

Possible Effect of Anthropogenic Environmental changes on Morphological Variation of some European Birds of Prey

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INTRODUCTION

Problems of animal adaptation to human activity have attracted increasing attention in recent years. Behavioural reactions are normally the quickest form of organism response to anthropogenic factors of varying intensity. Changes in ecology and quantity of species are also of much interest. Moreover there are few investigations into basic transformations of animal morpho-physiology, which concern vital aspects of their biology and influence heredity.

Correlation has been confirmed of changes in morpho-physiological traits of certain mammals under the influence of anthropogenic factors (primarily towards diminution and deformation of the skull as well as the skeleton as a whole) in Aurochs (Zalkin 1962; Paaev 1965; Werestschagin & Rusakov 1979; Kobrynczuk 1985), Saiga Antelope (Zhimov 1982; Pronjaev 1986) and Przewalski's Horse (Klimov 1990). Few such changes are known in birds. However, at the beginning of the 1970s Wladishevsky (1973) noted certain differences between "agricultural" and "urban" populations of House Sparrows *Passer domesticus* in the Carpathian Mountains region, such as diminution in size of body parts (stomach, limbs). Tomialojc's (1995) research on European House Sparrows concluded that modern western forms adapted to new environments more quickly than eastern ones. There is no doubt that the natural environments in Europe have been substantially transformed through human activity.

Our hypothesis is that during the last century western Palaearctic populations of birds of prey evolved more than eastern ones. In our opinion this is due to more intensive western anthropogenic factors which influence natural trends in evolutionary development of intraspecific forms. For birds of prey, one criterion for such a mode of evolution is, we suggest, intensification of sexual dimorphism in dimensions. We follow the conclusions of Hill (1944) and K.A. Judin (1958) that sexual size dimorphism in primitive members of the Falconiformes is expressed to a lesser degree than in more developed ones. Accordingly our second hypothesis is that decrease in the degree of sexual dimorphism within an intraspecific form of birds of prey indicates its inhibition in evolutionary development.

The influence of anthropogenic factors can lead to an imbalance of genetic and phenotypic structure of a species as a whole and of interspecific forms in particular. Wladishevsky (1973, 1975) concluded that "synanthropic" forms are more variable in body dimensions than "wild populations", connected with different directions of selection. One way of producing such an

imbalance of traits and increase in their coefficients of variance is by "infusion of blood" of domestic animals into wild ones, as with boars in Poland (Zurowski *et al.* 1970).

Thus we offer a third hypothesis: changes in traits through time, expressed as coefficients of variance, indicate the influence of factors (in this case anthropogenic) on a population of animals.

Our criteria for evaluating trait transformation in some birds of prey under the influence of anthropogenic factors are organ dimensions and their coefficient of variance, degree of sexual dimorphism and period of time when morphological changes could have taken place, based on the material available. The period (1824-1987) can be divided into three stages: first - 1824-1900, second - 1901-1930 and third - 1931-1987. These correspond with periods of varying degrees of intensity of anthropogenic influence on European fauna. The strongest impact was during the 1930s and beginning of the 1940s in connection with the Second World War, use of toxic chemicals and appearance of synanthropic populations of Rock Doves as a new prey-base.

MATERIALS AND METHODS

Investigations were carried out on four species of raptor widespread in the Palaearctic: Saker Falcon *Falco cherrug*, Goshawk *Accipiter gentilis*, Steppe Eagle *Aquila nipalensis* and Imperial Eagle *A. heliaca*. We used study collections in museums (Zool. Inst. of Russia, St. Petersburg; Moscow State University, Moscow; Ukrainian A. Sc., Kiev) and eagles discovered dead below electric power lines in Kazakhstan and Kalmikia in 1981-1986. Subspecies differentiation (except of birds found under power lines) was done according to distribution of intraspecific populations (Dementiev 1951). Only adult birds collected in their nesting period (April-August) and with labels defining sites were analysed.

We measured lengths of wing (Lw), tail (Lt), first claw (L1c), bill at cere (Lb), and height of bill at cere (Hb), taking bill and claw measurements as previously stated (Grazhdankin & Pererva 1986). A total of 261 Goshawks (135 f., 126 m.), 161 Saker Falcons (82 f., 79 m.) 91 Steppe Eagles (34 f., 57 m.) and 61 Imperial Eagles (39 f., 22 m.) were measured. Results were analysed for arithmetical mean, mean error, quadratic deviation, significance by t-test and coefficient of variation. Degree of sexual dimorphism (r) was determined according to the formula of Hill (1944): $r = A/B \times 100\%$ where A is arithmetical mean value of male traits and B of corresponding female traits. A decrease in the "r" value corresponds to an increase in sexual dimorphism, and increase to the contrary.

