**BULLETIN OF THE IRAQ NATURAL HISTORY MUSEUM**
Iraq Natural History Research Center & Museum, University of Baghdad
https://jnhm.uobaghdad.edu.iq/index.php/BINHM/Home
 Online ISSN: 2311-9799-Print ISSN: 1017-8678

*Bull. Iraq nat. Hist. Mus.*
(2022) 17 (2): 141-153. https://doi.org/10.26842/binhm.7.2022.17.2.0141

**ORIGINAL ARTICLE**

# MORPHOMETRIC FEATURES OF THE BEETLE *ACINOPUS* (*ACINOPUS*) *LAEVIGATUS* MENETRIES, 1832 (COLEOPTERA, CARABIDAE) IN THE MOUNTAIN ECOSYSTEMS OF UZBEKISTAN

Dilnoza F. Zokirova and Fazlitdin Z. Khalimov*
Samarkand State University, Samarkand, Republic of Uzbekistan
*Corresponding author: xalimov1968@list.ru

***Received Date: 05 May 2022, Accepted Date: 06 July 2022, Published Date: 20 December 2022***



## ABSTRACT

The morphometric parameters of *Acinopus* (*Acinopus*) *laevigatus* Ménétriés, 1832 (Coleoptera, Carabidae) were studied and their altitudinal variability was assessed. The length of head is the most variable, and the smallest value of the coefficient of variation is observed for the width of elytra. The length of body parts (head, pronotum, elytra) were more variable compared to their width. The correlation relationship between the morphometric parameters of different parts of the body was analyzed. A high correlation was found between the elytra length (EL) and the total body length (BL) (r=0.93), and the lowest correlation was found between the elytra width (EW) and the pronotum length (PL) (r=0.57). According to all measurement indicators, high-mountain representatives of beetles were inferior to middle-mountain individuals, and the variation in traits was also less. Only the width of the elytra turned out to be more variable in individuals of the highlands. Statistical analysis showed a rather high reliability of the influence of altitudinal belts on the morphometric parameters of beetles for all studied parameters. However, changes in body proportions in different altitudinal zones were not significant, except for the EW/BL index.

Keywords: *Acinopus*, Correlation, Ground beetles, Morphometry, Zarafshan Range.

## INTRODUCTION

Morphological structures of populations clarify the processes of adaptation of organisms to the environment and the formation of their relationships. In recent years, the approach to assessing the structure of insect populations based on morphometric characters has become widespread (Bulgarella *et al*., 2015; Rusynov and Brygadyrenko, 2017).

Although ground beetles remain poorly studied in this regard (Venn, 2007; Koivula, 2011), significant variations in morphometric parameters in these beetles have been revealed on the example of agrocenoses and urbanized landscapes. For example, *Carabus granulatus* decreases in size when living in the suburbs, while *C. cancellatus* decreases in size in the city (Sukhodolskaya and Saveliev, 2014); and even the phenotypic plasticity of females and males

to the action of some environmental factor in ground beetles of the same species can be different (Sukhodolskaya and Eremeeva, 2013; Sukhodolskaya, 2014).

Two populations of *Nebria kraatteri* in the Sila Mountains in Italy showed significant differences in many morphometric parameters (Talarico *et al.*, 2020). An increase in the length of the elytra and a decrease in the parameters of the head in *Pterostichus melanarius* in the northern and eastern directions were established (Luzyanin *et al.*, 2022).

In low-mountain and high-mountain populations of the beetle *Carabus odoratus* in the conditions of the Barguzin Range, a difference in the morphometric structure of the population was revealed, which gives the authors reason to assume that there is no constant genetic exchange between populations (Ananina and Sukhodolskaya, 2019). In some works, it is noted that in many species of ground beetles, body length and length of the abdomen are the most variable, and the length of head is the least variable (Stachewicz *et al.*, 2021). However, using the example of *Machozetus lehmanni*, it was found that the most variable character is the length of head, and the most stable character is the width of elytra. In different parts of the range, depending on soil conditions, morphological modifications can be observed, expressed primarily in the size of head (Zokirova *et al.*, 2022).

