

<https://doi.org/10.25221/fee.418.4>

<http://zoobank.org/References/13568A49-C2C5-4E99-AE94-34589A2E7911>

**LIFE CYCLE OF GROUND BEETLE *CHLAENIUS TRISTIS*
RETICULATUS MOTSCHULSKY, 1844 (COLEOPTERA: CARABIDAE)
IN THE CONDITIONS OF WESTERN TRANSBAIKALIA**

L. Ts. Khobrakova^{1,*}, S. G. Rudykh¹, Ts. Ulzii², Ch. Gantigmaa²

1) *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*

2) *Institute of General and Experimental Biology, Mongolian Academy of Sciences, Ulaanbaatar, 210351, Mongolia. E-mail: gantigmaa_ch@yahoo.de*

Summary. In the conditions of Western Transbaikalia, *Chlaenius tristis reticulatus* Motschulsky, 1844 has a one-year late spring – early summer life cycle with the hibernation of a young generation of beetles. The interpretation of their life cycle is based on the study of sex and age-related structure of imago, the seasonal activity of generative females, the above-ground activity of larvae, and stages of the development of beetles in the laboratory conditions. The changes in the seasonal activity of beetles on meadows with different soil moisture (steppified, moistened, and marshy meadows) were identified.

Key words: seasonal activity, meadows, larvae, pupa, adult, Siberia, Russia.

Л. Ц. Хобракова, С. Г. Рудых, Ц. Улзы, Ч. Гантигма. Жизненный цикл жужелицы *Chlaenius tristis reticulatus* Motschulsky, 1844 (Coleoptera: Carabidae) в условиях Западного Забайкалья // Дальневосточный энтомолог. 2020. N 418. С. 19-24.

Резюме. Жизненный цикл *Chlaenius tristis reticulatus* Motschulsky, 1844 в условиях Западного Забайкалья реализуется как одногодичный поздневесенний – раннелетний с зимовкой молодого поколения жуков. Расшифровка жизненного цикла основана на половозрастной структуре имаго, сезонной активности генеративных самок, напочвенной активности личинок и изучении стадий развития жуков в лабораторных условиях. Выявлено изменение сезонной активности жуков на лугах с разным увлажнением (остепнённом, влажном и заболоченном).

INTRODUCTION

Chlaenius tristis (Schaller, 1783) is a meadow-swamp species with Palaearctic distribution and spread. Phenological peculiarities of the species in the European part of the areal were obtained. Thus, in Ukraine, it is registered from the second half of April to the second half of September (Petrusenko & Petrusenko, 1971). The peak of activity differs depending on the natural zone. In the steppe, it is more often registered in May-June. In the forest-steppe, it is more often observed in June-July (Petrusenko & Petrusenko, 1971). In the

Asian part of the areal, *Ch. tristis reticulatus* Motschulsky, 1844 subspecies spreads from the Altai-Sayan mountain system to the Far East, including Transbaikalia and Northern Mongolia, and inhabits floodplain mixed forests, marshy meadows, and swamps (Khobrakova *et al.*, 2014; Schnitter, 2016). In 2009, data on the seasonal dynamic of the activity and life cycle of *Ch. tristis reticulatus* in the conditions of Mukhinsky swamps of Western Transbaikalia (Siberia) were obtained (Khobrakova, 2017). Ten years later, our studies were repeated on the same plot due to a long-term drought in the Western Transbaikalia. In this period, Mukhinsky swamps reduced in size, and the nearshore marshy meadows transformed into stepped meadows.

Therefore, the present study was aimed to investigate the changes in the demographical structure of *Ch. tristis reticulatus* on meadows with different soil moisture within Mukhinsky swamps and to interpret their life cycle based on the study of the parameters of sex and age-related structure of beetles, seasonal dynamics of the activity of generative females, and observation of different stages of the development in the laboratory conditions.

MATERIAL AND METHODS

The study of the life cycle of *Ch. t. reticulatus* and changeability of its seasonal activity was conducted on Mukhinsky swamps in the area of Ivolginskaya hollow (Western Transbaikalia). The material was collected every 7 days from May 20 to October 11, 2019. 477 imagoes and 172 larvae of ground beetles were collected in total with ground traps. The obtained samples were fixed in a 4% solution of formalin.