RESULTS

Saker Falcon

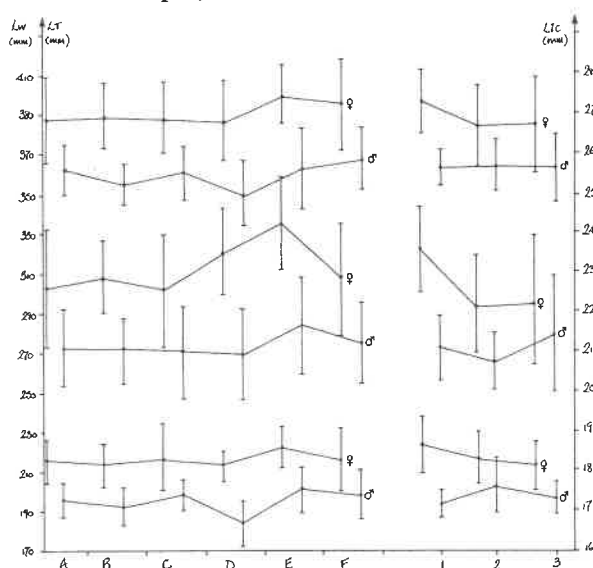
A widespread polymorphic species inhabiting natural zones of forest, steppe, forest-steppe and semi-desert from Central Europe in the west to Manchuria and China in the east. Saker Falcon subspecific structure is not yet defined: some authors distinguish 6 subspecies (Dementiev 1951; Weick 1980), while others 4 subspecies (Stepanian 1975) or 3 (Kozlove 1969).

We made a preliminary attempt to revise subspecies on the basis of the coefficient of differences (CD) (Mayr 1970). The following subspecies according to Dementiev (1951) were evaluated: *danubialis*, *cherrug*, *saceroides*, *coatsi*, *milvipes* and *hendersoni*, taken from west to east. For each of the five traits studied no difference of more than 0.74 was found (Fig. 1), whereas according to the "rule of 75%" a population is considered as an independent subspecies when CD = 1.28 (Mayr 1970).

Earlier, based on statistical analysis of colouration intensity in various forms of Saker Falcon, a distinct difference between *danubialis* and *milvipes* was shown (Grazhdankin 1988). Based on our analysis of metric traits of Saker Falcon subspecies, we concluded that no distinct differences exist at the subspecific level. Therefore we analysed the whole species as a monophyletic taxon. We expect the largest anthropogenic pressure to be on the western populations of Saker Falcon, sometimes united under the name *danubialis*, which inhabit Europe west of the River Volga.

During the last 100 years there was a marked diminution in all body parts of females in this population (Table 1, Fig. 1). Shortening of wing, tail and bill was almost significant ($t = 1.3-1.9$)

Figure 1. Changeability of length of wing (Lw), tail (Lt), and first claw (L1c) in subspecies (A-F) of the Sacer Falcon ($\bar{X} \pm SD$)
1, 2, 3 - traits changeability in *F. ch. danubialis* at time intervals: 1 - 1824-1900, 2 - 1901-1930, 3 - 1931-1987.
A - *F. ch. danubialis*, B - *F. ch. cherrug*, C - *F. ch. saceroides*, D - *F. ch. coatsi*, E - *F. ch. milvipes*, F - *F. ch. hendersoni*.



and height of the bill and the length of claw 1 were significant ($t = 2.9-2.3$). At the same time, over the whole area females had a lesser tendency to diminution. Males of the western population group *danubialis* changed quite differently (Table 2). There was a significant enlargement in the dimensions of wing, tail, claw and bill. The same tendencies in claw and bill were noted for the species as a whole, but length of tail and bill decreased somewhat during the last century.

There was a markedly wider variation of traits in females of the "*danubialis*" group (Fig. 1). Variation of traits through time was also greater than variation recorded between subspecies by Dementiev (1951). Besides, during the past century, variability in the range of dimensional traits as expressed by the coefficient of variation (CV) tended to increase, especially in western forms. This is in contrast to the decline in coefficient of variation for females as a whole. Thus, within the last decades, the species has been stable in dimensional traits but western populations tend to destabilisation with wide variation (Tables 1 & 2). There is also a marked diminution in sexual dimorphism in birds of the western "*danubialis*" population (Table 3).

