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Morphological variability of a population of *Anatolica eremita* (Coleoptera, Tenebrionidae): constancy of morphometric indices with variation of linear parameters of the body

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Variation of sizes and body proportions of male and female insects reflects the ecological stability of their populations. Insect populations include small, average-sized and large individuals, which use the ecological niches of their species differently. On the example of the darkling beetle *Anatolica eremita* (Steven 1829), which inhabits the sandy soils of Ukraine's steppe zone, we assessed the variation in body proportions for five groups: from the smallest, by 1.5·SD smaller than the average size, to the largest individuals, larger than average size for the population by 1.5·SD and over. It was found that *A. eremita* females have a smaller range of variation in morphometric characteristics compared to males. The morphometric indices of small-average and large beetles do not significantly change, i.e. average body proportions of *A. eremita* remain constant with variable linear sizes of the beetles. We discovered statistically significant deviation from normal distribution for 5 out of 6 considered morphometric indices, which indicates the existence of as yet uninvestigated natural processes in the studied *A. eremita* population, which need to be researched.

Key words: morphometric indices, intrapopulational variation, asymmetry, sexual dimorphism, body sizes

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INTRODUCTION

The adaptation of living organisms to changes in environmental conditions involves the formation of biochemical and physiological adaptations. One of their manifestations is morphological variation. The shape and linear sizes of the body are in many ways related to an organisms adaptations to conditions of existence (feeding, breeding) (Matthieu et al. 1997; Paetzold et al. 2005). Populations of invertebrates "accumulate" the effects of ecological factors over a certain period of time. The results of the influence of a certain factor are determined by the duration, intensity of the factors influence and synergism with other environmental effects, on the one hand, and by the efficiency of compensatory mechanisms on the molecular, genetic, cellular, organism, populational and ecosystemic levels, on the other hand (Brygadyrenko & Slynko 2015).

Morphological variation of a population is a manifestation of general genetic polymorphism and an indicator of the population s potential resistance in the conditions of high anthropogenic pressure upon its natural ecosystems (Brygadyrenko & Reshetniak 2014). The study of morphological variations of invertebrates allows us to evaluate their population s ability to maintain a constant body shape, to resist changes within average sizes (Brygadyrenko & Korolev 2015), and also to evaluate the properties of the invertebrates environmental conditions (Hodkinson & Jackson 2005). Morphological changes in a population of beetles are usually evaluated using morphometric indices (Brygadyrenko & Reshetniak 2014).

Selection at the level of the individual eliminates those which are not sufficiently adapted to certain environmental conditions, changing not only the average value for a feature or an index, but changing the parameters of statistical distribution, range of a characteristic s variation, therefore reflecting the optimum level of an organism s adaptation to environmental factors at particular levels of intensity (Cohen 1978). The extent of sexual dimorphism can be a sign of not only sexual selection in a population, but also a sign of extreme microclimatic conditions which affect the beetles (high temperature and low moisture of the air in the summer period) and limit the survivability of particular groups of organisms in a population (Bobyliov et al. 2014).

The abundance of darkling beetles in arid zones indicates the significance of their role in the functioning of desert and steppe ecosystems (Rogers et al. 1988; Chen et al. 2004). Darkling beetles are a significant component in the flow of energy in an ecosystem, for they are consumers of dead organic matter and living plant tissue, and are also prey for certain groups of insectivorous vertebrate animals (Cohen 1978; Cloudsley-Thompson 1991). Spatial distribution of darkling beetles within ecosystems depends upon the peculiarities of vegetation cover (Cloudsley-Thompson 1962; Rickard & Haverfield 1965; Rickard 1970; Sheldon & Rogers 1984). Darkling beetles are well adapted to hot and dry climates (Cloudsley-Thompson & Crawford 1970), they can survive droughts (Cloudsley-Thompson 1964; Gehrken & Sømme 1994) and resist climatic fluctuations (Cloudsley-Thompson 1975; Chen et al. 2004). Many researchers consider body modification as likely to be one of the adaptations of this group to environmental conditions (Cloudsley-Thompson 1962; Medvedev 1968, 1990; De Los Santos et al. 2000, 2002).

The range of the genus *Anatolica* Eschscholtz, 1831 includes South Ukraine, South Russia, the southern part of West and East Siberia, Kazakhstan, Mongolia, North and North-West China (Chernej 2005). The wide distribution of *Anatolica* beetles is related to their ability to adapt to extreme conditions of insufficient moisture. The beetles are small in size (no bigger than 15 mm) and have a body shape which ensures relative mobility of all body parts with their very strong conjunctions, which enables them to penetrate the gaps and voids in the soil, therefore allowing them to use it as an environment (Medvedev 1990). *Anatolica* species are characterized by having a reduced second pair of wings and consequent loss of the ability to fly (Medvedev 1990). The genus includes 80 soil-dwelling species (Medvedev 1990; Chernej 2005), the fauna of Ukraine has two species: *A. abbreviata* (Gebler, 1830) and *A. eremita* (Steven, 1829).