*Acinopus* (*Acinopus*) *laevigatus* belongs to the Eastern Mediterranean species of ground beetles (Abdurakhmanov, 2010) and is a widespread species in many countries of Europe and Asia (Lorenz, 2021). In Uzbekistan, *Acinopus laevigatus* was first mentioned by Alimdjanov and Bronshteyn (1956), and later Dadamirzaev (1978). It is one of the dominant species in the Zarafshan Range (Khalimov, 2020). It is an omnivorous species and damages cereals (wheat, rye, corn, barley, millet, oats), industrial (beets), vegetable (carrots), medicinal (plantain) crops, and also feeds on wild species of herbaceous plants (cereals, haze, Compositae) (Rusynov *et al.*, 2019). The main morphological differences of *Acinopus laevigatus* from other species common in Asia and the key to their identification are given in Azadbakhsh and Wrase (2016) and Wrase and Kataev (2016).

In our research, we set the following tasks: to identify variations in morphometric features in *Acinopus laevigatus* (1), correlations between different parts of the body (2) and to find out the patterns of changes in morphometric parameters at different heights of mountain ecosystems (3).

## MATERIALS AND METHODS

The collection of material was carried out in the mountainous regions of the Samarkand and Jizzakh regions of Uzbekistan during the period 2020-2021. The specimens were fixed with ethyl acetate and laid out in cotton pads. Also, for research, the collected material of the employees of the Department of Zoology of Samarkand University was used. A total of 79 beetles were studied. Species identification was carried out by R. Dudko (Institute of Systematics and Ecology of Animals, Russian Academy of Sciences, Novosibirsk, Russia) and I. Kabak (All-Russian Institute of Plant Protection, St. Petersburg, Russia).

To study the variability of morphometric parameters in vertical zones, the collection points were divided into two groups (A and B) according to the height above sea level. Group A included points with a height of 700-1200 m, and group B included points with a height of 1500-2000 m (Tab. 1).

**Table (1):** Collection point information.

| Collection points | Ridge | Height above sea level, m | Coordinates |
|---|---|---|---|
| Group A (height above sea level-700 -1200 m) | | | |
| Hazrati Dovud | Zarafshan Range | 1000-1200 | 39.489996°N, 66.620332°E |
| Etty uilli | Zarafshan Range | 1000-1200 | 39.435941°N, 66.988170°E |
| Hazrati Bashir | Zarafshan Range | 1100-1200 | 39.266667°N, 67.100000°E |
| Ingichka | Zarafshan Range | 750-900 | 39.728009°N, 65.982234°E |
| Yalpoqtepa | Zarafshan Range | 870-880 | 39.445450°N, 67.239336°E |
| Nurota | Turkestan Range | 1000-1200 | 40.516667°N, 66.750000°E |
| Group B (height above sea level-1500 -2000 m) | | | |
| Zhum-zhumsoy | Turkestan Range | 1700-1800 | 39.686128°N, 67.848304°E |
| Tahtakoracha | Zarafshan Range | 1500-2000 | 39.303106°N, 66.891646°E |
| Kamangaron | Zarafshan Range | 1500-1900 | 39.375913°N, 67.193234°E |
| Kumbelsoy | Zarafshan Range | 1600-1650 | 39.329416°N, 67.312788°E |
| Yul soy | Zarafshan Range | 1500-1900 | 39.291875°N, 66.940346°E |

Further study of the morphology of beetles was carried out in the entomological laboratory of the Faculty of Biology of Samarkand University. The material can be found at entomological collection of the university, where the weight of the collected material is stored. The study of morphometric parameters was carried out using a dimensional binocular microscope MBS-9 with a measuring ruler.

The following morphometric parameters were studied: HL-length of the head, HW-width of the head, DE -distance between the eyes, PL-length of the pronotum, PW-width of the pronotum, EL-length of the elytra, EW-width of the elytra, and BL-total body length (HL+PL+EL). Because the total body length may vary slightly depending on the position of the head and pronotum in different postures, the total body length was calculated as the sum of HL, PL and EL (Pl. 1). In addition, the proportions of different parts of the body were studied: HL/BL, HW/BL, DE/BL, PL/BL, PW/BL, EL/BL, EW/BL, PW/PL and EW/EL.

