Ecological Communication

Body Parameters of Wolves (*Canis lupus campestris*) in the Steppes of Kazakhstan

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ABSTRACT

The study of the morphometric characteristics of the wolf was aimed at identifying the potential properties of the species and intraspecific individual geographic and age variability depending on the habitat. The carcasses of 36 male and 26 female wolves were examined. This paper presents the results of morphometric studies of wolves of the Kazakh steppes, *Canis lupus campestris*. The animals of three identified areas (western, central, and eastern sections) were compared within their habitat. It was discovered that wolves throughout the habitat had practically no significant differences and were almost identical in appearance. At the same time, there was an increase in body length from west to east and in body weight from east to west. The morphological features of wolves from different areas were as follows: the wolves of the eastern area were larger, the animals of the central area were higher on their legs and had a squarer shape, and the animals of the western area were heavier. Pronounced sexual dimorphism was characteristic of the entire studied habitat. Comparison of the results obtained with the literature data showed that the steppe Kazakh wolves were morphologically similar to the wolves of the southeast of Ukraine and significantly different from the wolves of the Altai Territory. Besides, it turned out that representatives of subspecies *C. l. campestris* and *C. l. desertorum* were similar in body weight and length. It was also found that wolves in the steppes of Kazakhstan were subjected to intense hunting pressure, which is why the population core is actively renewed. The main result of the study is the clarification of the intraspecific structure depending on the habitat.

KEY WORDS: KAZAKHSTAN, MEASUREMENTS, MORPHOMETRY, STEPPE TERRITORY, WOLF CANIS LUPUS CAMPESTRIS.

INTRODUCTION

Separate works have been devoted to the intraspecific polymorphism of wolves and their subspecies systematic status (Bondarev, 2012, 2013; Yudin, 2013, Wagner and Ruf, 2019, Alvares et al., 2019). For Kazakhstan, the taxonomy of wolves was considered poorly developed as early as in the middle of the last century. The situation has not changed to this day. Some authors distinguish only two ecological forms of the wolf (forest wolf and desert-steppe wolf, others believe that the borders of Kazakhstan include the habitat of four subspecies, or races (Geptner, 1967) (Siberian forest wolf *C. l. lupus* and *C. l. altaicus*, desert wolf *C. l. desertorum*, steppe wolf *C. l. campestris*, mountain, or Tibetan, wolf *C. l. chanco*). The geographic variability of Kazakhstani wolves is high, but it has not been studied enough (Boitani et al., 2018; Shmalenko, 2020; Bergström et al, 2020).

The object of our research is the steppe subspecies of the wolf *Canis lupus campestris*, which occupies the steppe territory of Kazakhstan. Its habitat runs from the Altai and Tarbagatai mountains in the east to the Caspian Sea in the west; and in the north of the Caspian Sea, it continues further west into the southern Russian steppes (Geptner, 1967). The southern border of its distribution is in the area of the desert zone, the Betpak-Dala plateau, and the Ustyurt plateau. In the north, the area is limited to the forest-steppe zone. Outside the republic, the steppe wolf is found in the east of Lebanon (Yudin, 2013), in the

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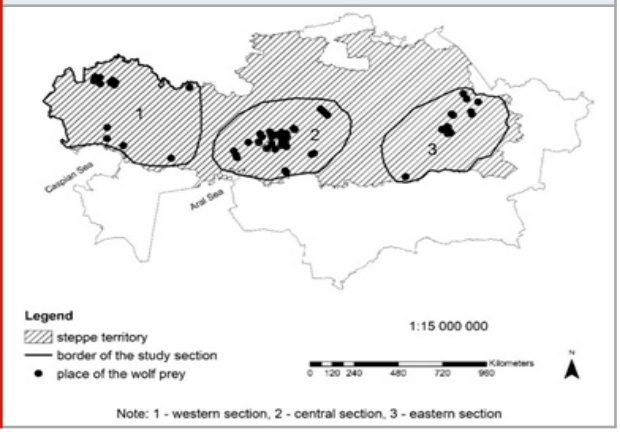
southern and eastern parts of Ukraine (Geptner, 1967), in the south of the European part of Russia, in the southern regions of Western Siberia (Bondarev, 2017, Bondarev & Malikov, 2018; Boitani et al., 2018; Shmalenko, 2020), in Transbaikalia and Mongolia, as well as in the north of China and the south of the Amur region (Yudin, 2013; Shmalenko, 2020).