The objective of this paper is to evaluate the morphological variability of an *Anatolica eremita* population in the conditions of urban agglomeration under the impact of a complex of anthropogenic factors such as environmental and atmospheric pollution caused by industrial enterprises.

A. eremita inhabits areas with light sandy and sandy loam soils with a sparse grass stand. This species is a polyphytophage, but can feed as a saprophage. Imagoes live for two years. During the diapauses, which last for 8 months, the fat content of *A. eremita* decreases from 12% to 4% (Hoffman 1984). During the reproductive season, females lay eggs no less than twice within a short period (1 - 2 days) (Chernej 2005). The beetles damage wild and cultivated plants (Medvedev 1965).

We suggested three hypotheses 1) the studied population of darkling beetles will be observed to have isometric (not relating to the size of the studied beetle, i.e. whether it is small, average or large) variation in the linear characteristics; 2) the distribution of the indices among females and males will be normal; 3) morphometric indices of smaller or larger individuals will be reliably different compared to the modal group.

MATERIALS AND METHODS

Imagoes of *A. eremita* were collected by manually in late June - early July 2015 in Prydniprovsky district of the city Dnipro, Ukraine (48°262'N, 35°072'E) on sandy soils near pine plantations close to Prydniprovska thermal power station, which is fueled by coal and near more than 10 industrial plants, which produce emissions into the aerial environment of the city. The main pollutants of the environment in the city Dnipro are metallurgical enterprises and producers of electrical energy. The most ecologically hazardous economic activities are metal ore mining, production of electricity, cast iron, steel and ferroalloys. According to the regional report on the condition of the environment in the Dnipropetrovsk Oblast, in 2015 the emissions of Prydniprovska thermal power station came to 32.9 thousand tons, and in 2016 the amount of emissions increased to 61.0 thousand tons (by 85.2%) due to increased production of electricity by 79.1%. The main pollutants of the city Dnipro and their limit value are as follows: dust - 2.7 TLV, ammonia - 1.0 TLV, nitrogen dioxide - 2.8 TLV, formaldehyde - 4.3 TLV, nitrogen oxide - 0.8 TLV, phenol - 1.0 TLV, oxocarbon - 1 TLV, nitrous oxide - 1 TLV. These emissions exert a complex influence on the population of *A. eremita.*

The beetles were collected manually and using Barber pitfall traps of 250 ml. The pitfall traps were buried so the top was at the level of the ground surface.

The collected darkling beetles (111 males and 49 females) were put in a 96% solution of ethanol for two weeks, after which they were air dried. The dried beetles were photographed with a digital camera with resolution 3 Megapixels through a binocular microscope MBS-10. The measuring was done using program ToupView 3.7 (Levenhuk). 11 linear and 3 angular characteristics were measured (Fig. 1). We researched the body length (Lb), head length (Lc), head width between the inner edge of the eyes (Sc), prothorax length (Lp), prothorax width at the forward edge (Sp1), maximum prothorax width (Sp2), prothorax width at the backward edge (Sp3), elytra length (Le), elytra width at points ¼ (Se1), ½ (Se2), ¾ (Se3) of the length of elytra in the direction from scutum to the vertex angle of the elytra, front (A) and back (B) angles of prothorax and the vertex angle of the elytra (C). The following indices were calculated: $(Sc+Sp2+Se1)/3\times Lb$ - ratio of arithmetical mean value of width of the head, prothorax and elytra to body length, Lp/Sp2 - ratio of prothorax length to maximum prothorax width, Le/Lp - ratio of elytra length to prothorax length, Se1/Sp2 - ratio of maximum elytra width to maximum prothorax width, Sp2/Sp3 - ratio of maximum prothorax width to its width at the backward edge, Se1/Se3 - ratio of maximum elytra width to minimum elytra width. To study the characteristics, we calculated $x \pm SD$, Ex and As (Table 1), plotted curves of distribution of the indices for males and females, calculated equations of distribution of characteristics