Morphometric features of the beetle *Acinopus*

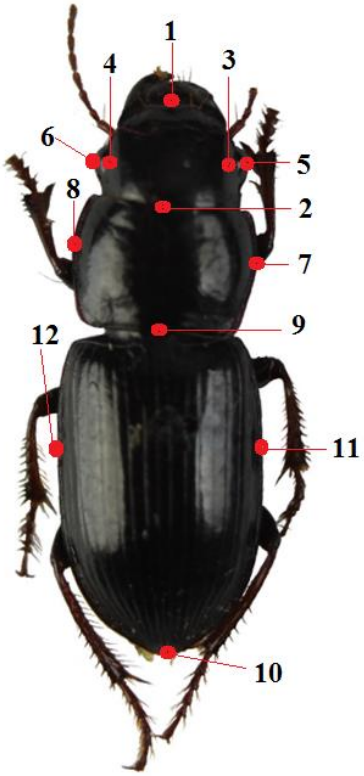


**Plate (1)**: *Acinopus laevigatus* and scheme of morphometric measurements: (1-2) Length of the head- HL, (3-4) Distance between the eyes- DE, (5-6) Width of the head - HW, (7-8) Width of the pronotum- PW, (2-9) Length of the pronotum- PL, (9-10) Length of the elytra- EL, (11-12) width of the elytra- EW**.**

Statistical processing of the obtained data was carried out using the standard package- Statistica 10. In this case, the arithmetic mean values, standard deviation, standard error, coefficient of variation and correlation coefficient between the sizes of different parts of the body were calculated.

## RESULTS AND DISCUSSION

The results of morphometric measurements of individual parts of the body of the beetle as a whole for all samples and for areas of different altitudinal mountain belts are presented in Table 2. The total body length of the beetle *Acinopus laevigatus* is 12-18 mm, that is, they turned out to be larger compared to the European population (11- 16 mm) (Rusynov *et al.*, 2019).

The variation of the studied morphometric parameters within the population is not very high and is a stable trait, since for unstable traits the coefficient of variation should be more than 33.3%. Statistical analysis of the data showed that the most variable is the length of the

head (Cv=11.95), and the smallest value of the coefficient of variation (Cv=6.67) is observed for the width of the elytra. Sufficiently high variability shows the distance between the eyes. In general, the lengths of body parts (head, pronotum, elytra) were more variable compared to their width.

**Table (2):** Morphometric parameters of the beetle *Acinopus laevigatus* and their variation.

| Body parts | Sites | Max. | Min. | Arithmetic mean, M | Standard deviation, sd | Standard error, m | The coefficient of variation, Cv,% |
|---|---|---|---|---|---|---|---|
| HW | Group A | 4.3 | 2.7 | 3.9 | 0.32 | 0.046 | 8.27 |
| | Group B | 4.3 | 2.7 | 3.5 | 0.22 | 0.048 | 6.29 |
| | In general, for the species | 4.3 | 2.7 | 3.8 | 0.32 | 0.038 | 8.40 |
| HL | Group A | 4.9 | 2.9 | 3.9 | 0.47 | 0.066 | 11.94 |
| | Group B | 4.4 | 2.9 | 3.6 | 0.38 | 0.084 | 10.56 |
| | In general, for the species | 4.9 | 2.9 | 3.8 | 0.46 | 0.054 | 11.95 |
| DE | Group A | 4 | 2.5 | 3.2 | 0.30 | 0.043 | 9.44 |
| | Group B | 3.5 | 2.6 | 3.0 | 0.24 | 0.051 | 7.99 |
| | In general, for the species | 4 | 2.5 | 3.1 | 0.31 | 0.037 | 9.83 |
| PW | Group A | 5.4 | 3.7 | 4.7 | 0.33 | 0.047 | 7.05 |
| | Group B | 5 | 3.9 | 4.3 | 0.29 | 0.064 | 6.77 |
| | In general, for the species | 5.4 | 3.7 | 4.6 | 0.35 | 0.042 | 7.71 |
| PL | Group A | 4.2 | 2.5 | 3.2 | 0.28 | 0.039 | 8.67 |
| | Group B | 3.4 | 2.6 | 2.9 | 0.22 | 0.049 | 7.56 |
| | In general, for the species | 4.2 | 2.5 | 3.1 | 0.28 | 0.033 | 9.01 |
| EW | Group A | 5.8 | 4.6 | 5.2 | 0.33 | 0.047 | 6.36 |
| | Group B | 5.8 | 4.5 | 5.0 | 0.36 | 0.078 | 7.09 |
| | In general, for the species | 5.8 | 4.5 | 5.1 | 0.34 | 0.041 | 6.67 |
| EL | Group A | 9.3 | 6.6 | 8.2 | 0.58 | 0.083 | 7.03 |
| | Group B | 8.7 | 7 | 7.8 | 0.40 | 0.088 | 5.18 |