Large-scale studies of steppe wolves in Kazakhstan have not been carried out yet. There are only a few regional data on the Aktobe region. This work is being performed for the first time. Its result demonstrates the exterior features of the physique and their variations in *Canis lupus campestris* in the steppe biogeocenoses of Kazakhstan, along their entire length. The purpose of this work is to study the parameters of the physique of wolves and their geographic variability in the steppe territory of Kazakhstan.

MATERIAL AND METHODS

In the ecological aspect, the area of collection of the material was a steppe. In Kazakhstan, the steppe occupies the northern and central regions, covering about 160 million ha, which is 59% of the republic's area, of which about 123 million ha are natural habitats. The immediate research area is located between 46° and 51° north latitude, 47° and 81° east longitude and has a length of 2.5 thousand km and a width of about 0.5 thousand km. Such a vast area of the steppe territory, as well as differences in the living conditions of animals, suggest the existence of morphometric differences in different ecological groups of wolves of the steppe subspecies. These circumstances prompted us to distinguish three areas within the studied region: the western, central, and eastern sections (Figure 1).

Figure 1: The area of the wolf study in Kazakhstan. Source: the figure was created by authors.



Note: 1 - western section, 2 - central section, 3 - eastern section

The western section is about 40 million ha and occupies the territory of the Caspian lowland and the Ural-Emba plateau, including the southern outskirts of Obshchy Syrt. The central section is about 30 million ha and occupies the plain of the Northern Aral Sea region and the Turgai plain. The eastern section is also about 30 million ha and is located on the territory of the Central Kazakhstan Uplands. A common feature of the climate in Kazakhstan is pronounced aridity and a high degree of continentality, with large daily and annual air temperature amplitudes and a significant moisture deficit. The object of the study was the wolf (*Canis lupus campestris* Dwigubski, 1804). The material was carcasses of wolves hunted by hunters from November to March in the period from 2017 to 2020. All animals were legally shot based on special permits for the hunting of animal species, the number of which is subject to regulation (KZ94VQQ00002234 dated 29.12.2017, KZ18VQQ00002244 dated 29.12.2017, KZ60VQQ00001100 dated 12.04.2017, KZ43VQQ00000533 dated 14.02.2017, KZ54VQQ00001305 dated 27.04.2017, KZ23VQQ00004191 dated 02.03.2018, KZ64VQQ00007333 dated 18.02.2019, KZ39VQQ00007298 dated 18.02.2018, KZ55VQQ00007107 dated 18.02.2019, KZ28VQQ00007302 dated 18.02.2019, KZ67VQQ00006988 dated 18.02.2019, KZ24VQQ00007083 dated 18.02.2019, KZ49VQQ00007118 dated 18.02.2019, KZ68VQQ00006970 dated 15.02.2019, KZ75VQQ00009948 dated 22.05.2019, KZ92VQQ00009448 dated 14.03.2019, KZ22VQQ00009447 dated 14.03.2019, KZ49VQQ00009446 dated 14.03.2019, KZ38VQQ00011584 dated 15.01.2020, KZ64VQQ00013832 dated 17.01.2020, KZ72VQQ00016695 dated 23.01.2020).

Special permits for the withdrawal of animal species, the number of which is subject to regulation, were issued by the territorial divisions of the Committee for Forestry and Wildlife at the request of individuals (hunters) through the electronic government web portal www.elicense.kz in electronic form. A total of 61 killed wolves were measured, of which 36 were males and 25 females (Table 1).

According to the degree of tooth wear, all studied individuals were divided into three age groups: young or less than a year old (from 7 months to 1 year), semi-mature or yearlings (from 1.5 years to 2 years), mature or adults (over 2.5 years). Among the mature wolves in the studied sample, only two males from the eastern section and one female from the western section were older than 6 years. Determination of morphological parameters of the physique was carried out by measuring the body and its parts using a centimeter elastic tape with a scale of 1 mm, a 150 mm mechanical caliper (accuracy up to 0.02 mm), and a 500 mm mechanical caliper (accuracy up to 0.1 mm). Determination of total body weight was carried out using an electronic balance (accuracy up to 5 g). Measurements were taken according to generally accepted methods.