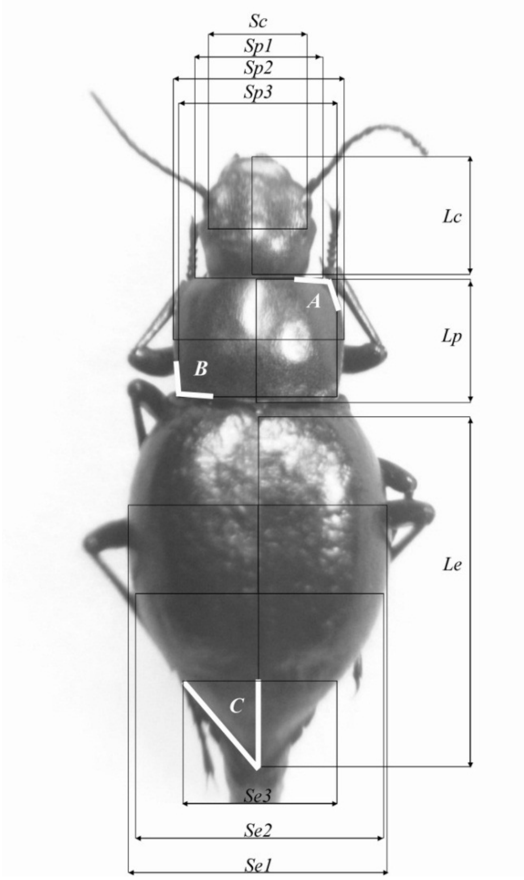

Fig. 1. Studied morphometric characteristics of *A. eremita*: *Lc*-head length, *Sc*-head width, *Lp*-prothorax length, *Sp1*-prothorax width at the forward edge, *Sp2*-maximum prothorax width, *Sp3*-prothorax width at the backward edge, *Le*-elytra length, *Se1*, *Se2*, *Se3*-width of elytra at points ¼, ½, ¾ of the length of elytra in the direction from scutum to vertex angle of elytra respectively, *A* and *B*-front and back angles of prothorax, *C*-vertex angle of elytra

(Fig. 2). To study sexual dimorphism between males and females we carried out analyses of variance (ANOVA) on linear characteristics, angles and indices.

For the evaluation of variation of characteristics depending upon the body length, we made Box Analysis (Fig. 3) for males and females. The abscissa axes showed five size groups according to body length: 1 - from minimum body length to value x - 1.5SD, 2 - from x − 1.5SD to x - 0.75SD, 3 - from x−0.75SD to x+0.75SD, 4 - from x+0.75SD to x+1.5SD and 5 - to x+1.5SD to maximum length according to the individuals N - body length. The axis of ordinates shows the values of the indices: their median, upper and lower quartile and fluctuation range.

The data analyzed in Statistica 13 (Dell Inc.). Differences between the selections were considered statistically significant at $P < 0.05$.

RESULTS

According to the results of ANOVA (Table 1), females are significantly ($P < 0.05$) larger than males according to prothorax length (Lp, by 4.3%) and prothorax width at the forward edge (Sp1, by 2.5%). Females have a smaller range of variation of characteristics compared to males (SD = 0.187 mm for Lp and 0.193 mm for Sp1).

According to morphometric indices (Table 2), males have a significantly narrower range of variation of index Se1/Sp2 than females (SD = 0.052 for male and 0.072 for female) (Fig. 2 D). The ratio of elytra width to maximum width of pronotum (Se1/Sp2) is correlated with reproductive efforts of females; the extensive variation of this index in the studied population suggests possible fluctuations of breeding performance of different female individuals.

Statistically significant positive asymmetry ($P < 0.001$) of *A. eremita* females was seen (Table 1) in characteristics of prothorax length (Lp, As_{female} = 3.93) and vertex angle of elytra (C, As_{female} = 3.30) and in ($P < 0.05$) prothorax width at the backward edge (Sp3, As_{female} = 1.95) and the back angle of the prothorax (B, As_{female} = 1.99). The males showed significant asymmetry ($P < 0.01$) only in the elytra vertex angle (Ń, As_{male} = 3.10). Positive asymmetry indicates the dominance of individuals which are smaller than the average value for this characteristic in the selection. In other words, females significantly differ from males in the length of the pronotum, but the similarities with males tend to increase in Lp. In the width of the pronotum between its front corners, the values of As_{male}, on the contrary, show a tendency towards increase in sexual dimorphism in *A. eremita*.

Among the indices, a statistically significant positive asymmetry was observed (Table 2) among the females for (Sc+Sp2+Se1)/Lb (As_{female} = 2.76), Lp/Sp2 (As_{female} = 8.28) and Se1/Sp2 (As_{female} = 8.94) (Fig. 2 A, B, D). Statistically significant negative asymmetry was observed among females for Sp2/Sp3 (As_{female} = - 10.77) (Fig. 2 E) and among males for Se1/Se3 (As_{male} = - 3.26) (Fig. 2 F).

Statistically significant excess was observed (Table 1) among females for prothorax length (Lp, Ex_{female} = 5.73, $P < 0.001$) and for maximum prothorax width (Sp2, Ex_{female} = 2.04, $P < 0.05$), prothorax width at the back edge (Sp3, Ex_{female} = 1.96, $P < 0.05$) and vertex angle of elytra (C, Ex_{female} = 2.20, $P < 0.05$), among males - for prothorax width at the forward edge (Sp1, Ex_{male} = 2.09, $P < 0.05$). In the indices, statistically significant positive excess was observed (Table 2) among males for (Sc+Sp2+Se1)/Lb (Ex_{male} = 2.73, $P < 0.05$) and Se1/Se3 (Ex_{male} = 8.91, $P < 0.001$). Significant positive excess was also observed among females for Lp/Sp2 (Ex_{female} = 18.08, $P < 0.001$), Se1/Sp2 (Ex_{female} = 22.86, $P < 0.001$), Sp2/Sp3 (Ex_{female} = 29.98, $P < 0.001$) and Se1/Se3 (Ex_{female} = 3.95, $P < 0.001$).
In Figures 3 and 4 shown variability of morphometric indices in 5 size groups depending on body length of *A. eremita* specimens in studied population. All studied morphometric indices do not significantly change excluding (Sc+Sp2+Se1)/Lb (Fig. 3 A) and Sp2/Sp3 (Fig. 4 D) for males.