The experiment included three lines of soil traps placed in salt mixed-grass sedge meadows with different degrees of soil moisture. The first line of traps was placed on the nearshore area on the steppified meadow (49 imagoes, 7 larvae), the second one – 30 m deep to the swamp on the moistened meadow (175 imagoes, 17 larvae), the third one – 60 m deep to the swamp on the marshy meadow (248 imagoes, 172 larvae). Each line contained 20 functioning traps placed every 5 m. Live traps were used to catch 13 alive larvae that were used to obtain pupae and imago.

To study the seasonal dynamics of sex and age-related structure and reconstruct the life cycle of the species, the authors evaluated the degree of the development of genital gonads in female and male imagoes with the identification of a teneral (t), immature (i), mature (m), and spent (s) ages (Wallin, 1987). The number of eggs of the generative females (mature) was estimated. The index of sex ratio was calculated by Šustek (1984).

RESULTS

The life cycle of *Chlaenius tristis reticulatus* in the conditions of meadows with different soil moisture (Mukhinsky swamps)

Steppified meadow, coastal part, first line. This site was not a natural habitat for *Ch. t. reticulatus* and their reproduction. But some beetles invade the area from the nearby moistened meadows. This site was characterized by the lowest abundance of beetles (49 specimens). In the sex composition, females dominated (21♂, 28♀), the sex ratio index was 0.14. The duration of the seasonal activity of the species was 104 days from May 20 to September 1. After the wintering, at the end of May, single immature specimens were registered. A small peak of the activity of beetles was characterized as a mid-summer and was observed in the second half of July and the beginning of August (Figure 1a). It consisted of immature, mature, and spent specimens. Only mature males were registered in this site. Cumulatively, 7 larvae were caught from June 28 to July 5. At the end of August – beginning of September, immature beetles were registered.