The data obtained were transferred to an electronic database, where they were grouped according to the gender and age of the animal, taking into account if they belonged to the western, central, or eastern section. Further statistical processing of the parameters was carried out in the Excel program using biometric techniques, and body build indices were calculated. After that, the results were compared with each other, as well as with the data of morphological parameters of other populations from published literature sources. The criterion for the selection of such populations was the territorial proximity of the region to Kazakhstan, as

well as the historical distribution area of the steppe wolf. Thus, to compare the data, wolves were selected from the adjacent territory of the southeast of Kazakhstan plains, southeast of Ukraine, as living within the habitat of *C. l. campestris* (Geptner, 1967), and the wolves of the Altai Territory, where the penetration of migrant steppe wolves from the territory of Kazakhstan to the territory of Russia is observed (Bondarev, 2013; Rakin, & Bondarev, 2020).

Table 1. Distribution of the studied wolves by regions of their killing

Gender and age groups	Number of measured animals by region, individuals				
	Western section	Central section	Eastern section	Total:	%
males (Mature: yearlings: less than a year old)	8 (4:3:1)	17 (8:5:4)	11 (6:4:1)	36 (18:12:6)	59
females (Mature: yearlings: less than a year old)	6 (1:0:5)	16 (2:6:8)	3 (1:2:0)	25 (4:8:13)	41
Total: (Mature: yearlings: less than a year old)	14 (5:3:6)	33 (10:11:12)	14 (7:6:1)	61 (22:20:19)	100

Table 2. Results of using the Chi-square (χ2) test to assess the distribution of the studied sample by gender and age groups

Indicator	Mature wolves	Yearlings wolves	Wolves less than a year old	Note
all wolves				
Observed (O)	22	20	19	N=61
Theoretically expected at 1:1:1(E)	20.33	20.33	20.33	N=61
(O-E)2/E	0.14	0.14	0.14	χ2=0.41
males				
Observed (O)	18	12	6	N=36
Theoretically expected at 1:1:1(E)	12	12	12	N=36
(O-E)2/E	3	0	3	χ2=6.0
females				
Observed (O)	4	8	13	N=25
Theoretically expected at 1:1:1(E)	8.33	8.33	8.33	N=25
(O-E)2/E	2.25	0.01	2.61	χ2=4.87

Table 3. Body weight of wolves of different gender and age groups in the context of regions, kg

Age group	Western section		Central section		Eastern section	
	n	M±m	n	M±m	n	M±m
Males mature	4	33.4±1.51	6	31.9±2.13	4	34.0±3.07
yearlings	2	27.7±0.35	4	32.5±2.07	3	31.1±0.81
wolves less than a year old	1	25.5	3	26.3±2.45	1	27.9
Females						
mature	1	23.5	2	24.7±1.85	1	27.6
yearlings	-	-	6	23.9±0.81	2	28.0±0.5
wolves less than a year old	5	26.1±0.76	7	25.2±0.49	-	-

RESULTS AND DISCUSSION

The poor knowledge of the steppe wolf was noted by Geptner (1967). Our studies of the subspecies showed the following results. The average age of wolves in the adult group is 3.5+ years, which indicates the intensive hunting of the population. This is confirmed by the low share of fertile animals in the sample (22%). Consequently, the population core is being actively updated. In our study, the ratio of the number of males to the number of females, in general, equaled 1.44:1. This ratio varies by age group: 1:2.2 among wolves less than a year old, 1.5:1 among yearlings, and 4.5:1 among the mature wolves. A similar ratio of males to females 1.4:1 was recorded by Tsyndyzhapova (2003) for the Baikal National Park. Smirnov and Korytin (1985), based on an analysis of numerous literature data on hunted wolves and an examination of museum collections, also found the predominance of males (1.22: 1 in the young wolves, 1.4:1 in the yearlings, and 1.28:1 in the mature ones). The ratio of mature wolves, yearlings, and young wolves in our material is 36%:33%:32%, which corresponds to a 1:1:1 ratio. Separately, by gender, the ratios are directly opposite: 50%:33%:17% for males, which is close to 3:2:1, and 16%: 32%: 52% for females, which coincides with 1:2:3. In a healthy population, underyearlings always predominate, with a decrease in the number of individuals of subsequent age categories (Yudin, 2013; Gankhuyag et al., 2021).