Goshawk

In the Palaearctic a variable number of subspecies is distinguished: 10 (Dementiev 1951), 8 (Gladkov 1941), 6 (Stepanian 1975; Weick 1980) and even one (Wattel 1981). We followed Dementiev and analysed 8 subspecies; *gallinarum*, *buteoides*, *gentilis*, *caucasicus*, *suschkini*, *schvedowi*, *albidus* and *fuijyamae*. To define deformation in metric traits it is sufficient to examine only data on nominal subspecies (Tables 1 & 2). There are trends towards diminution of wing and bill in both sexes and claw 1 in females. There is also a significant increase in tail length in both sexes. Simultaneously we found an increase in variation: in the last century coefficients of variation in wing, tail and bill in males and in tail and claw in females increased (Tables 1 & 2). Sexual dimorphism in the "*gentilis*" population decreased in height of bill and claw length and, as for other metric traits, there were unsteady modulations in time (Table 3).

Steppe Eagle

In the Palaearctic there are two subspecies (Dementiev 1951) but differences between males

are not sufficient for separation of given taxa with a differentiation coefficient (by Mayr 1970) of less than 1.28 (Grazhdankin & Pererva 1986). Steppe Eagles that perished from electrocution in 1981-1992 had smaller bills and claws than those in museums from the 19th and early 20th centuries (Grazhdankin & Pererva 1986). This was established for the species as a whole, whereas differential analysis of birds within the subspecies *orientalis* and *nipalensis* shows various trends. For "*nipalensis*" inhabiting Central Asia there is a decrease of traits in both sexes (Tables 1 & 2). Over the same time period there was some shortening of bill and claws in males of the western subspecies "*orientalis*", whereas in females there was some enlargement. Variation in degree of sexual dimorphism in these subspecies also developed differently (Table 3): this index was almost unchanged during the whole period in the eastern subspecies, whereas in the western one the tendency to stability of sexual dimorphism degree was marked only during the first three decades of the 20th century (second period).

Imperial Eagle

There are two separate, geographically isolated subspecies. In Russian territory the nominate *Aquila heliaca* showed a trend towards diminution (Tables 1 & 2), especially in males. Enlargement of the bill in females was noted at the same time, as for females of Steppe Eagles.

DISCUSSION

Variations in features of animals under anthropogenic impact has not been previously discussed in biology, due to the common view that evolutionary transformations require a long time process. Compared to the millions of years necessary for even insignificant differences to appear, similar effects within a decade do not seem probable, even though the cause of such changes may be considered evolutionary.

At present it is still impossible to give a full scientific description of anthropogenic factors. Hence it is reasonable to use such a term as "complex anthropogenic impact" and, when possible, to divide this into separate kinds of human activity. This report identifies two causes and accordingly two separate mechanisms for external metric trait transformation in birds of prey.

It would be simple to think that anthropogenic impact produces a unidimensional transformation, for example only diminution, but the collected data show a more complicated pattern. This is due, in our opinion, to a compromise between the natural evolutionary transformation of the species and new anthropogenic tendencies in wildlife.

The following two factors most affected Palaearctic birds of prey during the last decades:

1. A change in diet due to the disappearance of large prey species and appearance of new food sources.
2. A change in age structure of the population, due to extermination of adults and early breeding of young.

The effect of the first factor can be seen in Goshawks. At the turn of the century this species fed mainly on gallinaceous birds and hares (Kalchreuter 1981). From the 1930s the number of pigeons (wild and domestic) in Europe rose steeply (Thissen 1981) and in recent decades passerine birds also began to play an important role as food for Goshawks (Pererva 1988).

Birds of prey capture more small than large prey to feed nestlings and for their own nourishment. The catching of smaller prey requires a higher expenditure of energy. Goshawks of both sexes, now forced to capture small and medium-sized prey in comparison to their own size, show wing-shortening (as the general diminution equivalent) and simultaneous tail-lengthening, both of which are important for the successful pursuit of passerines and pigeons.

In the early 20th century, the diet and the dispersion of the Steppe Eagle were closely linked to suslik (Osmolovskaja 1953; Warshawski *et al.* 1983). Moreover, due to a steep rise in saiga numbers from the beginning of the 1950s as a result of successful protection (Zhirmov 1982), large birds of prey obtained a new source of food in saiga carcasses and younger animals. Such food is accessible at any season and Steppe Eagles began actively to consume it (Korelov 1962; Fadeev 1986).

Such interconnections between raptors and their prey can be seen increasingly often during the

Table 1. Changes of metric traits in different forms (sub-species) of female birds of prey in sequential time periods (1 - 1824-1900, 2 - 1901-1930, 3 - 1931-1987).