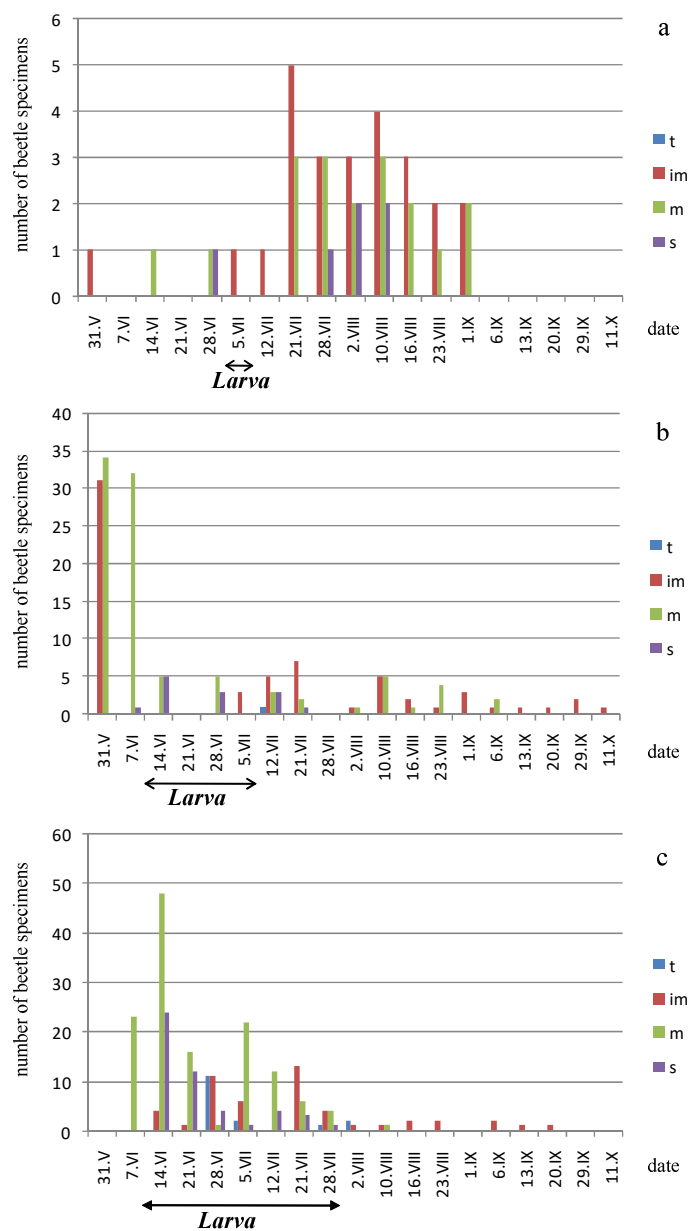


Fig. 1. Seasonal dynamics of activity of *Chaenius tristis reticulatus* adult and larva. Stages of beetles development: t – teneral, im – immature, m – mature, s – spent. Biotopes: a – steppificated meadow, b – moistened meadow, c – marshy meadow.



Figs 2–8. Stages of development *Chlaenius tristis reticulatus*. 2, 3 – larvae of third age (12–16 mm), 4, 5 – pupa (8–10 mm), 6, 7 – adult (teneral age) (11–14 mm), 8 – adult (immature age) (11–14 mm). Photo by S.G. Rudykh and L.Ts. Khobrakova.

Moistened meadow, second line. This site was more typical for this species and was located between dry and marshy meadows. The number of beetles was 3.5 times higher than in the first line (175 specimens). In the sex composition, males dominated (92♂, 83♀), the index of the sex ratio was -0.05. In this site, the seasonal activity was the longest – 144 days from May 20 to October 11 (Figure 1b). The peak of the activity of beetles was characterized as late spring and was registered at the end of May. The demographic structure of the species was pronounced. At the beginning of the season from May 20 to June 14, immature specimens that successfully wintered, reached generative condition, and started to reproduce were observed. The period of egg-laying was registered within 5 weeks from May 20 to June 28 with its peak on May 31. On average, each female laid 22 eggs. The maximum number of eggs per female was 38. Larvae appeared within three weeks from June 14 to July 5 with 71% of larvae appearing in the last week and starting to pupate later. Starting on July 12, the

first teneral specimens started to appear. Teneral and immature beetles went wintering till October 11.

Marshy meadow, third line. This site had optimum conditions for the inhabitation and reproduction of *Ch. t. reticulatus*. The number of beetles increased by 5 times (248 specimens) in comparison with the first line. In the sex composition, males dominated (142♂, 105♀), the sex ratio index was -0.15. The seasonal activity of beetles was characterized as early summer. It lasted for 105 days from July 7 to September 20. The peak of activity was registered on June 14 (Figure 1c). In the demographic structure of the specimen, all ages of imago and larvae were present. The period of egg-laying lasted for 7 weeks from June 7 to July 21. The peak of the reproduction was registered on June 14. On average, one female laid 12 eggs. The maximum number of eggs per female was 25-26. A long-term larvae activity was observed within 7 weeks from June 14 to July 28 with two peaks on June 21 (80 specimens, 47%) and July 12 (61 specimens, 36%). Consequently, the period of the appearance of young immature beetles elongated from June 28 to September 20. In the second half of September, teneral and immature beetles went wintering.

The stages of the development of *Ch. tristis reticulatus* in the laboratory conditions

Alive larvae of the third age (13 specimens) were collected using live traps on June 28. The larvae were kept separately in Petri dishes at a temperature of 21 °C on moist filtered paper. The length of larvae of the third age was 12–16 mm (Figs 2, 3). In 5–6 days, on July 2nd-3rd, mass pupation was observed. The stage of the pupa lasted for 4–5 days (Figs 4, 5). Young immature beetles appeared on July 7-8th (Figs 6, 7). The hardening of integuments of young beetles (5 specimens) took around 15 hours (Fig. 8).

CONCLUSION

The study of the sex composition of *Ch. tristis reticulatus* in the conditions of Mukhinsky swamps in 2019 and breeding of beetles from larvae showed that their life cycle in Western Transbaikalia was one-year late spring – early summer with wintering of a young generation of beetles. In the study of *Ch. tristis reticulatus* conducted in 2009, because of the lack of data in the beginning of the season and overlapping of the periods of reproduction of beetles and larvae, the life cycle was interpreted as two-year with mid-summer activity and wintering larvae and young immature beetles (Khobrakova, 2017).

