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Mirid bug species (Heteroptera: Miridae) of grape pests in the south of the Russian Far East

Клопы слепняки (Heteroptera: Miridae) вредители винограда на юге Дальнего Востока России

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Key words: Heteroptera, Miridae, Russian Far East, Primorskii Krai, *Apolygus spinolae*, *Apolygus lucorum*, *Neolygus aceris*, grape.

Ключевые слова: Heteroptera, Miridae, Дальний Восток России, Приморский край, *Apolygus spinolae*, *Apolygus lucorum*, *Neolygus aceris*, виноград.

Abstract. Two mirid bug species, *Apolygus spinolae* and *Neolygus aceris* (Heteroptera: Miridae) were registered during 2019–2021 on several varieties of grape grown in the south of the Russian Far East. Development of bug eggs in overwintering buds, sucking grape tissue by early instar nymphs living inside flower buds in spring, and further damage to leaves, inflorescences and berries by older instar nymphs and adults were observed. The developmental cycle in bugs of the new generation is completed by the end of the first ten days of July, after which the bugs disperse to other plants for further feeding and development. The sites of punctures made by bugs on leaves are suberized and then, as the leaves grow, the damaged areas collapse and fall off. Damaged inflorescence and ovaries fall off, and remaining berries are covered with brown scratches.

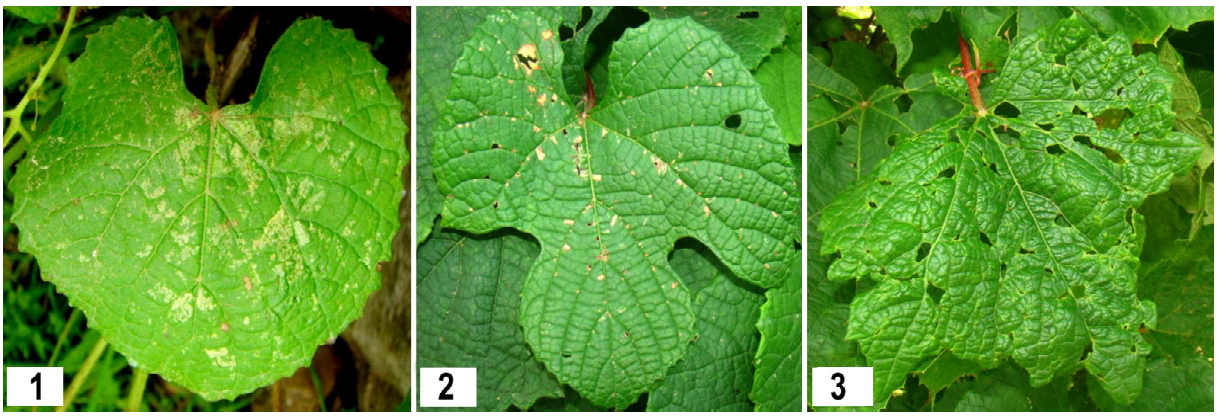
Резюме. В 2019–2021 гг. на юге Дальнего Востока России на винограде различных сортов обнаружено два вида клопов: *Apolygus spinolae* и *Neolygus aceris* (Miridae). Выявлено развитие яйца в зимующей почке, весной фиксировалось сосание младшими личинками, находящимися внутри почки генеративных органов винограда и дальнейший вред, наносимый старшими личинками и имаго листьям, соцветиям и ягоде. Цикл развития первой генерации клопов завершается в конце первой декады июля, после чего клопы разлетаются на другие растения для дополнительного питания и развития. Следы проколов клопами на листьях опробковевают, и по мере роста листа повреждённые участки выпадают. На ягоде появляются бурые шрамы. Поражённые соцветия и завязи опадают.

Introduction

For the past nine years (2011–2020), winegrowers of the Russian Far East were concerned by the invasion of some insects that damage leaves and berries (Figs 1–3). The first message about the pest came from Yu.G. Bozhko, a winegrower from the Chernigovskii District of Primorskii Krai [Brazhina, 2012]. In 2020 an assumption was made that, along with other insect pests new to Primorskii Krai, an invader from Southeast Asia locally referred to as «green blind cricket» (*Cyrtorhinus lividipennis* Reuter) appeared in the region [Bondrov, 2020]. In 2020, the winegrowers, who suspected the introduction of a quarantine pest with cuttings, sought advice from the Department of Natural Science Education, Far Eastern Federal University (School of Pedagogy, Ussuriysk) and the V.L. Komarov Mountain-Taiga Station, Far Eastern Branch, Russian Academy of Sciences.

The genus *Cyrtorhinus* Fieber, 1858, with its species being mostly predators [Yasunaga, 1999], belongs to the family Miridae. The only species of this genus distributed in our country is *Cyrtorhinus caricis* (Fallén, 1807). It has a Holarctic range and is known from the European part of Russia to Siberia and the Russian Far East, where it has been recorded from Kamchatka to Primorskii Krai and the Kuril Islands. Bugs of this species, living in waterlogged habitats, were collected from sedges [Kerzhner, 1978].