However, in our case, the number of young animals is practically equal to the number of semi-mature animals. One of the reasons may be the practice of wolf cub removal from the dens by the locals in the eastern part of the territory, as well as the extermination of the wolf in the early autumn period (due to damage to cattle breeding), which is not so developed in the central and western areas. Since young animals, due to their inexperience, are easier prey than adults, by the winter season, most of them are already dead in the eastern part of the habitat, the result of which we observe in the sample from this site. An increase in the proportion of young females over adults, as well as a twofold excess of females over males in the migrant group, might be a reaction of the genetic mechanism for regulating the gender ratio with a decrease in the density of animals. A similar picture was observed by Yudin (2013) in intensively developed populations. At the same time, the influence of the characteristics in the behavior of animals cannot be ruled out. Adult females, as more cautious individuals, are more likely to avoid being shot from a snowmobile than adult males, who, according to some hunters, often take on the role of distracting the pursuer. For this reason, there are probably fewer adult females in the sample than could be (Dhargupta, et al., 2020; Gankhuyag et al., 2021).

However, taking into account the ratio of five young wolves per fertile female, we assume that our sample is representative in terms of the gender and age structure of the entire population in the autumn-winter season. Taking into account the above, we carried out a statistical analysis of the studied sample of steppe wolves using the generally accepted Chi-square ($\chi 2$) test by calculating it and comparing the obtained value with the table value taking into account the number of degrees of freedom (Peker and Kubat, 2021). The observed distribution by gender does not differ from the theoretically expected one, since the actual value of the Chi-square test is less than the standard value with the number of degrees of freedom = 1. The observed distribution by age groups of the entire sample, and females in particular, also does not differ from the theoretically expected value, since the observed value of the Chi-square test is less than the standard value with the number of degrees of freedom = 2. At the same time, the analysis of age groups of males showed a significant difference between the observed distribution and the theoretically expected one in a ratio of 1:1:1, since the observed value of the Chi-square test corresponds to the tabulated value at P = 0.05 and the number of degrees of freedom = 2 (Table 2).

Body weight: The wolf that lives in the central regions of Kazakhstan has an average body size and weighs up to 55 kg (Kuznetsov, 1948). In our studies, the maximum weight of animals did not exceed 42 kg. The heaviest male at the age of 2.5+ years was obtained in the eastern section. The lightest male (25.3 kg) was obtained in the central section at the age of 2.5+ years. The average weight of adult males throughout the steppe territory equaled 32.9 ± 1.26 kg, with the heaviest animals living in the eastern section and the lightest in the central. The difference in weight between these populations was 6%. A female with a maximal weight of 29 kg was obtained in the central section at the age of about 9 months. A female with a minimum weight of 21 kg was obtained in the same area at the age of 1.5+ years.

The average weight of adult females was 25.1 ± 1.16 kg, which is 1/5 less than that of males. The males of the young wolves group had an average weight of 22.0 ± 1.28 kg, that is, 28.8% lower than that of the next age group of yearlings. In yearling males, the arithmetic mean weight corresponded to 30.9 ± 1.1 kg, which is 6% lower than the average weight of adult males. However, in the central area, the mass of yearling males was 1.8% higher than the mass of mature males. In females, the average weight of the young wolves was practically equal to the weight of the mature ones (25.6 ± 0.43 kg), and the mass of the yearlings was slightly lower (24.9 ± 0.91 kg). Unfortunately, single specimens of adult females by region cannot provide sufficient representativeness of the sample. We can unambiguously state that the animals of the eastern section had the largest body weight and that there was a decrease in this indicator in the central and western parts of the habitat (Table 3).

The coefficient of variation in males is almost two times higher than that of females and amounts to 14.7%, while in females it deviates only by 7.8%. This fact fits into the framework of the concept of gender differentiation by Geodakyan (1981), whose central position is the conclusion about the greater phenotypic variance (diversity) of males as compared to females. This

statement applies to most of the linear measurements we have made. Taking into account the presence of the acceleration effect in the wolf, noted in the 20th century, we compared the data on the mass of animals in the Aktobe region with our results (Table 4).