Subspecies	Trait	1824-1900			Periods 1901-1930			1931-1987			t
		N	Size	CV	N	Size	CV	N	Size	CV	
<i>A. gentilis</i>	Lw	11	369.8 ± 2.4	2.0	16	364.9 ± 1.5	1.6	9	367.0 ± 2.5	2.0	-0.8
	Lt	11	233.8 ± 3.0	4.1	16	256.8 ± 4.1	6.2	9	265.9 ± 1.9	2.0	+9.0
	Lb	11	26.4 ± 0.3	4.2	16	26.2 ± 0.2	3.1	9	26.3 ± 0.2	1.9	-0.3
	Hb	11	15.7 ± 0.3	5.7	16	15.4 ± 0.1	3.2	9	15.2 ± 0.2	3.9	-1.6
	L1c	11	34.2 ± 0.2	1.8	16	33.3 ± 0.2	2.7	9	33.7 ± 0.4	3.6	-1.0
<i>F. cherrug danubialis</i>	Lw	15	395.4 ± 4.3	4.2	15	383.5 ± 5.6	5.4	11	384.4 ± 7.6	6.3	-1.3
	Lt	15	223.1 ± 3.9	6.5	15	216.5 ± 3.6	6.2	11	213.0 ± 3.9	5.8	-1.8
	Lb	15	23.8 ± 0.3	5.0	15	23.1 ± 0.3	5.6	10	23.0 ± 0.3	4.3	-1.9
	Hb	15	14.6 ± 0.2	4.8	15	13.9 ± 0.2	5.0	11	13.8 ± 0.2	4.3	-2.9
	L1c	15	23.6 ± 0.3	4.7	15	22.2 ± 0.3	5.8	11	22.3 ± 0.5	7.2	-2.3
<i>F. cherrug cherrug</i>	Lw	6	384.0 ± 8.8	5.1	11	392.9 ± 4.8	3.9	11	389.5 ± 4.6	3.7	+0.6
	Lt	6	214.0 ± 3.9	4.1	11	212.7 ± 4.2	6.3	11	212.7 ± 3.1	4.7	-0.3
	Lb	6	23.6 ± 0.5	4.2	10	22.9 ± 0.5	6.1	11	23.7 ± 0.4	5.1	+0.2
	Hb	6	14.1 ± 0.2	3.5	10	14.1 ± 0.3	7.1	11	13.9 ± 0.2	5.0	-0.7
	L1c	6	23.1 ± 0.3	2.6	11	22.7 ± 0.3	3.5	11	23.3 ± 0.3	3.9	+0.5
<i>F. cherrug (Sum)</i>	Lw	32	393.1 ± 3.6	5.1	75	388.7 ± 2.5	5.6	94	389.1 ± 1.9	4.7	-1.0
	Lt	32	217.4 ± 2.0	5.2	75	216.4 ± 1.8	7.0	94	215.0 ± 1.3	5.8	-1.0
	Lb	32	23.5 ± 0.2	6.0	72	23.2 ± 1.2	6.0	89	23.4 ± 0.1	5.1	-0.4
	Hb	32	14.2 ± 0.2	5.6	74	14.0 ± 0.1	6.4	92	13.9 ± 0.1	5.0	-1.8
	L1c	32	23.3 ± 0.2	5.2	75	23.0 ± 0.2	7.0	94	23.3 ± 0.1	5.6	0
<i>Aquila n. orientalis</i>	Lb	6	39.6 ± 0.9	4.8	10	39.1 ± 0.5	4.1	51	41.1 ± 0.7	4.8	+1.3
	Hb	7	20.5 ± 0.4	5.4	10	19.8 ± 0.4	5.6	53	20.1 ± 0.7	3.8	-0.5
	L1c	7	34.3 ± 1.2	8.6	10	35.9 ± 0.9	7.5	50	35.6 ± 2.1	7.8	+0.5
	L2c	7	33.6 ± 0.2	5.7	10	34.5 ± 0.8	6.7	-	-	-	+1.1
	Lb	3	42.8 ± 1.3	4.2	7	41.7 ± 0.8	5.0	4	41.4 ± 0.5	2.2	-1.0
<i>Aquila n. nipalensis</i>	Hb	4	21.5 ± 1.0	8.4	7	21.7 ± 0.4	4.6	4	21.3 ± 0.4	3.3	-0.2
	L1c	4	38.9 ± 1.2	5.1	7	38.2 ± 0.9	6.0	4	37.7 ± 0.9	4.0	-0.8
	L2c	4	35.2 ± 0.9	4.3	7	35.8 ± 0.8	5.6	4	35.5 ± 0.9	4.2	+0.2
	Lb	16	44.0 ± 0.6	5.7	7	44.7 ± 0.5	2.7	13	45.3 ± 0.7	5.5	+1.4
	Hb	14	23.7 ± 0.2	3.4	7	24.0 ± 0.2	2.5	14	23.7 ± 0.3	4.2	0
<i>Aquila heliaca</i>	L1c	14	39.8 ± 0.8	7.0	8	39.2 ± 0.6	4.1	15	39.6 ± 0.7	6.8	-0.2
	L2c	14	36.7 ± 0.6	6.3	8	36.3 ± 0.5	3.6	14	36.4 ± 0.6	6.0	-0.4

Table 2. Changes of metric traits in different forms (subspecies) of male birds of prey in sequential time periods (see Table 1).