Statistically significant coefficient of variation (higher than 6.42 ± 1.79) was observed for (Table 1) head length (Lc), head width (Sc), prothorax length (Lp), prothorax width at the forward edge (Sp1), width of elytra at points ½ and ¾ of the length of elytra in the direction from scutum to vertex angle of elytra (Se2) and (Se3) respectively, among males for elytra length (Le), among females for prothorax width at the backward edge (Sp3).

Statistically significant coefficient of variation of indices (higher than 5.14 ± 1.84) was seen in ratio of prothorax length to maximum prothorax width (Lp/Sp2), ratio of elytra length to prothorax length (Le/Lp), ratio of width of elytra at the point ¼ to width of elytra at the point ¾ of the length of elytra in the direction from scutum to vertex angle of elytra (Se1/Se3).

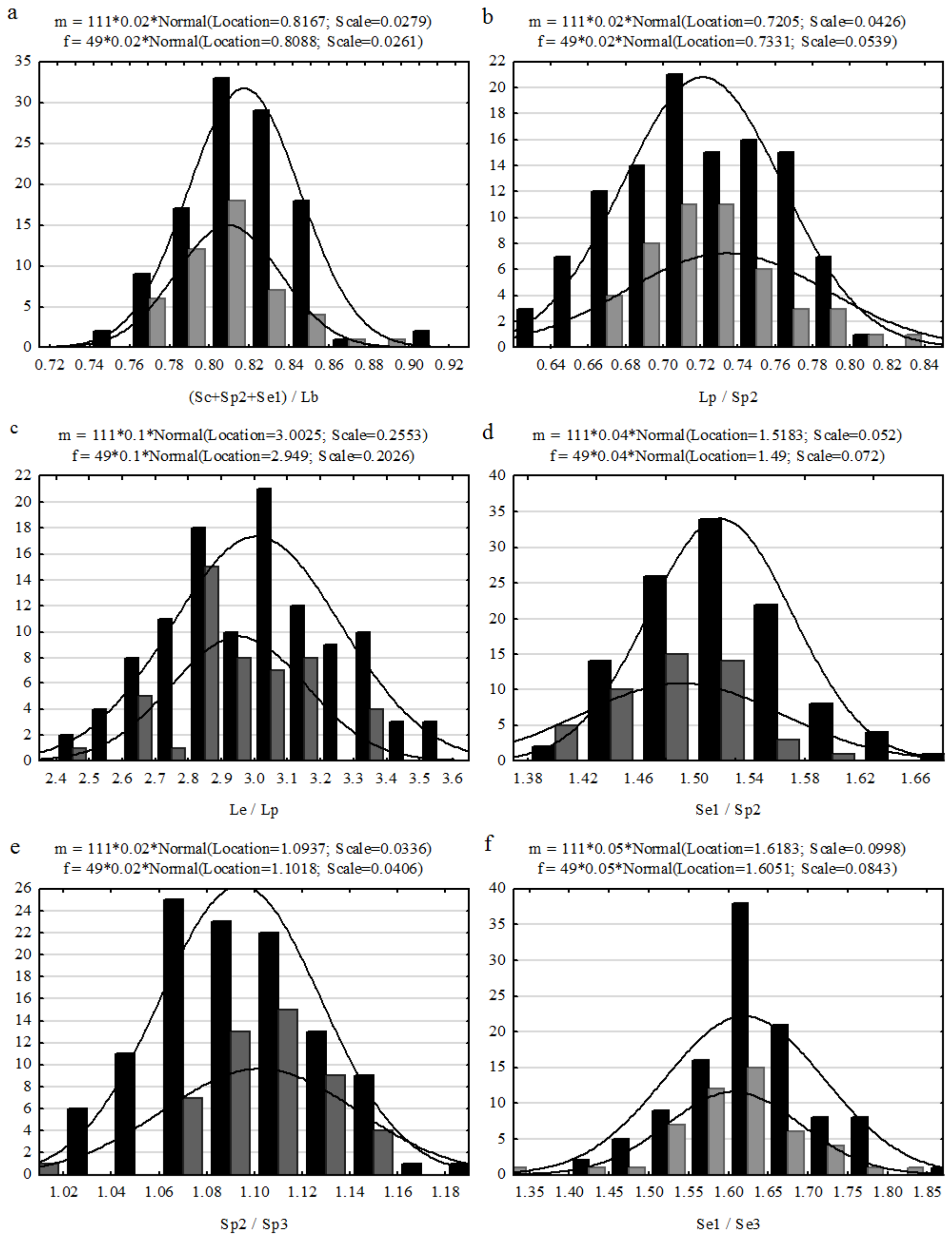

Fig. 2. Histograms of variability of morphometric indices of *A. eremita* (n = 160): a - (Sc+Sp2+Se1)/Lb, b - Lp/Sp2, c - Le/Lp, d - Se1/Sp2, e - Sp2/Sp3, f - Se1/Se3 indices; (Sc+Sp2+Se1)/Lb - ratio of arithmetical mean value of width of the head, prothorax and elytra to body length, Lp/Sp2 - ratio of prothorax length to maximum prothorax width, Le/Lp - ratio of elytra length to prothorax length, Se1/Sp2-ratio of width of elytra at the point ¼ of the length of elytra in the direction from scutum to vertex angle of elytra to maximum prothorax width , Sp2/Sp3 - ratio of maximum prothorax width to its width at the backward edge, Se1/Se3 - ratio of width of elytra at the point ¼ to width of elytra at the point ¾ of the length of elytra in the direction from scutum to vertex angle of elytra; on the X - axis mean of indices, on Y - axis the number of specimens; male (m) - black columns, female (f) - grey columns; Location-average value, Scale - SD

Table 1. Variability of linear characteristics in the studied population of *A. eremita* (n_{male} = 111; n_{female} = 49)