The Aktobe region is located within the western part of the study area, which is why the wolves weighed in the 1980s and wolves in the western part of our sample are animals of the same population, separated by a 30-35-year time interval. It makes no sense to analyze the change in mass in adult females and young males because of the single individuals in our sample. However, the change in the age dynamics of the mass of animals is evident. Thus, modern young wolves demonstrate a significant increase in weight in comparison with animals of the same age (for females up to 19.18%), while for mature males and yearling males, this indicator practically has not changed (0.6-0.7%).

Table 4. Changes in body weight of wolves in the western population over the past 30-35 years, kg

Observation period	Average indicator		Adults		Yearlings		Wolves less than a year old	
	males	females	males	females	males	females	males	females
1985	29.0±0.89	24.1±0.67	33.6±0.95	29.7±0.85	27.5±1.16	24.8±0.5	23.6±1.3	21.9±0.95
2017-2020	30.6±1.56	25.7±0.76	33.4±1.51	23.5	27.7±0.35	-	25.5	26.1±0.76
Acceleration effect,%	+5.52	+6.64	-0.60	-20.88	+0.73		+8.05	+19.18
t-test	0.87	1.53	-0.11		0.16			3.38

Table 5. The main indicators of linear measurements and body build indices of adult (mature) wolves

Parameter	Male indicators			Female indicators		
	Western section (n=3-4)	Central section (n=7-8)	Eastern section (n=5-6)	Western section (n=1)	Central section (n=2)	Eastern section (n=1)
Body length, cm	115.7±5.04	122.4±4.56	125.4±2.54	108.0	117.0±5.00	113.0
Oblique body length, cm	73.0±2.94	72.6±1.21	78.0±2.30	64.0	69.5±1.50	72.0
Height at the withers, cm	66.3±1.89	67.1±1.72	66.0±0.84	58.0	63.5±3.5	60.0
Chest circumference, cm	74.5±1.71	72.3±2.39	71.0±2.68	64.0	68.8±1.25	68.5
Foot length, cm	23.4±1.07	23.4±0.48	24.3±0.35	23.0	23.5±0.50	23.0
Stretch (Format) index, %	110.4±4.64	108.8±2.59	118.2±3.06	110.3	109.9±8.42	120.0
Massiveness index, %	112.9±5.18	108.1±2.21	107.5±3.34	110.3	108.5±4.01	114.2
Long-muzzle index, %	38.4±2.11	40.0±1.07	39.4±0.51	39.7	42.9±0.25	39.6
Broadhead index, %	49.7±3.87	48.7±2.49	51.8±2.17	51.4	47.6±0.50	50.6

Thus, the average total weight of males in the population showed an increase of 5.5%, and the weight of females by 6.6%, mainly due to the greater weight of young wolves. The increase in the bodyweight of young animals in our studies can be explained by the better provision of the forage base in 2017-2020 during the period of rearing the offspring, compared with the 1980s. Thus, in 1983-84 and 1984-85 massive deaths of saigas (Saiga tatarica) were observed (Nurushev, & Bajtanaev, 2018). Besides, from 1983 to 1988, according to the data of the Mangistau anti-plague station (Kaijrbaev, et al., 2019; Stasenko, & Zhupkali, 2019; Gankhuyag et al., 2021), a deep depression in the abundance of the great gerbil (Rhombomys opimus) was observed. Saiga and gerbils make up more than 70% of the diet of wolves in this area (Leontyev, 2017); therefore, a significant reduction in these food items is most likely reflected in the weight gain of young wolves (Stasenko, & Zhupkali, 2019; Gankhuyag et al., 2021).

Body length: The body length of adult males increases from west to east, with an intermediate value in the central section. As in mature males, the elongation of the body in the eastern direction is observed in males and females of the groups of yearlings and young wolves.

In adult females, the dynamics of an increase in body length from the western section to the central one is also traced, but this indicator decreases in the eastern section (Table 5). Probably, this is due to the small size of the sample which contained single individuals of extreme populations. Thus, in general, for steppe wolves, there is a clear tendency to increase in body length from west to east.