The study of the seasonal dynamics of the demographic structure of *Ch. tristis reticulatus* on meadows with different soil moisture allowed the authors to identify the most favorable site for the inhabitation and reproduction. These were moistened and marshy meadows that contained the highest number of imagoes and larvae.

It was noted that the peak of the beetle population on different types of meadows differed. In the steppified meadow, it was observed at the end of July – August; in the moistened meadow – at the end of May – beginning of June; in the marshy meadows – at the end of June – July. Probably, it was associated with mass reproduction of beetles on the marshy meadow with the highest share of active beetles in September – beginning of October and further active spread to the steppified meadow.

The past 10 years of drought and warming in the region led to the drying and transformation of marshy nearshore meadows to steppified meadows that became unsuitable for the inhabitation and reproduction of *Ch. tristis reticulatus*. In comparison with the study conducted in 2009 (Khobrakova, 2017), in 2019, the number of beetles and the share of female specimens in the nearshore area of Mukhinsky swamps reduced by 5 times, and in the

demographical structure, there were no mature females registered. The duration of the seasonal activity of the species increased by two weeks from 90 days to 104 days, which was associated with an increase of days with positive temperatures to mid-October (www.meteo.ru). The overgrazing of the area with bovine and small cattle (cows, sheep) contributed to the reduction of the beetle population on steppified meadows.

ACKNOWLEDGEMENTS

The authors are grateful to M.Yu. Proshchalykin and Yu.N. Sundukov (Vladivostok, Russia) for consultations in the preparation of the article.

The reported study partly was funded by State Program "Reactions of the Animal World of the Baikal Region on the Global Climate Changes" (№. AAAA-A17-117011810035-6; Federal Agency for Scientific Organizations 0337-2016-0002) and RFBR and MECSS, project number 20-54-44014.

REFERENCES

- Khobrakova, L.Ts. 2017. The ground beetles (Coleoptera, Carabidae) of the Mukhinskye swamps (Western Transbaikalia). *Nature of Inner Asia*, 1(2): 43–53. [In Russian]
- Khobrakova, L.Ts., Shilenkov, V.G. & Dudko, R.Yu. 2014. *The ground beetles (Coleoptera, Carabidae) of Buryatia*. Buryat Scientific Center, Ulan-Ude. 380 pp. [In Russian]
- Petrusenko, A.A. & Petrusenko, S.V. 1971. The ecological – faunal review of the ground beetles of the genus *Chlaenius* Bon. (Coleoptera, Carabidae) of Ukraine. *Vestnik of Zoology*, 6: 28–31. [In Russian]
- Schnitter, P. 2016. Vorläufige Checkliste der Laufkäfer (Coleoptera: Carabidae) der Mongolei 3. Beitrag zur Carabidenfauna der Mongolei. Erforschung biologischer Ressourcen der Mongolei. Exploration into the Biological Resources of Mongolia. *Martin-Luther-Universität Halle Wittenberg, Halle (Saale)*, 13: 197–220.
- Šustek, Z. 1984. The bicindicative and prognostic significance of sex ratio in Carabidae. *Ecology (SSR)*, 3: 3–22.
- Wallin, H. 1987. *Distribution, movements and reproduction of Carabid beetles (Coleoptera, Carabidae) inhabiting cereal fields*. Plant Protection Reports. Av. 15. Dissertations. Swedish University Agricultural Sciences, Uppsala. 109 pp.

© **Far Eastern entomologist (Far East. entomol.)** Journal published since October 1994.

Editor-in-Chief: S.Yu. Storozhenko

Editorial Board: A.S. Lelej, S.A. Belokobylskij, M.G. Ponomarenko, E.A. Beljaev, V.A. Mutin, E.A. Makarchenko, A.V. Gorochoy, T.M. Tiunova, M.Yu. Proshchalykin, S.A. Shabalin

Address: Federal Scientific Center of the East Asia Terrestrial Biodiversity (former Institute of Biology and Soil Science), Far East Branch of the Russian Academy of Sciences, 690022, Vladivostok-22, Russia.

E-mail: storozhenko@biosoil.ru

web-site: <http://www.biosoil.ru/fee>