Far Eastern Entomologist

Number 491: 24-30 ISSN 1026-051X (print edition) ISSN 2713-2196 (online edition) December 2023

https://doi.org/10.25221/fee.491.4
https://elibrary.ru/dfammb
https://zoobank.org/References/473B7535-8D07-40B4-A9FE-1EF2C3628C85

LIFE CYCLE OF *CARABUS GRANULATUS* LINNAEUS 1758 (COLEOPTERA, CARABIDAE) IN WESTERN TRANSBAIKALIA

L. Ts. Khobrakova*, S. G. Rudykh

*Institute of General and Experimental Biology, Siberian Branch of the Russian Academy of Sciences, Ulan-Ude, 670047, Russia. *Corresponding author. E-mail: khobrakova77@mail.ru*

Summary. In conditions of Western Transbaikalia, *Carabus granulatus* Linnaeus 1758 has a one-year spring–early summer life cycle with the hibernation of the last age larvae. The most optimal habitat conditions and the life cycle realisation for the species were found on the floodplain meadow, which was pronounced in the optimum sex and age-related structure with identification of stages of development of adult beetles and larvae in comparison with the steppe and saline meadows. Warm and long autumn of 2018 in Western Transbaikalia was conducive to the lengthening of the seasonal activity of species and the life cycle realisation characteristic of the conditions of the Russian Far East and Japan.

Key words: ground beetles, *Carabus granulatus*, life cycle, seasonal activity, Siberia, Russia.

Л. Ц. Хобракова, С. Г. Рудых. Жизненный цикл *Carabus granulatus* Linnaeus 1758 (Coleoptera, Carabidae) в Западном Забайкалье // Дальневосточный энтомолог. 2023. N 491. С. 24-30.

Резюме. Жизненный цикл *Carabus granulatus* Linnaeus 1758 в условиях Западного Забайкалья реализуется как одногодичный весенне-раннелетний с зимовкой личинок последнего возраста. В 2018 г. наиболее оптимальные условия обитания и реализации жизненного цикла для вида сложились на пойменных лугах, что выражается в оптимальной половозрастной структуре с выявлением всех стадий развития имаго и личинок по сравнению с остепненными и засоленными лугами. Теплая и длительная осень 2018 г. в Западном Забайкалье способствовала удлинению сезонной активности вида и реализации жизненного цикла, характерного для условий российского Дальнего Востока и Японии.

INTRODUCTION

Carabus granulatus Linnaeus 1758 is one of the abundant species of Carabidae on meadows of Western Transbaikalia (Moroldoev, 2009; Khobrakova, 2017). It is a meadow species widespread in Europe and Asia, introduced to North America (Catalogue of Palaearctic Coleoptera, 2017). The species has a one-year spring life cycle with larval development during the summer months and hibernation at the stage of young imago (Larsson, 1939; Thiele, 1977; Sharova & Dushenkov, 1979; Vasilyeva, 1978; Korobeinikov, 1979). The

species activity timing varied greatly in different parts of its areal. In Denmark it was observed throughout the year (Larsson, 1939), in Sweden – from January to November (Lindroth, 1992), in Central Russia (Ryazan Oblast, Bryansk Oblast, Mordovia) – from April to September (Vasilyeva, 1972; Inyaeva, 1983; Sharova & Kiselev, 1999; Trushitsyna, 2009), in Northwestern Russia (Arkhangelsk Oblast) – from June to August (Filippov, 2006), in Southern Eastern Siberia (Irkutsk Oblast, Buryatia) – from June to September (Shilenkov, 1978; Moroldoev, 2009; Khobrakova, 2017), in the Russian Far East and Japan – from May to the first half of September (Higashi *et al*., 1983; Kurenshchikov *et al*., 2010).

Reproduction duration also differed: from April to July in Denmark and Ryazan Oblast (Larsson, 1939; Trushitsyna, 2009), from May to June in Sweden (Lindroth, 1992), in June in Arkhangelsk Oblast (Filippov, 2006), from June to July in Bryansk Oblast (Vasilieva, 1972), Mordovia (Sharova & Kiselev, 1999), Southern Baikal Region (Shilenkov, 1978) and Western Transbaikalia (Moroldoev, 2009; Khobrakova, 2017).

