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Article

Information on the entomofauna of urbanized territories of Crimea, collected under conditions of climate warming

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Abstract. This paper presents data on insect species collected in parks and squares of Crimea during the abnormal winter warming of 2024, mainly in the southeastern part of the Crimean Peninsula. Average February temperatures in southeastern Crimea exceeded those for the entire period of instrumental meteorological observations at the Karadag scientific station, which determined the activity of imagoes of many insect species. A total of 67 species belonging to 60 genera, 29 families and seven orders were identified. In addition to the background species, pests were found: *Xanthogaleruca luteola* (O.F. Müller, 1766), *Monosteira unicostata* (Mulsant et Rey, 1852), *Halyomorpha halys* (Stål, 1855), *Nezara viridula* (L., 1758), *Leptoglossus occidentalis* Heidemann, 1910, *Anacridium aegyptium* (L., 1764), as well as protected species: *Xylocopa valga* Gerstaecker, 1872 and *Ocypus curtipennis* Motschulsky, 1849. Herpetobionts dominate in the collections, thamno- and dendrobionts are common, hortobionts are also found. The number of adults of the invasive pests *Halyomorpha halys* (Stål, 1855) and Leptoglossus occidentalis Heidemann, 1910 in the winter months in urbanized areas of the peninsula was insignificant; *Tachyporus hypnorum* (Fabricius, 1775) was represented by the largest number of individuals in the collected material.

Keywords: insects, global warming, Coleoptera, Dermaptera, Diptera, Hemiptera, Hymenoptera, Lepidoptera, Orthoptera

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Научная статья

Материалы по энтомофауне урбанизированных территорий Крыма, собранные в условиях климатического потепления

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Аннотация. Приведены данные о видах насекомых, собранных в парках и скверах Крыма во время аномального зимнего потепления 2024 г., преимущественно в юго-восточной части полуострова. Средние температуры февраля в юго-восточном Крыму превышали таковые за все время инструментальных метеонаблюдений на Карадагской научной станции, что обусловило активность имаго многих видов насекомых. Всего было выявлено 67 видов, относящихся к 60 родам, 29 семействам и 7 отрядам. Кроме фоновых видов были обнаружены вредители – *Xanthogaleruca luteola* (O.F. Müller, 1766), *Monosteira unicostata* (Mulsant et Rey, 1852), *Halyomorpha halys* (Stål, 1855), *Nezara viridula* (L., 1758), *Leptoglossus occidentalis* Heidemann, 1910, *Anacridium aegyptium* (L., 1764), а также охраняемые виды – *Xylocopa valga* Gerstaecker, 1872 и *Ocypus curtipennis* Motschulsky, 1849. В сборах доминируют герпетобионты, обычны тамно- и дендробионты, встречаются хортобионты. Численность имаго инвазивных вредителей *Halyomorpha halys* (Stål, 1855) и *Leptoglossus occidentalis* Heidemann, 1910 в зимние месяцы в урбанизированных районах полуострова была незначительной; наибольшим числом особей в сборах представлен вид *Tachyporus hypnorum* (Fabricius, 1775).

Ключевые слова: насекомые, потепление климата, Coleoptera, Dermaptera, Diptera, Hemiptera, Hymenoptera, Lepidoptera, Orthoptera

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Финансирование. Работа выполнена по теме «Изучение биотических и абиотических компонентов наземных экосистем, особенности их структурно-временной организации в различных климатических условиях среды» № 124030100098-0. Работа А.С. Сажнева выполнена в рамках государственного задания Министерства науки и высшего образования РФ № 124032500016-4.