Oblique body length: In adult males, the oblique body length is maximum in the east and minimum in the central part of the habitat, with an average value in the western part. In adult females, this value decreases from east to west. The dynamics of this measurement is similar to that of mature males in terms of yearlings and young wolves in both genders. Accordingly, the smallest indicator of the oblique body length of the steppe wolves is observed in the central section and the largest one in the eastern section.

Height at the withers: The highest height at the withers among adults for both genders is possessed by animals of the central section: 67.1 ± 1.72 cm for males, 63.5 ± 3.5 cm for females (Table 5). However, in the groups of semi-mature (yearling) and young (less than a year old) wolves in males and females, the maximum height at the withers is noted for the eastern section, with a decrease in this indicator in the western direction. Thus, the geographic-latitudinal dynamics of the average population height at the withers do not correspond to the dynamics of that in mature individuals and demonstrates an increase from west to east. It is possible that this feature is not significant in the geographical difference between the populations under consideration, and due to small samples, it cannot be unambiguously distinguished.

Chest circumference: In adult males, an increase in chest circumference from east to west by 3.5 cm is observed (Table 5). In adult female wolves, as well as in males and females of the yearling group, the largest chest circumference is presented for the central region, the middle one for the eastern region, and the smallest for the western region. In the group of young wolves, both genders tend to increase this indicator from west to east, that is, inversely proportional to the dynamics of the chest circumference of mature males. Thus, according to this indicator, a clear pattern common for all age and gender groups is not expressed, either.

Table 6. Comparison of the main parameters of adult wolves of lowland Kazakhstan, south-east of Ukraine and Altai Territory

Parameter	Indicator	Value							
		the steppe of Kazakhstan		South-East of the lowland Kazakhstan		South-East of Ukraine** (old – more than 6 years****)		Altai territory***	
		males	females	males	females	males	females	males	females
Body weight, kg	M±m	32.9±1.26	25.1±1.16	29.7	26.1	31.4±1.385 (35.3±2.793)	29.7±1.538 (29.9±1.757)	39.87±0.81	33.98±1.03
	t					0.80 (-0.78)	-2.39 (-2.28)	-4.65	-5.72
	The superiority of the steppe wolves of Kazakhstan, %			+9.72	-3.98	+4.56 (-7.29)	-18.33 (-9.12)	-21.19	-35.38
	SDD, %	+23.7		+12.1		+5.4 (+15.3)		+14.8	
Body length, cm	M±m	122.1±2.52	113.8±2.95	115.4	109.4	114.4±2.155 (123.8±3.043)	113.9±2.615 (109.6±1.327)	126.41±2.04	119.6±3.16
	t					2.32 (-0.43)	-0.03 (1.30)	-1.33	-1.34
	The superiority of the steppe wolves of Kazakhstan, %			+5.49	+3.87	+6.31 (-1.39)	-0.09 (3.69)	-3.53	-5.10
	SDD, %	+6.8		+5.2		+0.4 (+11.4)		+5.4	
Height at the withers, cm	M±m	66.6±0.88	61.3±1.97			76.5±0.5	(73±4.163)	78.91±1.23	72.22±0.81
	t					-9.78	(-2.54)	-8.14	-5.13
	The superiority of the steppe wolves of					-14.86	(-1.09)	-18.48	-17.81

SDD, % (the sexual dimorphism degree) is the ratio of the value of the parameter of males to the value of the parameter of females (borrowed from V.G. Yudin, 2013).

** based on materials by Smirnova and Domnich (2012).

*** based on materials by Bondarev (2013).

**** only for the southeast of Ukraine (in addition to the group of adult animals, the authors distinguished old individuals over 6 years into a separate group).

Foot length: The length of the foot in mature males increases from west to east by 0.9 cm (Table 5). However, in females of this group, with the minimum value of this indicator for the western and eastern parts of 23.0 cm, the maximum length was determined for the central part of 23.5 ± 0.5 cm, which is only 0.5 cm more (Table 5). In males and females of yearlings, as well as young females, the change in foot length corresponds to that of adult males. In the mature males, the dynamics are the opposite: the lengthening of the foot is observed from east to west. Despite the insufficient amount of the studied material, there is a tendency to increase the length of the foot from west to east. Many authors quite reasonably consider absolute indicators to be insufficient for assessing conformational characteristics, and use, as more reliable, body type indices, reflecting the proportions of the body (Yudin, 2013).