Subspecies	Trait	Periods			N	Size	CV	1931-1987			CV	t
		1824-1900	Size	CV				N	Size	CV		
<i>A.g. gentilis</i>	Lw	7	321,6±1,5	1,2	15	325,5±1,6	1,8	16	318,5±3,0	3,6	-0,9	
	Lt	7	200,0±4,5	5,5	15	215,0±3,6	6,2	16	222,8±4,6	8,1	+3,5	
	Lb	7	22,2±0,2	2,3	15	22,2±0,2	3,6	16	21,8±0,2	4,1	-1,4	
	Hb	7	13,6±0,2	3,7	15	13,6±0,1	2,2	16	13,5±0,1	3,0	-0,4	
	Lic	7	26,8±0,4	3,7	15	27,9±0,2	2,5	16	27,9±0,3	3,6	+2,2	
<i>F.ch. danubialis</i>	Lw	22	361,7±2,0	2,5	10	363,0±4,1	3,4	8	362,3±6,5	4,7	+0,1	
	Lt	22	192,8±1,5	3,5	10	203,7±3,9	5,7	8	197,0±3,1	4,2	+1,2	
	Lb	22	21,3±0,2	4,2	10	21,5±0,3	5,1	8	21,8±0,3	3,7	+1,4	
	Hb	22	12,9±0,1	4,7	10	13,2±0,2	4,5	8	13,1±0,2	5,0	+0,9	
	Lic	22	21,2±0,2	3,8	10	20,8±0,2	3,4	8	21,5±0,5	6,5	+0,6	
<i>F.ch. cherrug</i>	Lw	6	353,7±3,8	2,4	10	354,8±3,7	3,2	10	354,3±3,5	3,0	+0,1	
	Lt	6	194,8±2,1	2,4	10	190,3±2,4	3,7	10	191,8±3,8	5,9	-0,7	
	Lb	6	21,2±0,4	4,7	10	21,4±0,3	3,7	10	21,5±0,3	4,2	+0,6	
	Hb	6	13,2±0,3	4,5	10	13,3±0,1	2,3	10	12,9±0,2	4,7	-0,8	
	Lic	6	20,8±0,4	3,8	10	21,5±0,2	2,8	10	21,1±0,2	3,3	+0,7	
<i>F.cherrug (sum)</i>	Lw	37	361,5±2,2	3,7	75	362,3±1,8	4,1	82	360,2±2,0	5,0	-0,4	
	Lt	36	194,4±1,4	4,4	80	196,3±1,4	6,4	80	195,8±1,5	6,7	+0,7	
	Lb	36	21,4±0,2	6,1	83	21,2±0,1	6,1	83	21,2±0,2	10,4	-0,7	
	Hb	36	13,0±0,1	5,4	76	13,2±0,1	4,5	82	13,1±0,1	9,2	+0,7	
	Lic	37	21,2±0,1	4,2	75	21,5±0,1	5,6	84	21,5±0,1	5,6	+2,1	
<i>A.n. orientalis</i>	Lb	17	37,9±0,5	5,5	14	38,4±0,7	6,8	51	37,4±1,4	4,2	-0,3	
	Hb	18	19,3±0,2	4,7	15	19,8±0,2	4,0	51	19,1±0,7	3,9	-0,3	
	Lic	18	32,5±0,4	5,2	15	33,0±0,7	8,2	35	33,2±1,2	4,9	-0,2	
	L26	18	31,7±0,4	4,7	15	31,8±0,6	7,2	-	-	-	+0,1	
<i>A.n. nigralensis</i>	Lb	2	40,4±2,0	5,0	14	39,3±0,5	5,1	4	39,2±0,7	2,8	-0,6	
	Hb	2	21,2±0,6	2,8	15	20,9±0,2	3,8	5	20,7±0,3	2,4	-1,3	
	Lic	3	33,8±1,5	5,9	15	33,4±0,8	9,0	4	32,3±0,7	3,4	-0,9	
	L26	3	33,3±1,6	6,9	15	32,6±0,6	6,7	4	32,0±0,8	4,1	-0,7	
<i>Aquila heliaca</i>	Lb	12	42,1±0,6	4,5	-	-	-	8	41,4±0,7	4,8	-0,8	
	Hb	12	22,6±0,3	4,9	-	-	-	8	22,4±0,3	3,6	-0,5	
	Lic	12	35,0±0,6	6,3	2	34,4±0,3	-	7	34,7±1,1	7,8	-0,2	
	L26	12	33,5±0,6	5,7	2	33,1±0,2	-	7	33,9±1,2	8,6	+0,3	