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Introduction

The study of the entomofauna of the park zone of cities and towns is one of the tasks of urban entomology (Dremova, 2005) and usually includes an entomological survey of the territory which may comprise three ecological-faunistic research foci. These are searching for and assessing the state of biotopes of protected species in parks and squares, recording background insect species, and detecting pests that can have a negative impact on planted and existing plants in the surveyed area (Ivanov et al., 2009; Stryukova, 2016; Stryukova and Stryukov, 2020, 2022; Turtseva, 2008, etc.). Given the floristic diversity of the park zone of southeastern Crimea (Potapenko, 2018), the entomofauna of urbanized areas of southern Russia and the Crimean Peninsula is promising for comprehensive study.

Climate changes in recent decades affected the natural ranges of insect species in Eurasia (Ostrovsky, 2017; Pudovikov, 2019; Stryukova, 2016; Stryukova and Stryukov, 2020, 2022; Yasyukevich et al., 2013, etc.). For example, over the past thirty years, the average annual temperature in Crimea has increased by 1.5 °C, and the rate of climate change on the peninsula is 2–3 times higher than that on a planetary scale (Degterev, 2020). Among the climatic factors that affect insect populations, temperature, humidity, precipitation, light and wind, and atmospheric pressure are distinguished (Yakhontov, 1964). As a result, previously alien elements appear in the fauna of Crimea (Bega et al., 2022; Ivanov et al., 2021; Stryukova, 2016; Shorenko, 2020; etc.). In particular, some invasive pests may acclimatize in Crimea could cause uncontrolled outbreaks (Bega et al., 2022; Romanov et al., 2019; Shorenko et al., 2022; etc.). Therefore, studies of the phenology of species, in the context of global warming, are of particular importance.

The purpose of this work was to study the species diversity of active (emerging from winter diapause) insects in the park zone of urbanized areas of Crimea during thaws.

Materials and methods

The material was collected in January, February and early March 2024 in squares and parks mainly in the south-eastern part of Crimea (Feodosia, Koktebel, biological station of the Karadag Reserve in Kurortnoye; Sudak and Vladislavovka in Kirovsky District), as well as in Eastern Crimea (Kerch), on the southern coast of Crimea (Alushta) and in Western Crimea (Yevpatoriya).

Collection was mainly by hand (from the walls of houses, on asphalt, under stones and fallen leaves, on bark and in isolated cases under the bark of trees) and with Merike traps, followed by fixation of insects in a 70% ethyl alcohol solution and laboratory processing of the collected material. The material was mounted using standard entomological methods (Golub et al., 2021). Species were identified by the present authors using identification guides (Alekseev et al., 1965; Arnoldi et al., 1978; Kerzhner

Fig. 1. Research area. **A** – insect collection sites (marked with dots and an arrow) and average monthly air temperature in Eastern Europe in February (according to https://www.copernicus.eu/en); **B** – Feodosiya, embankment under conditions of winter anomalous warming February 7, 2024).

and Yachevsky, 1964, etc.), including the *Die Käfer Europas*[1], as well as reference collections. The systematic position of species is given in accordance with various entomological Internet catalogs: Fauna Europaea[2] and Insecta.pro[3].

Results and discussion

As a result of the survey of urbanized areas of Crimea, we collected 345 insect specimens belonging to seven orders, 29 families, 60 genera and 67 species. Legend: (1) Kerch, Mount Mithridates; (2) Feodosia, embankment; (3) Koktebel; (4) Karadag, biostation park; (5) Sudak, Genoese fortress; (6) Alushta, embankment; (7) Evpatoria, Tereshkova embankment; (8) Kirovsky district, village of Vladislavovka; work. – working individual, ♀ – female, ind. – specimen, * – species listed in the Red Book of the Republic of Crimea

List of insect species collected in urbanized areas of Crimea in winter-early spring season