Stretch (Format) index: The stretch (format) index (the ratio of wolves body length to its height) for males and females of the adult group is characterized by the maximum index for the eastern section and the minimum for the central one. The stretch of mature animals in the eastern part of the habitat is 6-8% more than in animals in the western section, at the same time, this index in the central area is less than in the western section only by 0.3-1.3% (Table 5). The similar nature of the dynamics is expressed in semi-mature and young females. However, according to the yearlings and young males, an opposite picture is observed. The maximum stretch indicator was found in the central section, and the minimum one in the eastern section. Young animals do not yet have a fully formed physique, so the data on them can only supplement the result obtained for adults. Thus, the stretch index has a maximum average value in the eastern section and a minimum in the central section.

Massiveness index: In males of the adult group, there is a regularity in a decrease in the index of massiveness from west to east, while in adult females the minimum indicator is in the central section, and the maximum is in the eastern one (Table 5). On the contrary, in both genders of the yearling group, as well as young males, the maximum value was noted for the central section and the minimum for the eastern one. In young females, an increase in this index is observed in the western direction. In general, for the population, there is an increase in the massiveness of animals with movement to the west.

Long-muzzle index: The ratio of muzzle length to head length in adult wolves is characterized by a maximum value in the central part of the habitat and minimum in the western and eastern parts (Table 5). At the same time, in females of yearlings, this indicator is maximal in the east, and in males of the young group and the group of yearlings, it increases to the west. Young females have a longer muzzle in the central part of the habitat, like wolves of the adult group. Thus, the ratio of muzzle length to head length is maximal for animals of the central part of the habitat.

Broadhead index: The ratio of the head width to its length in mature males and females is minimal in the central part of the habitat (Table 5). Similar dynamics are manifested in males of yearlings and young females. In females of yearlings and young males, there is a tendency towards an increase in this index to the west. Thus, the minimum indicator of the ratio of the width of the head to its length is characteristic of the central region. Comparison of the results of linear measurements, body weight, and body parts in wolves in the context of the populations under consideration undoubtedly gives an idea of the change in one parameter or another in different geographic groups of animals. Based on the considered exterior characteristics of wolves, it can be noted that the wolves of the eastern section are larger and have a longer body; wolves of the central section are higher on the legs, have a more square body and an elongated muzzle; and the wolves of the western section are more massive. When assessing the level of reliability of differences according to Student's test (t-test) of mean population values, the only reliably confirmed difference is in the weight of females in the eastern and central regions, but the insufficient sample size for females in the eastern region allows us to neglect this fact. For the rest of the indicators, no significant differences in body parameters were found between the geographical groups of wolves, based on which it can be concluded that all three populations are very close to each other.

At the same time, wolves in the eastern part of the habitat have a greater morphological difference from the animals in the western and central sections than the animals of these two sections between them. Morphological similarities and differences are determined by the habitat conditions and the species composition of the main food objects (Yudin, 2013). Thus, in our study, the main objects of food for wolves in the western and central sections are saiga and rodents, while in the stomachs of animals from the eastern section, we often found the remains of wild and domestic ungulates. Besides, the eastern section of the steppes is a hilly area with mountain ranges and interspersed forests, while the territory of the western and central sections is mainly low treeless plains (Shmalenko 2020; Gankhuyaga et al 2021).

The closeness of the Kazakh steppe wolves with wolves from other regions can be revealed by comparing their morphological data (Table 6). Comparison of the main parameters of mature wolves of lowland Kazakhstan, south-east of Ukraine, and Altai Territory is shown in Table 6. It shows that the wolves of the Kazakh steppes *C. l. campestris* are similar in body weight and length to the desert wolves *C. l. desertorum* in the southeast of flat Kazakhstan. The differences in measurements fall within the difference in the average values of these parameters between the considered populations of wolves of steppe Kazakhstan. This fact confirms the morphological closeness (if not identity) of the steppe and desert wolves of the Republic of Kazakhstan. Steppe wolves are similar in body weight and length to wolves in southeastern Ukraine, but have significant differences, mainly in males, in height at the withers and chest girth. Thus, if

Ukrainian wolves are on average 13% taller on their legs, then Kazakhstani wolves have a longer body by 6% and a larger chest circumference by 11% (Table 6).