Characteristics	Sex	x ± SD	CV	Ex	As	F	P
Lb, mm	male	12.227 ± 0.715	5.9	0.14	–0.38	2.755	0.099
	female	12.430 ± 0.711	5.7	–1.13	1.31		
Lc, mm	male	2.122 ± 0.249	11.7	–1.49	0.38	0.160	0.689
	female	2.106 ± 0.209	9.9	–0.72	0.25		
Sc, mm	male	1.910 ± 0.155	8.2	0.01	0.66	0.105	0.747
	female	1.919 ± 0.149	7.8	1.19	1.00		
Lp, mm	male	2.533 ± 0.198	7.8	0.56	–1.08	6.765	0.010
	female	2.620 ± 0.187	7.1	5.73***	3.93***		
Sp1, mm	male	2.731 ± 0.189	6.9	2.09*	5.51***	4.505	0.035
	female	2.801 ± 0.193	6.9	–0.13	–0.04		
Sp2, mm	male	3.517 ± 0.209	5.9	1.03	–0.13	3.016	0.084
	female	3.580 ± 0.214	6.0	2.04*	1.56		
Sp3, mm	male	3.218 ± 0.198	6.1	0.25	0.42	1.001	0.318
	female	3.252 ± 0.210	6.5	1.96*	1.95*		
Le, mm	male	7.571 ± 0.501	6.6	–0.47	0.04	2.464	0.118
	female	7.704 ± 0.473	6.1	–0.90	1.40		
Se1, mm	male	5.337 ± 0.310	5.8	0.54	–0.37	0.020	0.888
	female	5.329 ± 0.325	6.1	1.23	1.63		
Se2, mm	male	5.129 ± 0.334	6.5	1.40	–1.47	0.066	0.797
	female	5.144 ± 0.339	6.6	0.73	1.66		
Se3, mm	male	3.307 ± 0.239	7.2	0.87	1.71	0.234	0.629
	female	3.327 ±0.243	7.3	0.28	1.84		
A, °	male	139.5 ± 3.9	2.8	–1.06	–1.60	0.267	0.604
	female	139.9 ± 4.2	3.0	1.12	–0.15		
B, °	male	91.8 ± 4.1	4.5	–1.48	1.80	0.136	0.713
	female	91.5 ± 4.3	4.8	–0.74	1.99*		
C, °	male	40.7 ± 2.1	5.1	0.26	3.10**	0.007	0.934
	female	40.7 ± 2.0	4.9	2.20*	3.30***		

Note: Lb - body length, Lc - head length, Sc - head width, Lp - prothorax length, Sp1 - prothorax width at the forward edge, Sp2 - maximum prothorax width, Sp3 - prothorax width at the backward edge, Le - elytra length, Se1, Se2, Se3 - width of elytra at points ¼, ½, ¾ of the length of elytra in the direction from scutum to vertex angle of elytra respectively, A and B -front and back angles of prothorax, C - vertex angle of elytra; x - SD - standard deviation; CV - coefficient of variation, %; Ex - excess; As - asymmetry; *, ** and *** - significance of asymmetry and excess $P < 0.05$, 0.01 and 0.001, respectively.