Order Dermaptera
Family Forficulidae
1. *Forficula auricularia* Linnaeus, 1758
Material. (2), 12.02.2024, 1 specimen
Order Orthoptera
Family Acrididae
2. *Anacridium aegyptium* (Linnaeus, 1764)
Material. (3), 12.02.2024, 1 specimen
Order Hemiptera
Family Alydidae
3. *Camptopus lateralis* (Germar, 1817)
Material. (2), 7.02.2024, 2 specimens
Family Berytidae
4. *Berytinus montivagus* (Meyer, 1841)
Material. (2), 7.02.2024, 1 specimen
Family Coreidae
5. *Leptoglossus occidentalis* Heidemann, 1910
Material. (2), 1–5.01.2024, 1 specimen, 7.02.2024, 2 specimens, 8.02.2024, 1 specimen, 13.02.2024, 2 specimens, 28.02.2024, 2 specimens
Family Lygaeidae
6. *Arocatus melanocephalus* (Fabricius, 1798)
Material. (2), 7.02.2024, 1 specimen
7. *Lygaeus simulans* Deckert, 1985
Material. (2), 1–5.01.2024, 2 specimens, 7.02.2024, 2 specimens, 8.02.2024, 3 specimens; 10.02.2024, 1 specimen; (4), 1–5.01.2024, 2 specimens; (7), 6.03.2024, 1 specimen; (8), 12.02.2024, 1 specimen
8. *Orsillus depressus* (Mulsant et Rey, 1852)
Material. (1), 25.02.2024, 4 specimens; (2), 7.02.2024, 1 specimen
9. *Spilostethus pandurus* (Scopoli, 1763)
Material. (2), 1–5.01.2024, 1 specimen
Family Nabidae
10. *Nabis punctatus* A. Costa, 1847
Material. (2), 7.02.2024, 1 specimen
Family Pentatomidae
11. *Acrosternum heegeri* Fieber, 1861
Material. (2), 10.02.2024, 1 specimen

[1] Die Käfer Europas. Web page. URL: https://coleonet.de/coleo/index.htm (accessed: 25.02.2024).

[2] Fauna Europaea. Web page. URL: https://fauna-eu.org (accessed: 20.02.2024).

[3] Insecta.pro. Web page. URL: https://insecta.pro (accessed: 19.02.2024).

12. *Halyomorpha halys* (Stål, 1855)
Material. (2), 1–5.01.2024, 2 specimens, 7.02.2024, 4 specimens, 8.02.2024, 1 specimen, 10.02.2024, 1 specimen, 13.02.2024, 1 specimen
13. *Nezara viridula* (Linnaeus, 1758)
Material. (2), 1–5.01.2024, 1 specimen, 7.02.2024, 1 specimen, 8.02.2024, 2 specimens
14. *Peribalus strictus vernalis* (Wolff, 1804)
Material. (7), 6.03.2024, 1 specimen
15. *Rhaphigaster nebulosa* (Poda, 1761)
Material. (2), 8.02.2024, 1 specimen; (4), 12.02.2024, 2 specimens
Family Pyrrhocoridae
16. *Pyrrhocoris apterus* (Linnaeus, 1758)
Material. (2), 7.02.2024, 2 specimens, 10.02.2024, 1 specimen
Family Rhyparochromidae
17. *Eremocoris fenestratus* (Herrich-Schaeffer, 1839)
Material. (2), 7.02.2024, 1 specimen; (4), 12.02.2024, 1 specimen
Family Stenocephalidae
18. *Dicranocephalus agilis* (Scopoli, 1763)
Material. (2), 10.02.2024, 1 specimen
Family Tingidae
19. *Catoplatus carthusianus* (Goeze, 1778)
Material. (2), 1–5.01.2024, 1 specimen, 08.02.2024, 3 specimens
20. *Monosteira unicostata* (Mulsant et Rey, 1852)
Material. (2), 1–5.01.2024, 1 specimen, 08.02.2024, 1 specimen, 10.02.2024, 1 specimen
Order Coleoptera
Family Carabidae
21. *Harpalus distinguendus* (Duftschmid, 1812)
Material. (2), 10.02.2024, 1 specimen
22. *Lebia cyanocephala* (Linnaeus, 1758)
Material. (2), 7.02.2024, 2 specimens
23. *Lebia trimaculata* (Villers, 1789)
Material. (2), 7.02.2024, 2 specimens, 10.02.2024, 1 specimen
Family Cerambycidae
24. *Dorcadion carinatum* (Pallas, 1771)
Material. (2), 29.02.2024, 1 specimen
Family Chrysomelidae
25. *Xanthogaleruca luteola* (O.F. Müller, 1766)
Material. (7), 6.03.2024, 5 specimens
Family Coccinellidae
26. *Chilocorus bipustulatus* (Linnaeus, 1758)
Material. (2), 7.02.2024, 1 specimen
27. *Coccinella septempunctata* Linnaeus, 1758
Material. (1), 25.02.2024, 3 specimens; (2), 1–5.01.2024, 5 specimens, 7.02.2024, 14 specimens, 10.02.2024, 2 specimens; (7), 6.03.2024, 5 specimens
28. *Hippodamia variegata* (Goeze, 1777)
Material. (2), 10.02.2024, 1 specimen
29. *Nephus ludyi* (Weise, 1897)
Material. (4), 1–5.01.2024, 1 specimen
30. *Parexochomus nigromaculatus* Goeze, 1777
Material. (2), 7.02.2024, 1 specimen
Family Cryptophagidae
31. *Cryptophagus* sp.
Material. (2), 8.02.2024, 2 specimens
Family Dermestidae
32. *Anthrenus scrophulariae* (Linnaeus, 1758)
Material. (1), 7.02.2024, 1 specimen