Table 3. Sexual dimorphism indices ($\bar{r}$) in different sub-species of birds of prey in the Palaearctic (1824 - 1987)

Subspecies Trait	<i>F. ch. danubialis</i>				<i>F. ch. cherrug</i>				<i>F. cherrug</i> (sum)							
	Lw	Lt	Lb	Hb	L1c	Lw	Lt	Lb	Hb	L1c	Lw	Lt	Lb	Hb	L1c	
1. 1824-1900		91.5	86.4	89.5	88.4	89.8	92.1	91.0	89.8	93.6	90.0	92.0	89.4	91.1	91.5	91.0
2. 1901-1930		94.7	94.1	93.1	95.0	93.7	90.3	89.5	93.5	94.3	94.7	93.2	91.6	92.2	94.3	93.5
3. 1931-1987		94.3	92.5	94.8	94.9	96.4	91.0	90.2	90.7	92.8	90.6	92.6	91.1	90.6	94.2	92.3
trend in time	1-2	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-
intervals	2-3	+	+	-	+	-	-	-	+	+	+	+	+	+	-	+

Subspecies Trait	<i>A. gentilis gentilis</i>				<i>A. n. orientalis</i>				<i>A. n. nipalensis</i>				<i>A. heliaca</i>					
	Lw	Lt	Lb	Hb	L1c	Lb	Hb	L1c	L2c	Lb	Hb	L1c	L2c	Lb	Hb	L1c	L2c	
1. 1824-1900		87.0	85.5	84.1	86.5	78.4	95.7	94.1	94.8	94.3	94.4	98.6	86.9	94.6	94.3	95.4	87.9	91.3
2. 1901-1930		89.2	83.7	84.7	88.2	84.0	98.0	100	91.9	92.2	94.2	96.3	87.4	91.1	-	-	-	-
3. 1931-1987		86.8	83.8	82.8	88.8	82.8	91.0	95.0	90.4	-	94.7	97.2	85.7	90.1	91.4	94.5	87.6	93.1
trend in time	1-2	-	+	-	-	-	-	-	+	+	+	+	+	+	+	+	+	-
intervals	2-3	+	-	+	-	+	+	+	+	+	-	-	+	+	-	+	+	-

comment: + tend to increase ($\bar{r}$)
- tend to decrease ($\bar{r}$)

last decades, leading to the direct correlation of many events in the eagle's life to the migratory status and time schedule of cattle and other ecological parameters of saiga (Zhironov 1992; Fadeev 1986).

We believe that further *nipalensis* specialisation for rodent capture (marmots, susliks and mice) is mainly responsible for the progressive diminution of the species. That this process is natural is suggested by the constant degree of sexual dimorphism in nominal subspecies (Table 3), even against the background of simultaneous diminution of males and females. *Orientalis*, inhabiting the region of densest saiga population (Kalmikia, Kazakhstan), had changes in degree of sexual dimorphism with differently directed trends between the three periods.

The second cause is the change in age structure of the populations of raptors. If this process is due to extermination of the adults, the nesting places are liberated for the young and this alters the general appearance of the population. For Goshawks from Denmark, such a process of replacing adult breeding females by younger ones was described in detail by Thissen (1981). Young Goshawks have different body proportions from the adults. For example, young North American *Accipiter gentilis atricapillus* have shorter wings and longer tails than adults (Mueller *et al.* 1976). This, in addition to other changes in body structure such as wingloading, is suggested to aid flight for the young.

Such selection would promote the process of wing shortening and tail lengthening in the eastern European populations of Goshawks in two ways: first, by larger breeding participation of birds with extreme proportions, and secondly by the gain in power expenditure while hunting numerous small and medium-size prey.

Therefore the anthropogenic changes observed in 20th century Europe and during the last decades on the Asian continent lead to transformation of behaviour, ecology and numerical decrease of birds of prey. They also affect profound biological peculiarities of the species. This is alarming because the direction of the changes does not coincide with the natural evolutionary processes in wildlife. Natural selection is replaced by an artificial one.