Morphometric features of the beetle *Acinopus*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | In general, for the species | 9.3 | 6.6 | 8.1 | 0.57 | 0.068 | 7.01 |
| BL | Group A | 18.0 | 12 | 15.3 | 1.20 | 0.172 | 7.83 |
| | Group B | 15.9 | 12.8 | 14.4 | 0.90 | 0.195 | 6.22 |
| | In general, for the species | 18.0 | 12 | 15.1 | 1.20 | 0.143 | 7.94 |

As you know, the sizes of different parts of the body are closely interconnected. However, the degree of dependence in the sizes of various parts of the body may vary. To determine the degree of dependence, a correlation analysis was carried out between the morphometric parameters of the measured body parts of beetles (Tab. 3). A high correlation was found between elytra length (EL) and total body length (BL) (r=0.93), between pronotum width (PW) and head width (HW) (r=0.92). The smallest correlation was found between the width of the elytra (EW) and the length of the pronotum (PL) (r=0.57). Also, a weak relationship was noted between the width of the elytra (EW) and the length of the elytra (EL) (r=0.66), between the length of the head (HL) and the length of the pronotum (PL) (r=0.68).

**Table (3):** Correlation dependence (r) between the sizes of different parts of the body in *Acinopus laevigatus* (n=79).

| Body parts | HW | HL | DE | PW | PL | EW | EL | BL |
|---|---|---|---|---|---|---|---|---|
| HW | | | | | | | | |
| HL | 0.78 | | | | | | | |
| DE | 0.87 | 0.80 | | | | | | |
| PW | 0.92 | 0.82 | 0.87 | | | | | |
| PL | 0.80 | 0.68 | 0.82 | 0.76 | | | | |
| EW | 0.74 | 0.70 | 0.74 | 0.74 | 0.57 | | | |
| EL | 0.84 | 0.71 | 0.75 | 0.81 | 0.73 | 0.66 | | |
| BL | 0.87 | 0.87 | 0.85 | 0.88 | 0.83 | 0.74 | 0.93 | |

On different altitudinal belts of mountains, the morphometric characteristics of body parts differed significantly (Diag. 1). By all parameters studied, beetles from low-mountain and mid-mountain sites of research were larger than beetles from high-mountain habitats. The variation of seven morphometric parameters out of 8 studied was higher in beetles from the sites of group A. Only the width of the elytra turned out to be more variable in individuals from the sites of group B (Tab. 4). Statistical analysis showed a rather high reliability of the influence of altitudinal belts on the morphometric parameters of beetles for all studied parameters (Tab. 5).