Family Histeridae
33. *Hister quadrimaculatus* Linnaeus, 1758
Material. (2), 10.02.2024, 1 specimen
Family Scarabaeidae
34. *Aphodius fimetarius* (Linnaeus, 1758)
Material. (2), 8.02.2024, 1 specimen
35. *Cetonia aurata* (Linnaeus, 1761)
Material. (2), 1.01.2024, 1 specimen, 7.02.2024, 1 specimen; (4), 29.02.2024, 1 specimen
36. *Onthophagus taurus* (Schreber, 1759)
Material. (2), 13.02.2024, 1 specimen
Family Staphylinidae
37. *Aloconota gregaria* (Erichson, 1839)
Material. (2), 7.02.2024, 1 specimen, 8.02.2024, 1 specimen
38. *Anotylus sculpturatus* (Gravenhorst, 1806)
Material. (2), 8.02.2024, 1 specimen
39. *Mocyta fungi* (Gravenhorst, 1806)
Material. (2), 1–5.01.2024, 2 specimens
40. *Mycetoporus longulus* Mannerheim, 1830
Material. (2), 1–5.01.2024, 2 specimens, 7.02.2024, 1 specimen, 8.02.2024, 1 specimen
41. *Mycetoporus piceolus* Rey, 1883
Material. (2), 1–5.01.2024, 1 specimen
42. *Ocypus curtipennis* Motschulsky, 1849*
Material. (2), 13.02.2024, 1 specimen
43. *Philonthus carbonarius* (Gravenhorst, 1802)
Material. (2), 13.02.2024, 1 specimen
44. *Philonthus umbratilis* (Gravenhorst, 1802)
Material. (2), 7.02.2024, 1 specimen
45. *Quedius boopoides* Munster, 1923
Material. (2), 1–5.01.2024, 2 specimens, 2.02.2024, 1 specimen
46. *Quedius ochripennis* (Ménétriés, 1832)
Material. (2), 1–5.01.2024, 1 specimen
47. *Tachyporus nitidulus* (Fabricius, 1781)
Material. (2), 1–5.01.2024, 2 specimens
48. *Tachyporus hypnorum* (Fabricius, 1775)
Material. (2), 1–5.01.2024, 17 specimens, 7.02.2024, 33 specimens, 8.02.2024, 82 specimens, 10.02.2024, 1 specimen, 13.02.2024, 3 specimens; (4), 14.02.2024, 1 specimen
49. *Tachyporus pusillus* Gravenhorst, 1806
Material. (2), 1–5.01.2024, 11 specimens, 8.02.2024, 2 specimens; (4), 12.02.2024, 1 specimen
Order Hymenoptera
Family Apidae
50. *Apis mellifera* Linnaeus, 1758
Material. (4), 26.02.2024, 2 specimens
51. *Xylocopa valga* Gerstaecker, 1872*
Material. (2), 1–5.01.2024, 1 specimen; (4), 26.02.2024, 1 specimen; (5), 9.02.2024, 2 specimens
Family Formicidae
52. *Camponotus aethiops* (Latreille, 1798)
Material. (4), 26.02.2024, 5 work.
53. *Crematogaster schmidti* (Mayr, 1853)
Material. (2), 8.02.2024, 1 work.; (6), 21.02.2024, 1 work.
54. *Lasius bombycina* Seifert et Galkowski, 2016
Material. (2), 8.02.2024, 1 work.
55. *Lasius neglectus* Van Loon, Boomsma et Andrasfalvy, 1990
Material. (2), 8.02.2024, 1 work.
56. *Messor ponticus* Steiner et al., 2018
Material. (2), 16.02.2024, 3 work., 1 ♀