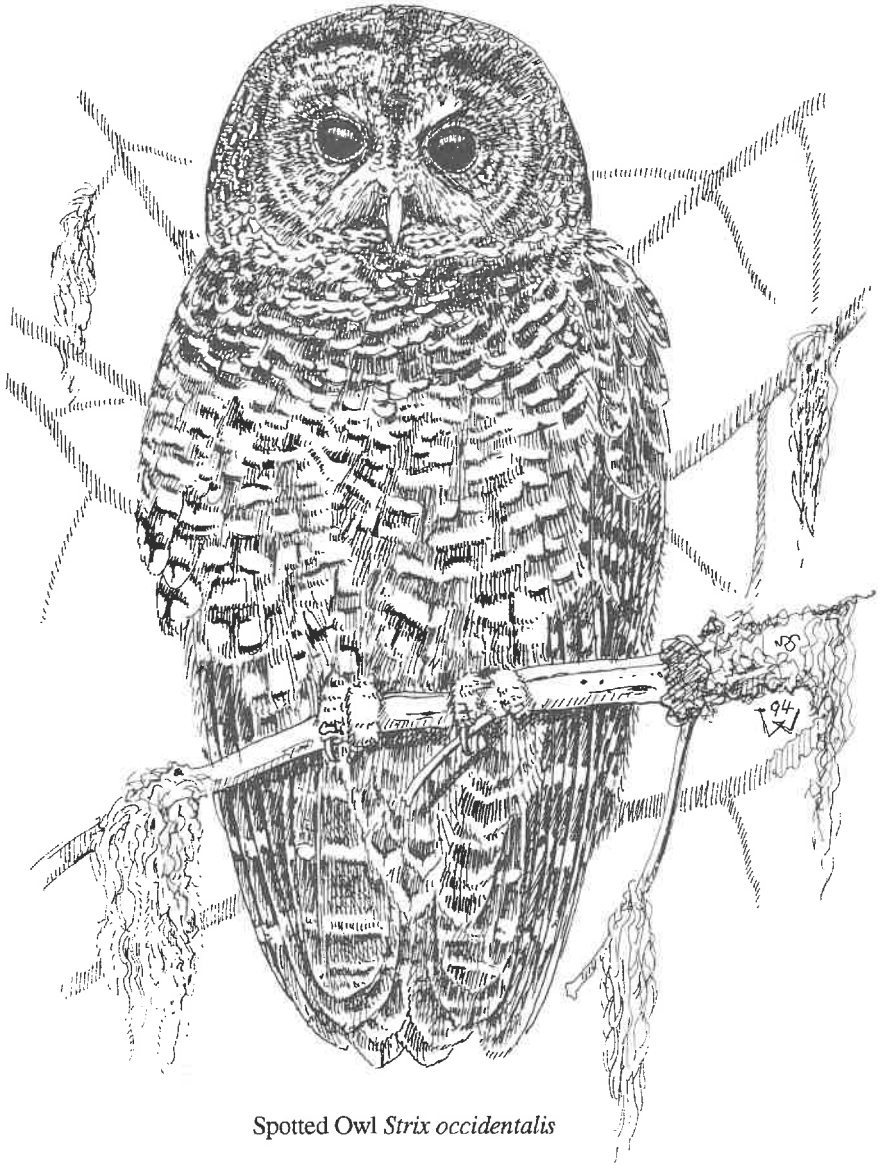
It is impossible to neglect these changes because they violate one of the fundamental principles of nature protection strategy - the conservation of natural biodiversity.