DISCUSSION

Variation of the body sizes of imagoes is defined by the abundance of certain larvae individuals in a population (Boggs & Freeman 2005), i.e. the proportions and absolute body sizes are formed genetically and are connected with the larval stage of development, but for each particular darkling beetle they are defined during first minutes when the imago emerges from the pupa, after which they remain constant for a few years after the cuticle - sclerotization is completed. However, in the extreme ends of the range (in the south and north parts of the range) there are often seen individuals with larger or smaller sizes (Blanckenhorn & Demont 2004), and the parameters of distribution of absolute sizes and body proportions indicate the condition of a population, and how the environmental conditions satisfy the needs of the beetles'population (Sukhodolskaya 2013; Brygadyrenko & Reshetniak 2014;

Table 2. Variability of the morphometric indices in the studied population of *A. eremita* (n_{male} = 111; n_{female} = 49

Indices	Sex	x ± SD	CV	Ex	As	F	P
(Sc+Sp2+Se1) / Lb	male	0.817 ± 0.028	3.2	2.73**	1.21	2.875	0.092
	female	0.809 ± 0.026	3.4	1.22	2.76**		
Lp / Sp2	male	0.720 ± 0.043	7.4	–1.90	–0.20	2.524	0.114
	female	0.733 ± 0.054	5.9	18.08***	8.28***		
Le / Lp	male	3.002 ± 0.255	6.9	–1.12	0.01	1.685	0.196
	female	2.949 ± 0.203	8.5	0.10	0.21		
Se1 / Sp2	male	1.518 ± 0.052	4.8	0.13	1.19	7.851	0.005
	female	1.490 ± 0.072	3.4	22.86***	8.94***		
Sp2 / Sp3	male	1.093 ± 0.034	3.7	–0.54	1.29	1.753	0.187
	female	1.102 ± 0.041	3.1	29.98***	–10.77***		
Se1 / Se3	male	1.618 ± 0.100	5.2	8.91***	–3.26**	0.646	0.423
	female	1.605 ± 0.084	6.2	3.95***	–1.36		

Note: (Sc+Sp2+Se1)/Lb - ratio of arithmetical mean value of width of the head, prothorax and elytra to body length, Lp/Sp2 - ratio of prothorax length to maximum prothorax width, Le/Lp = ratio of elytra length to prothorax length, Se1/Sp2 - ratio of width of elytra at the point ¼ of the length of elytra in the direction from scutum to vertex angle of elytra to maximum prothorax width, Sp2/Sp3 - ratio of maximum prothorax width to its width at the backward edge, Se1/Se3 - ratio of width of elytra at the point ¼ to width of elytra at the point ¾ of the length of elytra in the direction from scutum to vertex angle of elytra; x - SD - standard deviation; CV - coefficient of variation, %; Ex - excess; As - asymmetry; *, ** and *** - significance of asymmetry and excess P < 0.05, 0.01 and 0.001, respectively

Brygadyrenko & Slynko 2015). The sizes and shape of animals' bodies are also influenced by a location N - elevation above sea level (Chown & Klok 2003; Schmidt-Nielsen 1984), which affects a population in a similar way to the fluctuations in body size across latitude range, and perhaps is strongly connected with the duration of a season' warm period.

The unsuitability of an environment for a population is defined, first of all, by the frequency of anomalies in the development of individuals, asymmetry in body composition (Weller & Ganzhorn 2003). However, this type of reaction is more likely to occur under the intense influence of environmental factors which are far higher from optimum values. We do not consider mutational deformities in this research. We are interested in fluctuations of body proportions relative to the average value in groups of individuals with smaller and larger body sizes.

In the studied population of *A. eremita*, polymorphism of absolute values of the studied characteristics is higher among females than among males. This may be an indicator of the fertility of certain female individuals. In steppe ecosystems with a general lack of moisture, which varies from season to season, darkling beetles can have different parameters of population in different years (Rogers & Rickard 1975). The feeding of images and larvae of ground beetles in steppe conditions can change depending upon the domination of a certain type of food in the territory in different years of research (Brygadyrenko & Nazimov 2014, 2015), thus affecting the morphology of a population.

With *A. eremita* imagoes having non isometric variation, there should be statistically significant differences by morphometric indices between different size groups (small, average and large individuals) of the species. However, the

