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**SEXUAL SIZE DIMORPHISM IN GROUND BEETLE CARABUS
EXARATUS QUENSEL, 1806 (COLEOPTERA, CARABIDAE)**

Abstract: *sexual Size Dimorphism (SSD) is considered to be the indicator of environmental quality. Peculiarities of its variation reflect trends in traits evolution. We estimated the values of SSD in populations from two distanced regions of Russia – Chechnya and Krasnodarskiy Province. In total those values did not differ, but SSD was higher in elytra and pronotum parameters in beetles from Chechnya and lower –*

by head parameters. Advancing research in this direction promises to unravel the ecological processes that structure soil biodiversity and to predict the impacts of global change on terrestrial ecosystems.

Keywords: *Sexual Size Dimorphism, ground beetles, morphometric variation, environmental quality, evolution.*

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ПОЛОВОЙ ДИМОРФИЗМ, ПРОЯВЛЯЮЩИЙСЯ В РАЗМЕРЕ У ВИДА ЖУКОВ *CARABUS EXARATUS* QUENSEL

Аннотация: половой размерный диморфизм (SSD) считается показателем качества окружающей среды. Особенности его изменчивости отражают тенденции эволюции признаков. Авторы оценили значения SSD в популяциях из двух отдаленных регионов России – Чечни и Краснодарского края. В целом эти значения не отличались, но SSD был выше по параметрам надкрылий и переднеспинки у жуков из Чечни и ниже – по параметрам головы. Продвижение исследований в этом направлении обещает раскрыть экологические процессы, которые формируют биоразнообразие почв, и предсказать последствия глобальных изменений для наземных экосистем.

Ключевые слова: половой диморфизм по размерам, жужелицы, морфометрическая изменчивость, качество окружающей среды, эволюция.

Introduction. Soil biodiversity encompasses a complex network of interactions among functionally and trophically diverse organisms, playing a vital role in supporting ecosystem functions and services such as carbon sequestration, organic matter decomposition, and enhancing plant performance and resistance to pests and stress [2; 3]. Gaining insights into the organization of soil communities necessitates studying spatial, environmental, and biotic drivers, and this poses challenges [4; 7]. Mandatory and permanent members of terrestrial soil communities are ground beetles (Coleoptera, Carabida). They take the upper levels in the food networks, their ecology and biology are studied well and they are treated as the excellent bioindicators. We have long been investigating morphometric variation in carabids paying the close attention to such the phenomena as Sexual Size Dimorphism (SSD) [5; 8; 9]. It is well developed in ground beetles, female-biased and varied in environmental gradients. *Carabus exaratus*, the object of present study, is not the exception. Its SSD grew in altitude gradient [10]. In this study we have elaborated those studies taking into account newly received data.

Material and methods. *C. exaratus* is an eurytopic species with forest and forest-meadow features that have a spring-summer type of reproduction, an autumn recy-

cling [1]. This species lives from the foothill steppes to the subnival zone, dominates in mountain slopes and floodplain forests. For a long time it was considered endemic to the Caucasus and Transcaucasia, but then it was found in the Southern Urals and in the south of the Tyumen region.

We sampled beetles in two distanced regions of Russia: Chechen Republic (three plots at 43° N, 45° E, 25 – 91 m.a.s.l. in the floodplain forests of Chernie Gori region) and Krasnodarskiy Province (two plots at 44° N, 39° E, 700 m.a.s.l., beach forest and meadow). Later in text these sites will be notes as «Chechnya» and «Krasnodar». Beetles were sampled by pitfall traps. The dried beetles were photographed with a digital camera Nikon D5100 with resolution 16 Megapixels. The measuring was done using «Manual Carabid morphometric measurement for the method by Sukhodolskaya». Initial code of the latter is available under the free – permissive license MIT [6]. The selected specimen were measured for 6 linear characteristics: the elytra length (as distance between posterior end of scutellum and terminus of right elytron), elytra width (as distance between anterior-distal corners of elytra), pronotum length (measured along of central furrow), pronotum width (at the backward edge between back angles), head length (as distance between labrum and juncture of occiput and postgena), head width (between the inner edge of the eyes). In total 620 specimen were measured.

SSD was assessed according to the methods accepted in global practice: $SSD = (\text{Mean value of the trait of females} / \text{Mean value of the trait of males}) - 1$.

Results and discussion. SSD values in a whole did not differ in the populations of two sites (Fig. 1), but when counting separately for the each measured trait some conclusions could be made (Fig. 2). Though in most cases confident intervals nearly overlapped, SSD by elytra and pronotum parameters were higher in the beetles from Chechnya but by the head parameter – in the beetles from Krasnodar.

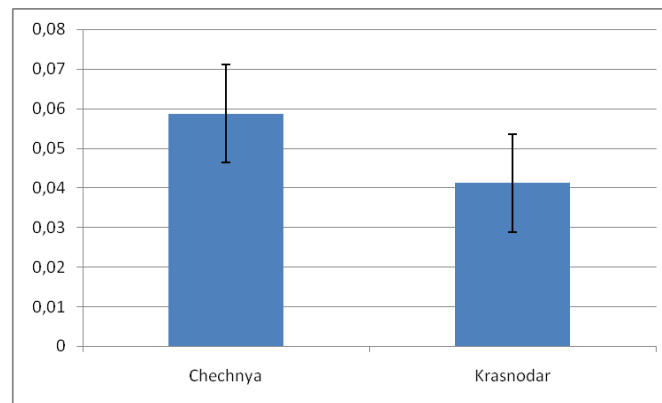


Fig. 1. Values of SSD in studied populations of *C. exaratus* (in total by all traits)

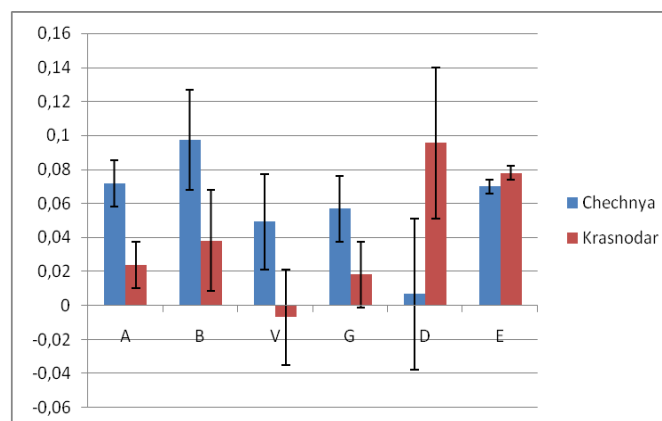


Fig. 2. Values of SSD in studied populations of *C. exaratus* by measured traits.

A – elytra length, B – elytra width, V – pronotum length, pronotum width,
D – head length, E – distance between eyes

Our results was the first experience in SSD estimating in *C. exaratus*, when two samples inhabiting different geographical regions were compared. Some studies were devoted to that problem too. In ground beetle *Carabus odoratus* Shil. SSD changed in altitude gradient being the lowest in the middle mountains, but in *C. exaratus* SSD increased in altitude gradient [9]. In another mounain species – *Pterostichus montanus* Motch – SSD correlated with population abundance [10]. Attempts are being made to assess sexual dimorphism in other ground beetle species [5; 11; 12]. Considering that sexual dimorphism can be an indicator of habitat, and its values for individual traits indicate the direction of evolution of these traits, it is important to replenish the database on the variability of the sizes of females and males of ground beetles in environmental gradients. And our work is one of the steps being taken.

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