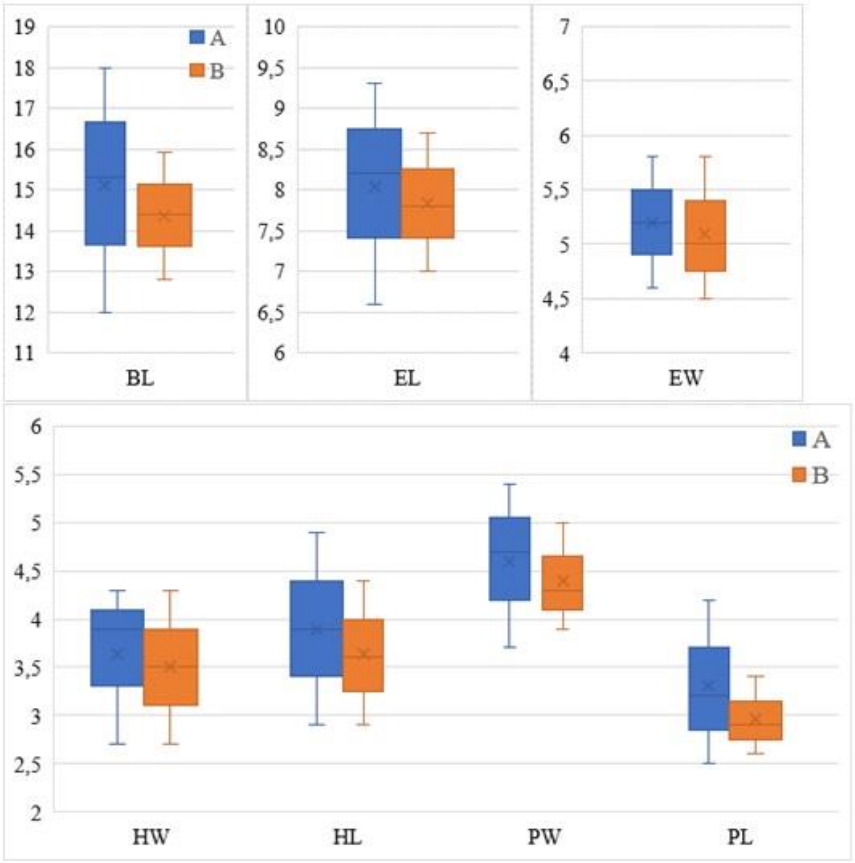


**Diagram (1):** Comparison of morphometric parameters of *Acinopus laevigatus* found in plots A and B (units - mm).

**Table (4):** Significance criteria for differences in the morphometric parameters of *Acinopus laevigatus* between sites of groups A and B.

| Parameters | F | P-value | F critical |
|---|---|---|---|
| Head width | 14.33816823 | 0.000300883 | 3.965094067 |
| Head length | 6.496938246 | 0.012794873 | |
| Distance between eyes | 12.56866036 | 0.000670964 | |
| Pronotal width | 21.86752971 | 1.22358E-05 | |
| Pronotum length | 12.70575066 | 0.000630052 | |
| Elytra width | 4.341575247 | 0.040510343 | |
| Elytra length | 12.12339984 | 0.000823861 | |
| Total body length | 12.9116339 | 0.000573393 | |

**Table (5):** Variability of morphometric indices of *Acinopus laevigatus* in different altitude belts of mountains**.**

| Indices | Sites | Index value | Variation, Cv,% | *F* at $F_{0,05}$=3.96 | *p* |
|---|---|---|---|---|---|
| HW/BL | Group A | 0.23±0,002 | 5.10 | 2.38 | 0.13 |
| | Group B | 0.23±0,001 | 2.57 | | |
| HL/BL | Group A | 0.25±0,002 | 6.82 | 0.45 | 0.51 |
| | Group B | 0.25±0,003 | 5.88 | | |
| PW/BL | Group A | 0.31±0,002 | 3.92 | 1.25 | 0.27 |
| | Group B | 0.30±0,002 | 3.33 | | |
| PL/BL | Group A | 0.21±0,001 | 4.67 | 2.29 | 0.13 |
| | Group B | 0.20±0,002 | 4.13 | | |
| EW/BL | Group A | 0.34±0,002 | 4.75 | 5.06 | 0.03 |
| | Group B | 0.35±0,005 | 7.03 | | |
| EL/BL | Group A | 0.54±0,002 | 2.93 | 1.89 | 0.17 |
| | Group B | 0.54±0,003 | 2.63 | | |
| DE/BL | Group A | 0.21±0,002 | 5.22 | 1.42 | 0.24 |
| | Group B | 0.21±0,002 | 4.24 | | |
| PW/PL | Group A | 1.48±0,01 | 5.36 | 0.37 | 0.54 |
| | Group B | 1.48±0,02 | 5.53 | | |
| EW/EL | Group A | 0.63±0,005 | 5.49 | 2.68 | 0.11 |
| | Group B | 0.64±0,010 | 6.89 | | |

A significant decrease in body size with increasing altitude was also noted in other groups of arthropods (Janes, 1994). Smaller body sizes in high-mountain populations can be explained by more severe conditions of high-mountain stations, expressed primarily by lower temperatures. In the studies of Krasnov (Krasnov *et al*., 1996), in three species of tenebrionids, a decrease in body size along the altitude gradient was observed, which the author explains by the influence of ambient temperature. However, in one species, the opposite trend was observed. Highland populations of the dung flies *Scathophaga stercoraria* and *Sepsis cynipsea* were smaller, and under laboratory rearing conditions, high temperatures led to a decrease in body size (Blanckenhorn, 1997).