When breeding beetles in laboratory conditions, the period of egg-laying was extended and could last until August (Berlov & Berlov, 1997; Kolesnikov, 2005).

In Europe and the European part of Russia, larvae were observed in nature from the end of May – June to the end of July – August (Larsson, 1939; Filippov, 2006; Trushitsyna, 2009). In the Russian Far East, *C. granulatus* larvae wintered on Sakhalin Island (https:// www. biwahaku.jp/study/gomimushi/akaganeosamushi.html).

While the appearance of beetles of a young generation in Europe, Central Russia, and Western Transbaikalia was registered in late July – August – September (Larsson, 1939; Vasilieva, 1972; Shilenkov, 1978; Inyaeva, 1983; Lindroth, 1992; Sharova & Kiselev, 1999; Trushitsyna, 2009; Khobrakova, 2017), in the north of the Russian Plain in July – August (Filippov, 2006).

Purpose of present study is to identify features of life cycle of *C. granulatus* and demographic structure of three populations on different types of meadows in Western Transbaikalia in 2018.

MATERIAL AND METHODS

Stationary studies were conducted in Western Transbaikalia in the Ivolginsky Basin 15 km south-west of Ulan-Ude in 2018. Features of demographic structure and life cycle of *C. granulatus* were studied on three types of meadows: floodplain (Mukhinsky swamps, TNI8), steppe (Mukhinsky swamps, Mukha015), saline (Ivolga River floodplain, Khubishkal 005). Soil and vegetation characterisation of meadow ecosystems in the Ivolginsky Basin was given according to Ubugunova *et al*. (2011).

Insects were collected with ground traps and each line contained 20 traps placed every 5 m. A 4% solution of formalin was used for fixation of insects. The material was collected every 10 days throughout the vegetation season from May 20 to October 30, 2018 on floodplain meadow (91 specimens), on steppe meadow (60 specimens), and on saline meadow (6 specimens) (totally 157 specimens).

The sex ratio index was calculated by Sustek (Sustek, 1984). Index values close to 0 corresponded to approximately equal sex ratio and characterise optimum habitat conditions for the species.

To characterise the demographic structure of the nd beetle populations, the generative condition of imago was determined in all females and males according to Wallin's method (Wallin, 1987). The teneral (**t**), immature (**i**), mature (**m**), and spent (**s**) ages of imago were

identified according to the degree of genital gonads development. The interpretation of species life cycle was based on spectrum of demographic structure, duration of seasonal activity dynamics, reproduction periods of females, egg-laying, and wintering stages.

RESULTS

Our studies have shown peculiarities of seasonal activity dynamics of demographic structure and life cycle of *C. granulatus* on the floodplain, steppe and saline meadows in the Ivolginsky Basin.

Relatively high number of beetles was found on the floodplain meadow (0.08 spec./10 traps per day). The most optimal habitat conditions for the sex composition of the species were also formed on the floodplain meadow with a slight predominance of females (51 ♂, 55 ♀, S=0.04).

In the floodplain meadow, the beginning of *C. granulatus* imago activity was registered in late May, and the end of activity observed in early September (Fig. 1). The duration of the seasonal activity was 110 days. The demographic structure of the population was well pronounced. At the beginning of the season, immature specimens were noted, that reached generative condition and produced maximum number of eggs in mid-June. Later reproduced spent specimens were registered.

The period of egg-laying lasted from the late May to the late July (70 days). On average, one female laid 3.3 eggs per season, with a maximum of 15 eggs per female. A larvae activity was observed within the following periods: early July (6 specimens), mid-August (4 specimens), early September (14 specimens), late September (125 specimens), mid-October (18 specimens). Most specimens overwinter at the stage of third age larvae, while a few specimens do it the immature imago stage.