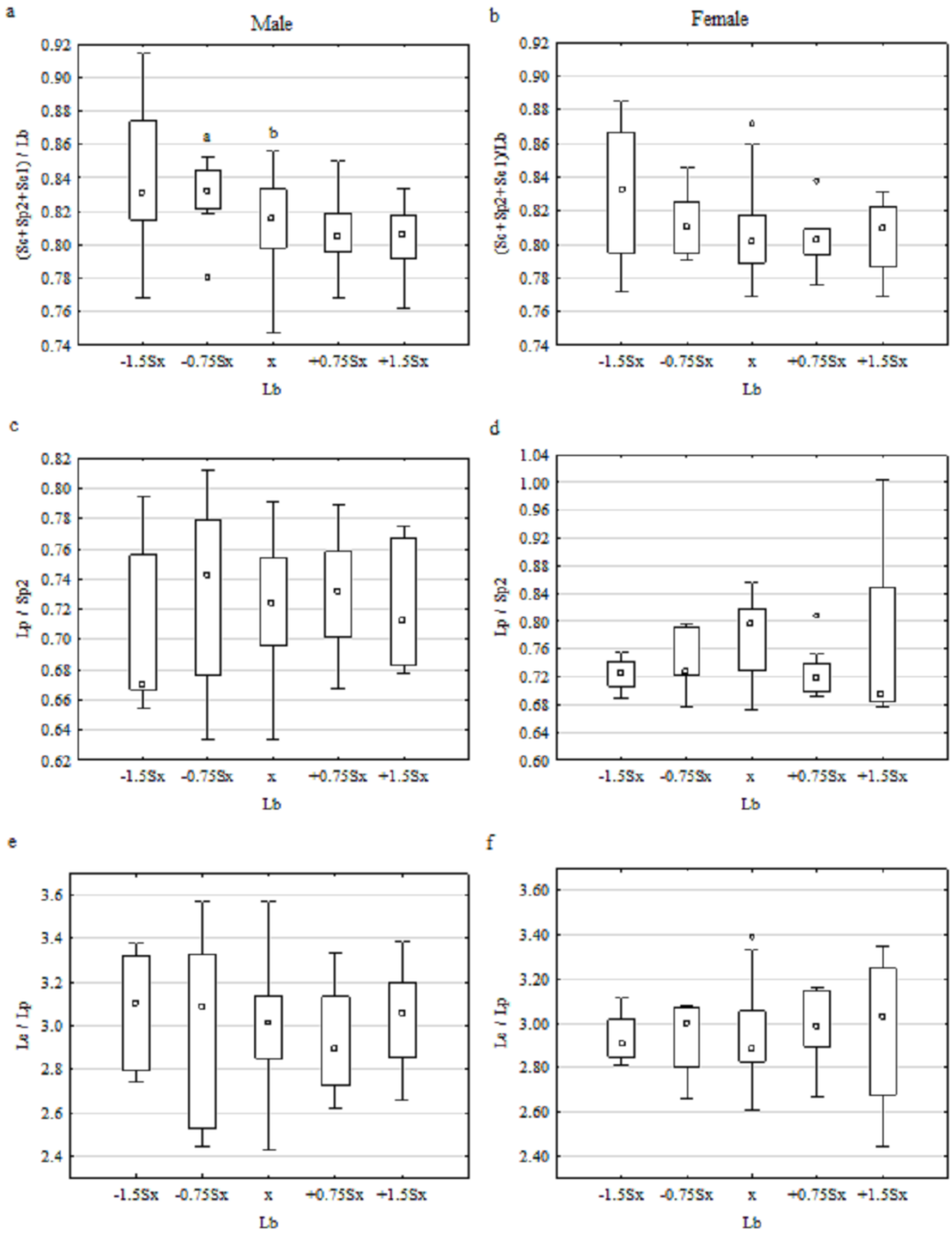

Fig. 3. Box plots of morphometric indices of *A. eremita* (n = 160):
a, b - box plot diagram of (Sc+Sp2+Se1)/Lb, *c, d* - box plot diagram of Lp/Sp2, *e*, *f* - box plot diagram of Le/Lp; (Sc+Sp2+Se1)/Lb - ratio of arithmetical mean value of width of the head, prothorax and elytra to body length, Lp/Sp2 - ratio of prothorax length to maximum prothorax width, Le/Lp - ratio of elytra length to prothorax length; on X-axis from - 1.5SD to +1.5SD, on Y-axis the index value is indicated; box: 25 - 75%; whisker: non-outlier range; on the right - males (n = 111), on the left - females (n = 49).