In a laboratory experiments on ground beetles, a decrease in body size with increasing temperature was also noted. Moreover, it is reported that larger species decreased disproportionately more than beetles with a smaller body size (Tseng *et al*., 2018). However, due to the presence of rather opposite data on the effect of altitudinal gradients on the morphometric parameters of beetles, this issue requires further study.

According to some authors (Sharova, 1981; Slinko *et al.*, 2008), the analysis of morphometric characters does not give a complete picture of the population variability of the species. According to them, body proportion indices are more informative. However, differences between beetles in different altitudinal zones were observed only in terms of the EW/BL index ($F=5.06$ at $F0.05=3.96$, $p<0.05$). The difference between the beetles of different belts in terms of other indices of body proportions was not statistically significant.

Thus, the studied morphometric parameters of the beetle *Acinopus laevigatus* are more or less stable and their variation is not very high. However, the variation in the size of different parts of the body differed significantly. It should be noted that the length of body parts (head, pronotum, elytra) were more variable compared to their width. Comparison of the beetles of the studied territories did not show significant differences in the horizontal direction. However, in the vertical direction, which includes, the individuals of the high-mountain and mid-mountain stations differed significantly. The vegetation cover of the studied points differed both horizontally and vertically. However, these differences are not very significant, since all points are located on the territory of neighboring regions. Horizontally, climatic conditions do not differ much. But vertically, climatic conditions change significantly. Apparently, the size of the body of beetles is more dependent on climatic conditions and less dependent on the vegetation cover. Of course, these statements require more detailed study.

## CONCLUSIONS

*Acinopus* (*Acinopus*) *laevigatus* Menetries, 1832 is the most widespread species of ground beetles in the mountain ecosystems of Uzbekistan. The study of the morphometric features of such organisms is very important for understanding and presenting the ways of morphological adaptations of organisms in different altitudinal zones. In individuals from different altitudinal zones, there are obvious differences in morphometric parameters, which is proved by statistical analyses. Beetle specimens from the upper belts of mountains are characterized by smaller sizes of body parts, as well as their low variability.

## CONFLICT OF INTEREST STATEMENT

"The authors have no conflicts of interest to declare."

## LITRETURE CITED

Abdurakhmanov, G. M. and Klicheva, S. M. 2010. Zoogeographical characteristics of the ground beetles (Coleoptera, Carabidae) of the Steppe areas of the Southeast of Russia and Northeast of Azerbaijan. *The South of Russia*: *Ecology*, *Development*, 1: 63-75. (In Russian). [Crossref]

Alimdjanov, R. A. and Bronshteyn, T. G. 1956. Invertebrate animals of the Zarafshan valley. Publishing House of the Academy of Sciences of the UzSSR, Samarkand, 348 pp. (In Russian).

Ananina, T. L. and Sukhodolskaya, R. A. 2019. Study of the morphometric structure of ground beetle populations of the Barguzin Ridge on the example of *Carabus odoratus*

*barguzinicus* (Shil, 1996). Natural complexes of the North-Eastern Transbaikalia. BNTs SB RAS Publishers, p 66-73. (In Russian) [Crossref]

Azadbakhsh, S. and Wrase, D.W. 2016. A new species of the genus *Acinopus* Dejean, 1821 from west of Iran (Coleoptera; Carabidae; Harpalini) with a key to species of Iran. *Zootaxa*, 4147 (5): 583-588.[Crossref]

Blanckenhorn, W.U. 1997. Altitudinal life history variation in the dung flies *Scathophaga stercoraria* and *Sepsis cynipsea*. *Oecologia*, 109: 342-352.

Bulgarella, M., Trewick, S. A., Godfrey, A. J., Sinclair, B. J. and Morgan-Richards, M. 2015. Elevational variation in adult body size and growth rate but not in metabolic rate in the tree Weta Hemideina crassidens. *Journal of Insect Physiology*, 75: 30-38. [CrossRef]

Dadamirzaev, A. 1978. To the fauna and ecology of ground beetles (Coleoptera, Carabidae) of the Tashkent Region. *In*: Ecology of vertebrates and invertebrates in Uzbekistan. Fan, Tashkent, p. 77-87. (In Russian)

Janes, S.W. 1994. Variation in species composition and mean body size of an avian foliage-gleaning guild along an elevational gradient: correlation with arthropod body size. *Oecologia*, 98: 369-378.