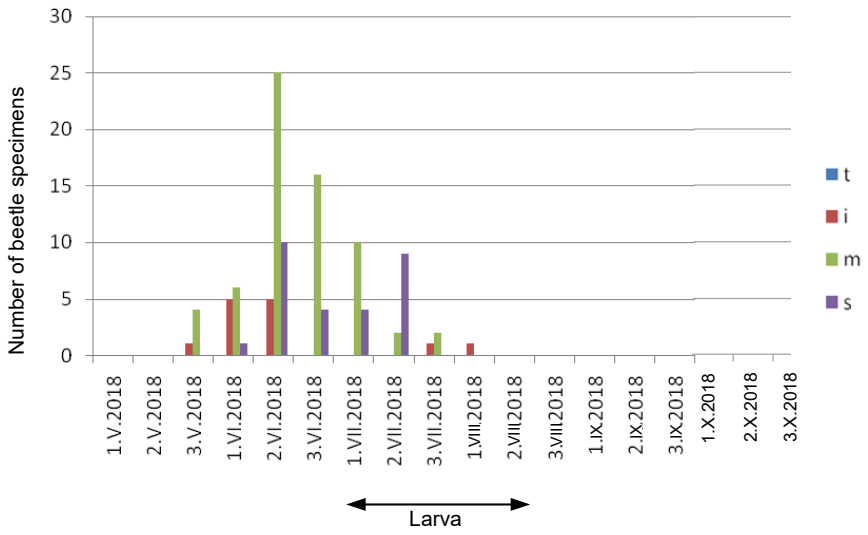

Fig. 1. Seasonal dynamics of *Carabus granulatus* activity on floodplain meadow in 2018. Abbreviations: t – teneral imago, i – immature imago, m – mature imago, s – spent imago.

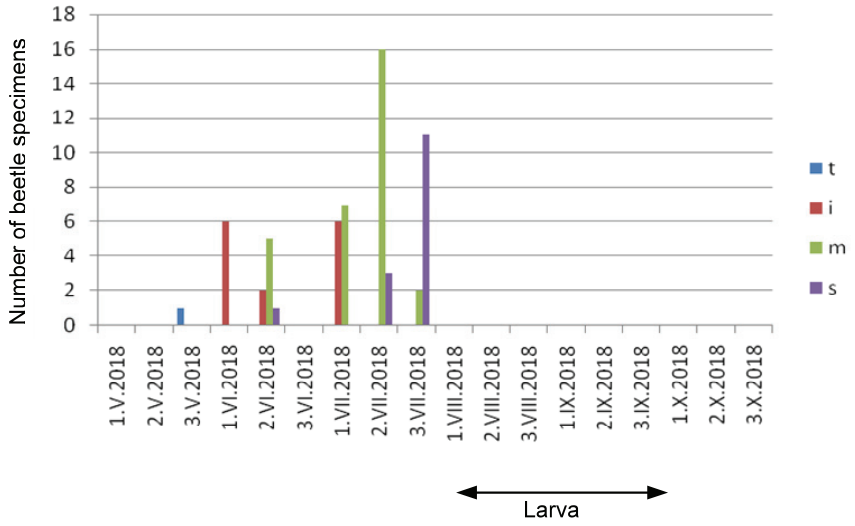

Fig. 2. Seasonal dynamics of *Carabus granulatus* activity on steppe meadow in 2018. Abbreviations as in Fig. 1.

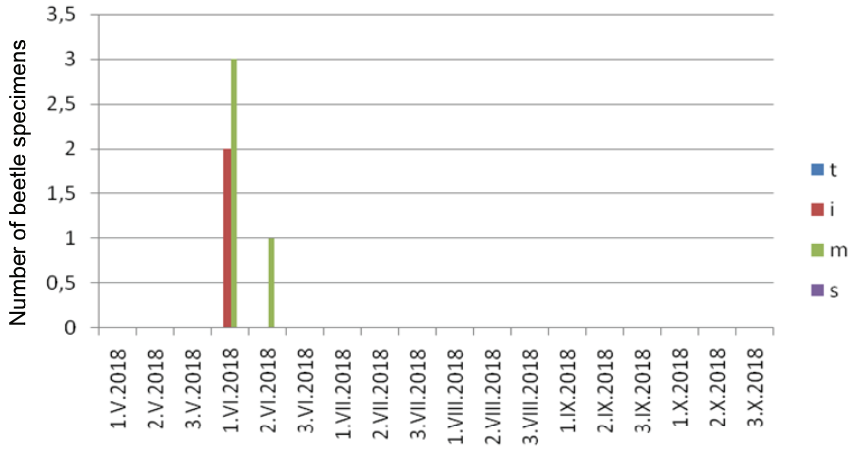

Fig. 3. Seasonal dynamics of *Carabus granulatus* activity on saline meadow in 2018. Abbreviations as in Fig. 1.