REFERENCES

- DEMENTIEV, G.P. 1951. Ptizi Sovetskogo Sojuza, t.1. Chistsnie ptizi. M., Izdatelstvo AN SSSR. 652
- FADEEV, V.A. 1986. Svjaz stepnich orlov s saigakami v Kazakstane. V kn.: Redkie zhivotnie Kazakstana. Alma-Ata, Nauka: 125-126.
- GLADKOV, N.A. 1941. Taxonomy of Palaearctic Goshawks. *Auk*, v.58, N1: 80-90.
- GRAZHDANKIN, A.V. 1988. Kolichestvennaja ozenka okraske po otrazhatelnoj sposobnosti operenja i vozmozhnosti ejo primenjenja pri issledovanijah izmenschivosti ptiz. *Zool.J.*, t.67, 7: 1066-1072.
- GRAZHDANKIN, A.V. & V.I. PERERVA 1986. Priznaki polovogo dimorfizma u stepnogo orla (*Aquila nipalensis*) i mogilnika (*A. heliaca*). *J. Obshchei biologii*, t. 47, 2: 268-273.
- HILL, N.P. 1944. Sexual dimorphism in the Falconiformes. *Auk*, v.61, N2: 228 - 234.
- JUDIN, K.A. 1953. Morfologitscheskie adaptatsii sem. Falconidae v svyazi s voprosami sistematiki. - V kn.: Pamjati akad. P.P. Suschkina, M. - L: Izdatelstvo AN SSSR: 135-208.
- KALCHREUTER, H. 1981. The Goshawk in Western Europe. In *Understanding the Goshawk*. pp. 18-27.
- KLIMOV, V.V. 1990. Loschadj Przhivalskogo. M.: Agropromizdat: 253.
- KOBYRNZUK, F. 1985. The influence of inbreeding on the shape and size of the skeleton of the European bison. *Acta theriol.* v.30,n 21-31: 379-422.
- KORELOV, M.N. 1962. Ptitsi Kazakstana. t.2. Otrjad chistsnie ptizi. Alma-Ata, Izdatelstvo AN Kaz.SSR: 488-707.
- KOZLOVA, E.V. 1969. Rodstvennije svyazi sokolov-balobanov i kretscheta i verojatnaja istorija ih rasselenija. *Zool.zh.* t.48, v.12: 1838-1851.
- MAYR, E. 1970. Printsipi zoologitscheskoj systematiki. M., Mir, 454.
- MUELLER, H.C., D.D. BERGER & G. ALLEZ 1976. Age and sex variation in the size of Goshawks. *Bird-Band.*, v.47,N4: 310-318.
- OSMOLOVSKAJA, V.I. 1953. Geographitscheskoje raspredelenije Chistjih ptits ravninnogo Kazakstana i ich znatschenije v istrebleniji vrediteljei. *Tr. Inst., geogr. Mat. po biogeogr SSSR*, v.54, 219-307.

- PAAVER, K.L. 1965.** Formirovanije teriofauniji i izmentschivost mlekopitajuschich Pribaltiki v holotsene. Tartu, 493.
- PERERVA, V.I. 1988.** Soprijazhennost geographitscheskoji izmentschi vosti pitanija i podvidovoji structurji khitschnich ptiz.-V kn.: Ekologija i povedenije ptits. M.: Nauka, 54-64.
- PRONJAEV, A.V. 1986.** Phenotypitscheskaja charakteristika populjatsciji saigaka.- Tes.dokl. 4 sjezda Vsesojuzn. teriol. obtschestva, t.3, M., Nauka, 163-164.
- STEPANIAN, L.S. 1975.** Sostav i raspredelenije ptits fauni SSSR: Nevorobjinije. M.: Nauka, 370.
- THISSEN, J., MÜSKENS G. 1981.** Trends in the Dutch goshawk population.- in *Understanding the Goshawk*. 28-42.
- TOMIALOJ, L. 1985.** Urbanization as a test of adaptive potentials in birds.- Acta XVIII Congressus Internat. ornithol., August 16-24. 1982. Moscow. Nauka, v.2: 608-614.
- WARSCHAVSKIJI, S.N., R.S. WARSCHAVSKIJI, V.K. GARBUZOV, P.I. KAMNEV A.V. POPOV, M.N. SCHILOV & N.V. TSCHEPOTJIEV 1983.** Osobennosti razmetschenija i tschislennosti populatsiji stepnogo orla v zapadnoji tschasti areala v svjazi s tschislennostju malogo suslika. V kn.: Vid i ego produktivnost v areale. M.: Nauka: 48-53.
- WATTEL, J. 1981.** The goshawk and its relatives.- In *Understanding the Goshawk*. 6-15.
- WAICK, F. 1980.** *Die Greifvögel der Welt*. Hamburg, Berlin: P.Parey. pp.159.
- WERESTSCHAGIN, N.K. & O.S. RUSAKOV 1979.** Kopjitiije severo-zapada SSSR, L.: Nauka, 308.
- WLADJISCHEVSKIJ, D.V. 1973.** Morphologitscheskije reaktscii ptits izmenenije usloviji suschestvovaniija v anthropogennom landschafte.- V Kn.: Problemi evolutsii. Novosybirsk, :Nauka, t.3. 242-248.
- WLADJISCHEVSKIJ, D.V. 1975.** Ptitsi v anthropogennom landschafte. Novosybirsk, : Nauka: 198.
- ZHIRNOV, LV. 1982.** Vozvraschtsenije k zhizni: Lesnaja promischlennost, 223.
- ZALKIN, V.I. 1962.** K istorii zhivotnovodstva i ochti v vostotschnoji Europe.- Mat. issledov. po archeologii SSSR, N 107: 5-129.
- ZUROWSKI, W. H.SIUDOWA & B.GALKA 1970.** Effect of single pig's blood addition on the local wild bear (*Sus scrofa*) population. *Transactions of IX Internat. Congr. of Game Biologists* (Moscow, September 1969) Moscow: 253-238.

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Spotted Owl *Strix occidentalis*