Khalimov, F. 2020. The ground beetles (Coleoptera, Carabidae) of the Karatepa and Chakilkalyan mountains (west part of Zarafshan Mountains Range, Uzbekistan). *Biosystems Diversity*, 28: 265-271. [CrossRef]

Koivula, M. 2011. Useful model organisms, indicators, or both? Ground beetles (Coleoptera, Carabidae) reflecting environmental conditions. *ZooKeys*, 100: 287-317. [CrossRef]

Krasnov, B., Ward, D. and Shenbrot, G. 1996. Body size and leg length variation in several species of darkling beetles (Coleoptera: Tenebrionidae) along a rainfall and altitudinal gradient in the Negev Desert (Israel). *Journal of Arid Environments*, 34: 477-489.

Lorenz, W. 2021. Carabcat database. *In* Bánki, O., Roskov, Y., Döring, M., Ower, G., Vandepitte, L., Hobern, D., Remsen, D., Schalk, P., De Walt, R. E., Keping, M., Miller, J., Orrell, T., Aalbu, R., Adlard, R., Adriaenssens, E., Aedo, C., Aescht, E., Akkari, N., Alonso-Zarazaga, M. A. *et al*., Catalogue of Life Checklist (v.03 (08/2021)). [Crossref]

Luzyanin, S., Saveliev, A., Ukhova, N., Vorobyova, I., Solodovnikov, I., Anciferov, A., Shagidullin, R., Teofilova, T., Nogovitsyna, S., Brygadyrenko, V., Alexanov, V. and Sukhodolskaya, R. 2022. Modeling sexual differences of body size variation in ground beetles in geographical gradients: A Case Study of *Pterostichus melanarius* (Illiger, 1798) (Coleoptera, Carabidae). *Life*, 12 (1): 112. [Crossref]

Rusynov, V. I. and Brygadyrenko, V. V. 2017. Morphological variability of a population of *Anatolica eremita* (Coleoptera, Tenebrionidae): constancy of morphometric indices with variation of linear parameters of the body. *Baltic Journal of Coleopterology*, 17 (2): 205-217. [ResearchGate]

Rusynov, V. I., Martynov, V. O. and Kolombar, T. M. 2019. Coleoptera pests of stored food supplies and field crops. *In*: Current problems of agrarian industry in Ukraine. Accent Graphics Communications & Publishing, Vancouver, Canada, p. 34-133. [Crossref]

Sharova, I. Kh. 1981. Life forms of ground beetles (Coleoptera, Carabidae). Nauka, Moscow, 359 pp. (In Russian)

Slinko, V. O., Brygadyrenko, V. V. and Pakhomov, O. Y. 2008. Morfologicheskaya izmenchivost *Bembidion varium* (Carabidae, Coleoptera) v usloviyakh antropogennogo vozdejstviya [Morphological variability of *Bembidion varium* (Carabidae, Coleoptera) in the conditions of anthropogenic pressure]. *Proceedings of the National Academy of Sciences of Azerbaijan* (*Biological Sciences*), 64 (5-6): 200-206. (In Russian)

Stachewicz, J. D., Fountain-Jones, N. M., Koontz, A., Woolf, H., Pearse, W. D. and Gallinat A. S. 2021. Strong trait correlation and phylogenetic signal in North American ground beetle (Carabidae) morphology. *Ecosphere*, 12 (11): 1-11. [Click here]

Sukhodolskaya, R. 2014. Variation in body size and body shape in ground beetle *Pterostichus melanarius* Ill. (Coleoptera, Carabidae). *Journal of Agri-Food and Applied Sciences*, 2 (7): 196-205. [Researchgate]

Sukhodolskaya, R. A. and Savelyev, A. A. 2014. Influence of ecological factors on the size characteristics of the ground beetle *Carabus granulatus* L. (Coleoptera, Carabidae). *Ecology*, 5: 369-375. (In Russian)