The wolves of the Altai Territory are distinguished, being much heavier (up to a third of the mass of Kazakh wolves), and 18-19% higher on their feet; they are also slightly longer and with a large chest circumference. That means that they surpass the Kazakh wolves in all respects. Thus, in terms of external parameters, the wolves of the Altai Territory are more distant from the Kazakh steppe wolves than the wolves of the southeast of Ukraine. According to the above criteria, adult wolves of the Altai Territory reliably exceed the wolves of steppe Kazakhstan in body weight and height at the withers, while the differences are not significant in body length and chest circumference. Adult male wolves of southeastern Ukraine under the age of 6+ years, in comparison with mature males of steppe Kazakhstan, have significantly lower indicators of height at the withers and chest girth. Based on morphometric data, it can be assumed that the genetic relationship of wolves in the steppe regions of Kazakhstan and Ukraine is preserved, as well as the unity of *C. l. campestris* and *C. l. desertorum* on the territory of Kazakhstan.

Sexual dimorphism is most pronounced in Kazakh steppe wolves, reaching maximum values in terms of the difference in weight and body length. In Altai wolves, the difference in chest circumference and height at the withers is best expressed. Ukrainian wolves have the smallest difference between linear measurements and bodyweight of males and females. According to Yudin (2013), a more pronounced sexual dimorphism characterizes the state of a population at the stage of intensive processes of evolutionary development. As a confirmation, the number of wolves in southeastern Ukraine over 40 years (from 1970 to 2009) increased from 7 individuals (!) to 1,276 individuals (Smirnova, & Domnich, 2012), which suggests the influence of gene drift (the consequences of a "bottleneck"), probably a high proportion of inbreeding and a low degree of genetic diversity in the population. On the contrary, the wolves of steppe Kazakhstan allow us to conclude that they have a higher genetic diversity (Stasenko, & Zhupkali, 2019; Gankhuyag et al., 2021).

SDD, % (the sexual dimorphism degree) is the ratio of the value of the parameter of males to the value of the parameter of females, borrowed from Yudin (2013).

On the territory of the steppes of Kazakhstan, males predominate in the sexual structure of wolves, and their ratio to females is characterized as 1.44:1. The average age of adult animals is 3.5+ years. The ratio of mature wolves to young wolves under the age of two is expressed as 1:3.5. The ratio of mature wolves, yearlings, and young wolves for the entire sample corresponds to a ratio of 1:1:1, but separately for males it equals 3:2:1 and for females 1:2:3. This indicates intense pressure from the selective hunting press, and an active renewal of the population core. All three populations of steppe wolves in Kazakhstan are almost identical in terms of the studied parameters of body build. At the same time, there are slight differences between mature animals:

- the mature wolves of the eastern section have bigger weight, in comparison with the wolves of the central and western sections, by 6.2% and 1.8% for males and by 10.5% and 14.8% for females, respectively;
- the mature wolves of the eastern section have a higher stretch index relative to the wolves of the central and western sections (by 7.9% and 6.6% for males and by 8.4% and 8.0% for females, respectively);
- the mature wolves in the central section have a greater height at the withers compared to the wolves in the western and eastern sections (by 1.2% and 1.6% for males and by 8.7% and 5.5% for females, respectively);
- the mature wolves of the central section have a more elongated muzzle relative to the length of the head, compared with wolves of the western and eastern sections (by 4.0% and 1.5% for males and by 7.5% and 7.7% for females, respectively);
- the mature males in the western section weigh more than the males in the central section (by 4.2%) and the males in the eastern section (by 4.8%).

CONCLUSION

An increase in the average weight of wolves of the western population over the past 30-35 years has been noted in males by 5.5% and in females by 6.6%, mainly due to the greater weight of modern young wolves. In the steppe wolves of Kazakhstan, the degree of sexual dimorphism is more pronounced than in the wolves of the south-east of Ukraine and the Altai Territory. In wolves of subspecies *C. l. campestris* and *C. l. desertorum* on the territory of Kazakhstan, no significant differences in body weight and length were found. The wolves of steppe Kazakhstan are most similar in morphometric parameters to the wolves of the southeast of Ukraine.

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