57. *Plagiolepis taurica* Santschi, 1920
Material. (4), 26.02.2024, 1 work.
58. *Tetramorium chefketi* Forel, 1911
Material. (2), 10.02.2024, 1 work.
Family Vespidae
59. *Polistes dominula* (Christ, 1791)
Material. (2), 1.03.2024, 1 specimen
60. *Vespula germanica* (Fabricius, 1793)
Material. (2), 2.03.2024, 1 specimen
Family Ichneumonidae
61. *Ophion luteus* Linnaeus, 1758
Material. (2), 1–5.01.2024, 1 specimen
Order Lepidoptera
Family Nymphalidae
62. Vanessa atalanta (Linnaeus, 1758)
Material. (2), 8.02.2024, 1 specimen
Family Sphingidae
63. Macroglossum stellatarum (Linnaeus, 1758)
Material. (3), 7.01.2024, 1 specimen
Order Diptera
Family Calliphoridae
64. Lucilia caesar Linnaeus, 1758
Material. (2), 12.02.2024, 2 specimens; (3), 1–5.01.2024, 2 specimens; (7), 6.03.2024, 2 specimens
65. Calliphora vicina Robineau-Desvoidy, 1830
Material. (2), 12.02.2024, 5 specimens; (3), 1–5.01.2024, 5 specimens; (7), 6.03.2024, 3 specimens
Family Syrphidae
66. *Eristalis tenax* (Linnaeus, 1758)
Material. (4), 14.02.2024, 10 specimens
67. *Eupeodes corollae* (Fabricius, 1794)
Material. (4), 14.02.2024, 2 specimens