In the steppe meadow, the beginning of *C. granulatus* activity lasted from the late May to late July (Fig. 2). The duration of seasonal activity was 70 days. Teneral beetles were registered in late May, indicating wintering of beetles at the larval stage. Immature specimens were registered during June – July. Mature specimens had the peak of activity in mid-July, indicating reproduction of the species. The period of egg-laying lasted from mid-June to late July (50 days) with its peak in early July. On average, one female laid 3.7 eggs per season, with a maximum of 8 eggs per female. Larvae were registered in early August (1 second age larva), in late September (4 specimens of third age). Third age larvae went wintering in 2018.

In the saline meadow, the activity of *C. granulatus* was practically not pronounced (Fig. 3). Only single immature and mature specimens were registered in early and mid-June.

CONCLUSION

In the conditions of Western Transbaikalia, *Carabus granulatus* has a one-year spring–early summer life cycle with the hibernation of the last age larvae. In the last decade, climatic changes in Transbaikalia increased the duration of the autumn period. This was reflected in the lengthening of the seasonal activity of species by almost a month in the 2018 observations in contrast to the 2009 season (Khobrakova, 2017). The duration of the seasonal activity of species increased to 150 days, starting from late May to mid-October.

Depending on the type of meadow, the peak of activity of species shifted. The species was active in early June; however single specimens were registered on the saline meadows. While on the floodplain meadow the peak activity was observed in mid-June, on the steppe meadow the peak of activity shifted to mid-July.

Analysis of the species population structure on different types of meadows showed that the most optimal habitat conditions and life cycle realisation were established on the flood-plain meadow. This is confirmed by the presence of all developmental stages of imago and larvae in one biotope, a relatively high number of beetles and an almost equal ratio of females to males.

In the Western Transbaikalia, *C. granulatus* has the same one-year life cycle with the hibernation of larvae in the 2018 season as in the conditions of the Far East and Japan.

ACKNOWLEDGMENTS

The reported study was carried out at the expense of the state assignment of the Institute of General and Experimental Biology, Siberian Branch of the Russian Academy of Sciences on the 0271-2021-0001 project.

REFERENCES

Berlov, O.E. & Berlov, E.Ya. 1997. Life cycle of three Siberian populations of the ground beetle *Carabus granulatus* (Coleoptera, Carabidae). *Bulletin of the Irkutsk State Agricultural Academy*, 7: 34–36. [In Russian]

Catalogue of Palaearctic Coleoptera. 2017. Eds. I. Löbl, D. Löbl. Rev. and upd. ed. In: *Vol. 1: Archostemata – Myxophaga – Adephaga*. Brill, Leiden; Boston. 1443 pp.

Filippov, B.Yu. 2006. Seasonal aspects of the life cycles of *Carabus granulatus* and *C. glabratus* (Coleoptera, Carabidae) in the northern taiga. *Zoologicheskyi Zurnal,* 85(9): 1076–1084. [In Russian]

Higashi, S., Fukuda H., Haruki M. & Ito K. 1983. Faunal makeup and distribution of ground beetles in a dairy area Bekkai, Northern Japan. *Environmental Science, Hokkaido,* 6(1): 15–26.

Inoue, H. 1953. *Carabus granulatus* Linnaeus, 1758. *Biological indicator ground beetles database, Japan.* Available from: https://www.biwahaku.jp/study/gomimushi/akaganeosamushi.html (accessed 10 September 2023)

Inyaeva, 3.I. 1983. Species composition and distribution of ground beetles (Coleoptera, Carabidae) in the fields. P. 98–107. In: *Fauna and ecology of soils and invertebrates of the Moscow region*. Nauka, Moscow. [In Russian]

Khobrakova, L.Ts. 2017. Ground beetles (Coleoptera, Carabidae) of the Mukhinsky swamps (Western Transbaikalia). *Nature of Inner Asia*, 1(2): 43–53. [In Russian]