Sukhodolskaya, R. A. and Eremeeva, N. I. 2013. Body Size and Shape Variation in Ground Beetle Carabus aeruginosus F.-W., 1822 (Coleoptera, Carabidae). *Siberian Ecological Journal*, 6: 803-812. (In Russian)

Talarico, F., Mazzei, A., Gangale, C., Scrivano, G. and Brandmayr, P. 2020. Morphometric differences in populations of *Nebria kratteri* Dejean & Boisduval, 1830 from two old forests in Calabria (Coleoptera, Carabidae). *Fragmenta Entomologica*, 52 (1): 57-62. [Crossref]

Tseng, M., Kaur, K. M., Pari, S. S., Sarai, K., Chan, D., Yao, C. H., Porto, P., Toor, A., Toor, H. S. and Fograscher, K. 2018. Decreases in beetle body size linked to climate change and warming temperatures. *Journal of Animal Ecology*, 87: 647–659. [Crossref]

Venn, S. 2007. Morphological responses to disturbance in wing-polymorphic carabid species (Coleoptera: Carabidae) of managed urban grasslands. *Baltic Journal of Coleopterology*, 7(1): 51-60. [Click here]

Wrase, D. W. and Kataev, B. M. 2016. Four new species of genus *Acinopus* Dejean, 1821, subgenus *Acinopus* from southern Iran, from Sinai, and from western Saudi Arabia, and faunistic and taxonomic notes on species previously described (Coleoptera, Carabidae, Harpalini, Harpalina). *Linzer biologische Beiträge*, 48 (2): 1783-1806. [Click here]

Zokirova, D. F., Alimova, L. Kh. and Khalimov, F. Z. 2022. Study of morphometric features of *Machozetus lehmanni* Menetries, 1848 - endemic to Central Asia. *Scientific Review. Biological Sciences*, 1: 16-21. (In Russian) [Click here]

BULLETIN OF THE IRAQ NATURAL HISTORY MUSEUM

Zokirova and Khalimov

*Bull. Iraq nat. Hist. Mus.*
(2022) 17 (2): 141-153.

# القياسات المظهرية لخنفساء
# *Acinopus* (*Acinopus*) *laevigatus* Menetries, 1832
# (Coleoptera, Carabidae)
# في النظم البيئية الجبلية لأوزبكستان

**ديلنوزا ف. زوكيروفا و فازليتدين ز. خاليموف**
جامعة ولاية سمرقند ، سمرقند ، أوزبكستان

***تأريخ الاستلام: 2022/5/5، تأريخ القبول: 2022/7/6، تأريخ النشر: 2022/12/20***

الخلاصة

دُرِسَت المَعلَمات المظهرية للنوع *Acinopus* (*Acinopus*) *laevigatus* Ménétriés, 1832 (Coleoptera, Carabidae) وتم تقييم تباينها الطولي. اذ تَبين ان طول الرأس هو الأكثر تبايناً؛ كما لوحِظَ ان أصغر قيمة لمعامل الاختلاف لعرض الجناح الغمدي. كانت اطوال أجزاء الجسم (الرأس، ظهر الصدر الامامي، الجناح الغمدي) أكثر تبايناً مقارنةً بعرضها. تم تحليل علاقة الارتباط بين المعلمات المظهرية لأجزاء مختلفة من الجسم؛ اذ وجد ان هنالك ارتباط كبير بين طول الجناح الغمدي (EL) وطول الجسم الكلي (BL) (r = 0.93) ، وأقل ارتباط وجد بين عرض الجناح الغمدي(EW) وطول ظهر الصدر الامامي (PL) (r = 0.57 ).

وفقًا لجميع مؤشرات القياسات، فأن افراد الخنافس في أعالي الجبال كانت أدنى من أفراد وسط الجبال، وكان التباين في الصفات أيضًا أقل؛ كما اتضح أن عرض الجناح الغمدي يكون أكثر تنوعًا في أفراد المرتفعات. أظهر التحليل الإحصائي موثوقية عالية إلى حد ما لتأثير أحزمة الارتفاع على البيانات المظهرية للخنافس لجميع المتغيرات المدروسة. ومع ذلك، لم تكن التغييرات في نسب الجسم في مناطق الارتفاعات المختلفة معنوية، باستثناء مؤشر EW / BL.