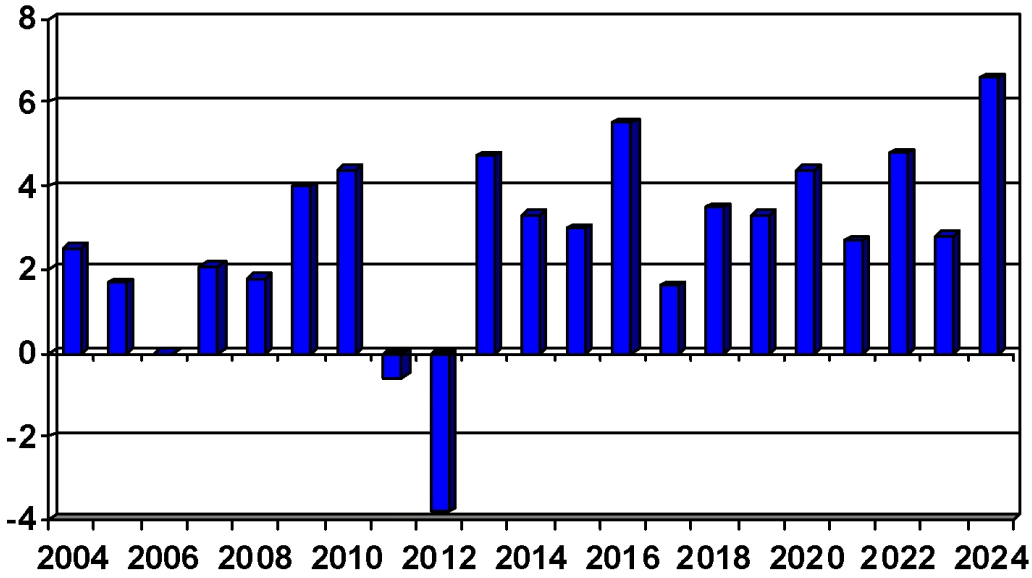

Fig. 2. Long-term data on average air temperature (°C) in the south-east of Crimea in February 2004–2024 (according to data from the Karadag scientific station).

According to the European monitoring service Copernicus[4], in 2024 the February temperature in Central and Eastern Europe was 3.3°C above the average for this month. In February 2024, the average temperature in Crimea also exceeded the long-term values (Fig. 2). According to the Karadag Scientific Station, the mean January temperatures in southeastern Crimea did not exceed those for a long period, but the daily temperatures at the beginning of the month were close to the record highs recorded in 2010 (max +15.4 °C). March is usually a cold time of year for Crimea with frosts in the first ten days. However, in 2024, the daily temperatures were above the norm: in southeastern Crimea they fluctuated at +6...+12 °C.

Our data showed two abnormal peaks of insect activity in Crimea, which coincided with the maximum winter temperature peaks: from January 1 to 7 (daily temperatures max +9.8...14.4 °C, min +3.3...7.5 °C) and from February 1 to 15 (daily temperatures max +8.1...16.5 °C, min +1.0...9.5 °C). The February peak was more productive in terms of the number of collections. Daily insect activity peaked at midday and ended around 16 p.m. due to a decrease in temperature. All species except *Anacridium aegyptium* were found active in various park biotopes. One individual of *A. aegyptium* was found in a state of diapause on February 12, 2024, and an active overwintered adult was found in the park of the Karadag Scientific Station on March 28, 2024.

In the period under study, the collections were dominated by beetles (Coleoptera) in terms of the number of species – 44%, other groups in percentage terms are represented as follows: Hemiptera – 27%, Hymenoptera – 18%, Diptera – 6%, Lepidoptera – 3%, Dermaptera and Orthoptera – 1.5% each. According to the classification of V.V. Yakhontov (1964), insect species were distributed by ecological groups as follows: herpetobionts – 57%, thamno- and dendrobionts – 35%, hortobionts – 8%.

In addition to background species, insect pest species were detected (Table 1). All pests were detected as single specimens, which is probably due to the period of the surveys and the non-selective collection method. Most of the pests belong to Hemiptera, among which two species – *H. halys* and *L. occidentalis* – are invasive (Stryukova and Stryukov, 2022). We have found that these species tolerate short-term temperature drops well, apparently due to their high adaptive capacity. In the study area, they were found in a live inactive state even with slight frosts. When the air temperature rose above +10 °C, both of these species were noted by us in small numbers in an active state in parks and public gardens.