Kolesnikov, F.N. 2005. On the biology of the red-thighed form *Carabus granulatus* Linnaeus, 1758. P. 127–128. In: *Ecological diversity of soil biota and soil bioproductivity. Materials IV (XIV) All-Russian meetings on soil zoology.* Tyumen. [In Russian]

Korobeinikov, K.I. 1979. Beetles of the Ilmensky Nature Reserve and their seasonal dynamics of activity. P. 60–62. In: *Proceedings of the Institute of Plant and Animal Ecology of the USSR Scientific Center. Structural and functional relationships in biogeocenoses of the southern Urals, Vol. 130*. Publishing House of the USSR Academy of Sciences, Sverdlovsk. [In Russian]

Kurenschikov, D.K. Rogatnykh, D.Yu., Yakubovich, V.S. & Babenko A.S. 2010. Fauna and seasonal dynamics of activity of ground beetles (Coleoptera, Carabidae) in the vicinity of Khabarovsk. *Bulletin of Tomsk State University*. 330: 179–184. [In Russian]

Larsson, S.G. 1939. Entwicklungstypen und Entwicklungszeiten der Dänischen Carabiden. *Entomologiske Meddelelser*, 20: 277–560.

Lindroth, C.H. 1992. *Ground beetles (Carabidae) of Fennoscandia: a zoogeographical study*. *Part 3 (English translation of 1945 original German text).* Intercept, Andover, UK. 814 pp.

Moroldoev, I.V. 2009. *The structure of communities of ground beetles (Coleoptera, Carabidae) in the cryoarid forest-steppe of the south of the Vitim Plateau. Abstract of the dissertation for the degree of candidate of biological sciences.* Ulan-Ude. 18 pp. [In Russian]

Sharova, I.Kh. & Dushenkov V.M. 1979. Types of development and types of seasonal activity of ground beetles (Coleoptera, Carabidae). P. 15–25. In: *Fauna and ecology of invertebrates*. Moscow State Pedagogical University, Moscow. [In Russian]

Sharova, I.X. & Kiselev I.E. 1999. *Dynamics of the population structure of ground beetles (Coleoptera, Carabidae) in urban landscapes of the city of Saransk*. Mordovian State Pedagogical Institute Publishing House, Saransk. 213 pp. [In Russian]

Shilenkov, V.G. 1978. Peculiarities of biology of common species of ground beetles (Coleoptera, Carabidae) of the fauna of the Southern Baikal region. *Entomologicheskoe Obozrenie*, 57(2): 290–301. [In Russian]

Sustek, Z. 1984. The bioindicative and prognostic significance of sex ratio Carabidae (Insecta, Coleoptera). *Ecologia (CSSR)*, 3(1): 3–22.

Thiele, H.-U. 1977. *Carabid beetles in their environments: a study on habitat selection by adaptations in physiology and behavior*. Springer-Verlag. 369 pp.

Trushitsyna, O.S. 2009. Demographic features of local populations of species of the genus *Carabus* L. (Coleoptera, Carabidae) in the mosaic of floodplain meadows in the south of the Meshchera Lowland. *Eurasian Entomological Journal*, 8(4): 399–410. [In Russian]

Ubugunova, V.I., Rupyshev Yu.A., Khobrakova L.Ts., Ubugunov V.L., Baldanov B.Ts. & Lavrentieva I.N. 2011. Ecosystems of the Mukhinsky lowland meadow-swamp locality (Ivolginskaya hollow). *Bulletin of the Buryat State Agricultural Academy*, 1(22): 51–59. [In Russian]

Vasilyeva, P.M. 1978. Features of the development of some species of ground beetles in the Bryansk region. P. 40–52. In: *Fauna and ecology of invertebrate animals*. Moscow. [In Russian]

Vasilyeva, R.M. 1972. Seasonal dynamics of the activity of dominant species of ground beetles (Carabidae) in the conditions of contact between forest and forest-steppe in the Bryansk region. P. 53–64. In: *Fauna and ecology of animals*. Moscow. [In Russian]

Wallin, H. 1987. *Distribution, movement and reproduction of Carabid beetles (Coleoptera, Carabidae) inhabiting cereal fields*. Plant protection reports and dissertation of the Swedish Univercity for Agriculture Sciences, Uppsala, 15: 3–19 + 109 pp.