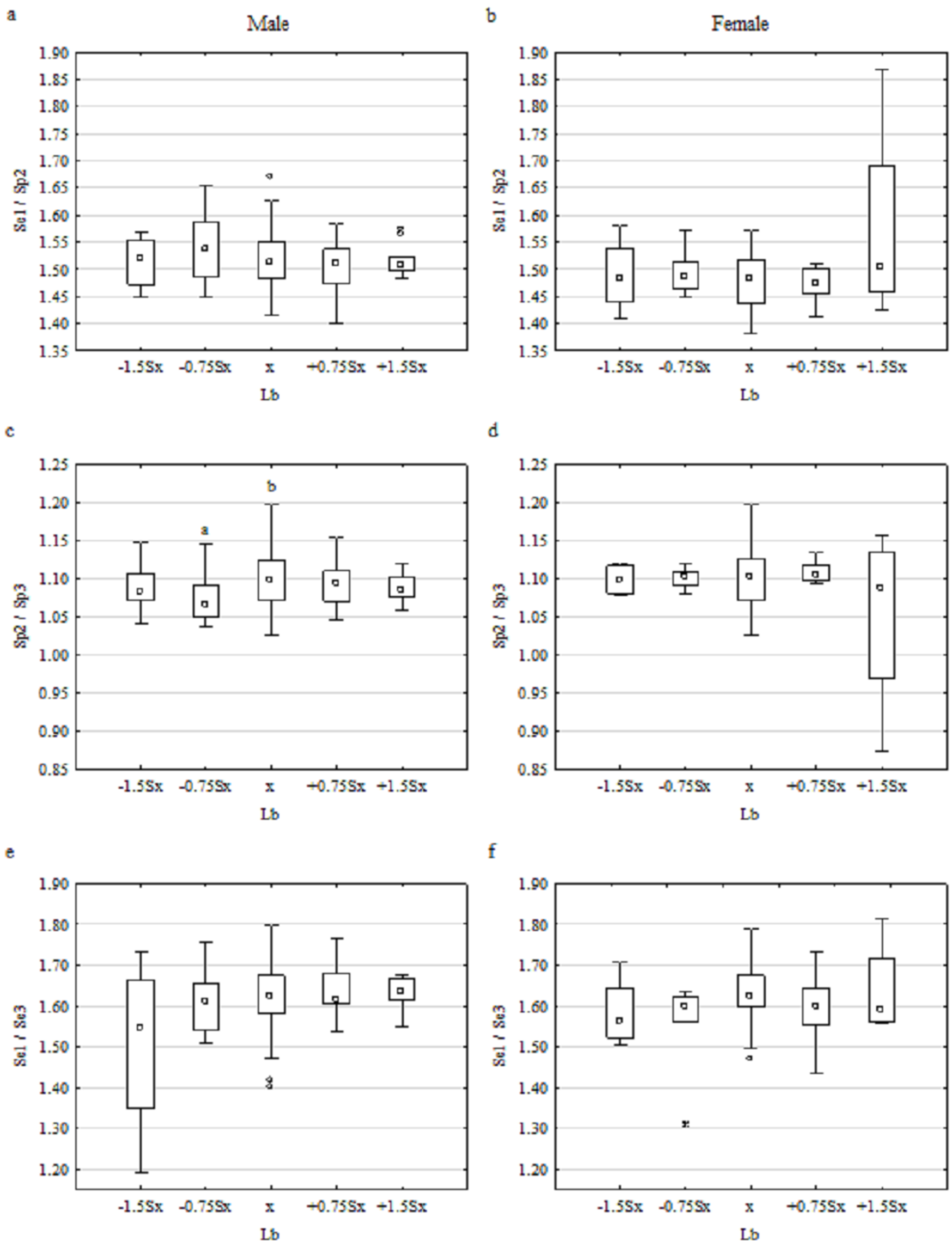

Fig. 4. Box plots of morphometric indices of *A. eremita* (*n* = 160):
a, b - box plot diagram of Se1/Sp2, *c*, *d* - box plot diagram of Sp2/Sp3, *e, f* - box plot diagram of Se1/Se3; elytraSe1/Sp2 - ratio of width of elytra at the point ¼ of the length of elytra in the direction from scutum to vertex angle of elytra to maximum prothorax width; Sp2/Sp3 - ratio of maximum prothorax width to its width at the backward edge, Se1/Se3 - ratio of width of elytra at the point ¼ to width of elytra at the point ¾ of the length of elytra in the direction from scutum to vertex angle of; on X-axis from - 1.5SD to +1.5SD on Y-axis the index value is indicated; box: 25 - 75%; whisker: non-outlier range; on the right - males (n = 111), on the left - females (n = 49).

morphometric indices do not significantly change, i.e. body proportions of *A. eremita* remain unchanged with variation of linear sizes. Compared to females, *A. eremita* males have a narrower range of variation in linear characteristics, prothorax length (Lp) and prothorax width at the front edge (Sp1) and the index Se1/Sp2. The obtained results indicate the direction of the micro evolutionary process in a certain population of *A. eremita*. 5 out of 6 studied indices were observed to have significant asymmetry. Statistically significant positive asymmetry ($\check{S} < 0.001$), which indicates the decrease in the value of index Se1/Se3, occurs both among females and males.

The detailed studies of average values of morphometric characteristics of beetle populations (Sukhodolskaya & Eremeeva 2013; Sukhodolskaya 2014; Sukhodolskaya & Saveliev 2014) focus on discovering the most significant ecological factors which define the geographic and ecological variations of different species. Research on certain populations of non-flying beetles based on a much wider factual base (Brygadyrenko & Korolev 2015) will allow us to identify the patterns of intrapopulational variation, which is the first stage in the development of geographic variation.

CONCLUSION

Thus, our first hypothesis that the studied population of darkling beetles will be observed to have isometric variability of linear characteristics and indices was rejected. The second hypothesis that the distribution of indices among females and males will be normal was proven. This indicates that the studied population was not excessively affected by the external factors. The study results indicate that the third hypothesis that the morphometric coefficients of smaller and larger individuals will be higher compared to the modal group was proved to be incorrect: we observed no statistical relation between the variation of the linear characteristics and body proportions.

The identification of the relationship between ecological factors and morphometric indices in different taxonomic groups of invertebrates is important for understanding the interconnections of living organisms inside populations. Unfortunately, this direction of studies is still only at the initial stage of its development. The identification of general patterns requires a significant amount of factual material on different species of living organisms. This research represents one stage in the accumulation of data on morphological variation of beetle populations in natural conditions. The discovery of statistically significant deviations from the normal distribution of linear characteristics and morphometric indices is an indicator of as yet undiscovered natural processes in the studied population, which requires further research.

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