Table 1. Insect pests detected in an active state in urbanized areas of Crimea, during the abnormal winter warming in 2024

Species	Host plant; damage type (Stryukova, 2016; Stryukova and Stryukov, 2020, 2022, etc.)
Elm leaf beetle *X. luteola*	Various species of elm (*Ulmus* sp.); skeletonization of tree leaves
Poplar lace bug *M. unicostata*	Various species of poplars (*Populus* sp.); leaf chlorosis, plant contamination with bug excrement and exuvia
Brown marmorated stink bug *H. halys*	Polyphage. Damages a wide range of fruit, vegetable, ornamental and forest plants. The leaves of the damaged plant lose turgor, weaken and wither
Southern green stink bug *N. viridula*	Polyphage. Damages a wide range of ornamental plants. The leaves of the damaged plant lose turgor, weaken and wither
Western conifer seed bug *L. occidentalis*	Pine seeds (*Pinus* sp.). Damage reduces the number of viable seeds

[4] Copernicus. Web page. URL: https://www.copernicus.eu/en (accessed: 20.02.2024).

Fig. 3. Early emergence of worker ants (Formicidae) to the soil surface, Karadag Biological Station, 26.02.2024: **A** – *Camponotus aethiops*; **B** – *Plagiolepis taurica* (marked with an arrow) on a narrow-leaved crocus flower (*Crocus angustifolius* Weston).

The bulk of the collected species were insects that overwinter at the imago stage. Their appearance in the active state is associated with the establishment of atypical warm weather in February, more typical of the spring season. Of considerable interest is the early emergence of *Cetonia aurata,* observed in January and February, while we usually found this species no earlier than April. For *Coccinella septempunctata*, which is ubiquitous in the park area during the study period, mating of individuals was recorded at the very beginning of March (March 6, 2024).

In addition to Scarabaeidae, characteristic elements of the soil biocenosis are beetles of the family Staphylinidae, which were found in the collections in the largest quantities (19%), and earwigs, which is probably also associated with the abnormal heating of the soil during the study period. On the soil surface, the maximum temperature values reached + 12.9 °C for January and + 18.3 °C for February. In the forest litter of Karadag, this figure was slightly less + 8.3 °C for January and + 9.0 °C for February. The discovery of an active adult individual of the protected species *Ocypus curtipennis* on 13.02.2024 in the park zone of Feodosia is the earliest known date of discovery of this species – usually is recorded in Crimea no earlier than March (Krasnaya Kniga, 2015).

The Lepidoptera in the collections are represented by species that are usually found until late autumn, but were previously rarely noted in winter. The two discovered species of dipterans of the family Calliphoridae, *Lucilia caesar* and *Calliphora vicina*, are synanthropic species common during thaws. However, the beginning of active summer in winter for species of the family Syrphidae in the absence of food plants is not typical. The two species were collected by Merike traps on Karadag, with *Eristalis tenax* in significant quantities.

The early emergence of Formicidae ants on the soil surface during the study period (Fig. 3) that we discovered is unique for the south-east of Crimea. In addition, an active adult *Ophion luteus* in winter was noted in the fauna of Crimea for the first time. This species is typical of the spring season, as it develops on Lepidoptera caterpillars (Broad et al., 2015). Two species of social wasps, *Polistes dominula* and *Vespula germanica*, collected in Feodosia in early March, are usually found in the south-east of the peninsula in April–May. The discovery of *Xylocopa valga* in early January and February is also not typical for this time of year (the imago usually emerges in April), but such cases have been noted before (Krasnaya Kniga.., 2015). Thus, climate change has a significant impact on the entomofauna of Crimea, which is currently not predictable.

Conclusions

As a result of this study, 67 insect species belonging to 60 genera, 29 families and seven orders were identified in urbanized areas of Crimea under the conditions of abnormal winter warming in 2024, however, the real diversity of species that showed activity during the thaw is most likely much higher. The largest number of species (29) in the collections are beetles, especially the Staphylinidae family, and the smallest are earwigs with one widespread synanthropic species *Forficula auricularia*. Orthoptera in the winter collections are represented by one individual of *Anacridium aegyptium* in a state of diapause. In

addition, two species with a regional level of protection were found (Krasnaya kniga..., 2015), as well as six species of insect pests that, under favorable conditions, could negatively affect the vegetation of the surveyed parks and squares.

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