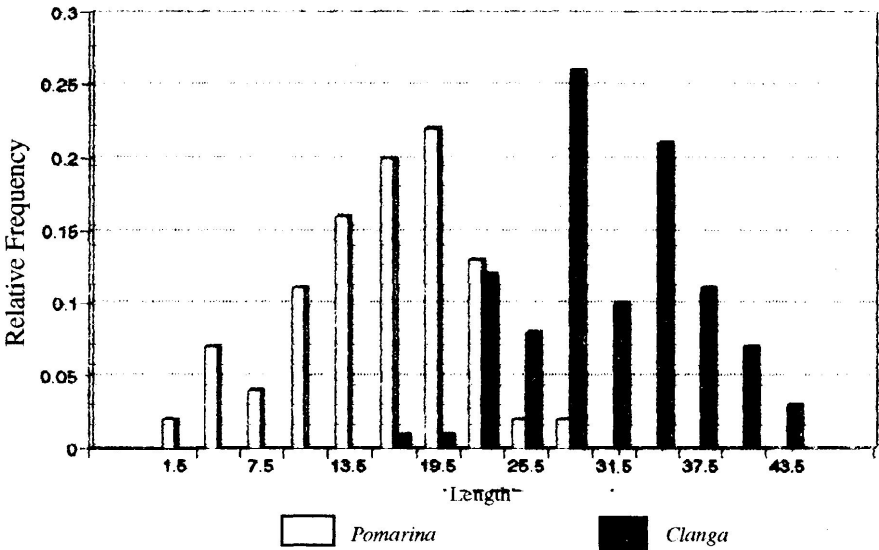
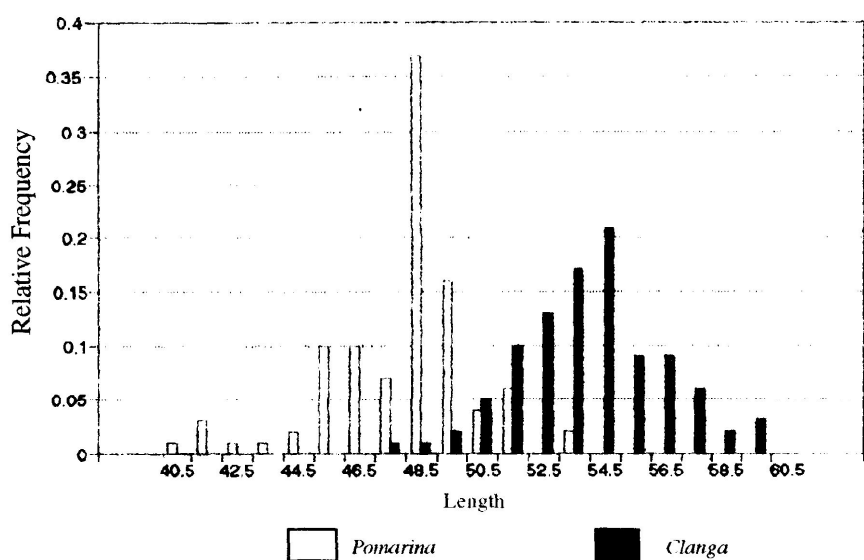


Figure 9. Greater Spotted Eagle vs. Lesser Spotted Eagle Length of Middle Toe Without Talon.



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