Cyrtorhinus lividipennis Reuter, 1885, mentioned by D.V. Bondrov, is found in northern (along the border with Mongolia), central, and southeastern China, Japan, the Korean Peninsula, and Taiwan; further in the tropics, it reaches India and Samoa [Kerzhner, Josifov, 1999]. This species has not been found in our country. According to T. Yasunaga [Yasunaga, 1999], it is well-known, economically important predator preying on eggs of delphacid cicadas that are rice pests. Thus, the information about this pest, as well as the name of the bug species allegedly found on grapes in our region, is erroneous.



Figs 1–3. Bug damages of grape leaves. 1 — numerous traces of punctures after nymphs and adults sucking; 2 — formation of dry incrustations in punctured areas; 3 — falling off incrustations with holes appearance.

Рис. 1–3. Повреждения листьев винограда клопами. 1 — многочисленные следы проколов в результате сосания личинками и имаго; 2 — образование засохших корочек в местах проколов; 3 — выпадение корочек с образованием дыр.

In the south of the Republic of Korea, damage to grapes from bugs has been recorded since 1995. In 1998 and 1999, *Apolygus spinolae*, previously considered a secondary pest for grapes, was studied in cages installed on vines of the Campbell Early grape variety [Kim et al., 2000]. The authors assessed the damage caused to grapes by nymphs and adults of this bug species and reported the signs of damage to leaves, inflorescences, and berries. The sucking by bugs caused the deformation of leaves on vine, falling off of shoots, inflorescences, ovaries, covering of berries with crusts (corking), cracking of damaged berries, and harvest decrease.

In the present report, we aimed to identify the bug species that are found on the grape varieties in the south of the Russian Far East and those causing damage to grape flowers, leaves, and berries.

Material and methods

We carried out the study in the periods from late April and early May to late October 2019–2021 at field research stations in the Ussuriyskii Urban Okrug (villages of Kaymanovka and Zarechnoye) and during route trips made to study the species composition of mirid bugs that are grape pests in Primorskii Krai. For this, we used the following study techniques: visual observations, manual collection of bugs, shaking bugs off plant branches onto a cloth sheet, collection with a scoop net, photographing, and also collection and keeping of found bug nymphs for rearing and further identification of adults. Nymphs and adults were kept in cages installed on vines of Amur grape, *Vitis amurensis* Rupr., in natural conditions, and also in portable cages [Markova et al., 2018].

In the study, we used the information provided by practicing gardeners of the Far Eastern region for 2011–2020: the Khabarovskii District (village of Berezovka), Khabarovskii Krai; the Khorolskii (village of Khorol), Kirovskii (village of Gornye Kluchi), Chernigovskii (village of Orekhovo), Nadezhdinskii (village of Novy), Shkotovskii (town of Shkotovo), and Partizanskii (town of Partizansk) districts, and also the Lesozavodskii (town of Lesozavodsk), Ussuriyskii (village of Zarechnoye), Artemovskii (town of Artyom) and Vladivostok (village of Kiparisovo) urban okrugs, Primorskii Krai (https://plodpitomnik.ru/forum).

The material was identified by F.V. Konstantinov and is deposited in the collection of the Zoological Institute, Russian Academy of Sciences (St. Petersburg).

Results and discussion

As a result of observations on vines of Amur grape, *V. amurensis*, three species of bugs of the family Miridae were identified, which were similar to each other by the elongated oval body shape, greenish color, and a body size of 4.7–6.2 mm: *Apolygus spinolae* (Meyer-Dür, 1841), *Apolygus lucorum* (Meyer-Dür, 1843), and *Neolygus aceris* Kerzhner, 1988. In the Key to Insects of the USSR Far East [Kerzhner, 1988a], all three species were mentioned within the genus *Lygocoris* Reuter, 1875 under the following subgenera: *Lygocoris* (*Apolygus*) *lucorum*, and *Lygocoris* (*Apolygus*) *spinolae*, *Lygocoris* (*Neolygus*) *aceris*. Currently, the subgenera *Apolygus* China, 1941 and *Neolygus* Knight, 1917 are cited by most experts as independent genera.

We and amateur gardeners recorded bugs from grapes of the following varieties: Alpha, Wilder, Valiant, Campbell, Mars, Einset Seedless, Ramming's Chasselas, Alyoshenkin, Ananasnyi rannii, Zhemchug Saba, Tayozhnyi izumrud, Zagadka Sharova, Khasanskii Bousa, Sputnik, etc.

Apolygus lucorum (Meyer-Dür, 1843)

Material. **Primorskii Krai, *Ussuriyskii Urban Okrug*:** Zarechnoye vill., household plot, Amur grape, *V. amurensis*, 23.VI.2020, T.O. Markova leg. — 1♀; Kaymanovka vill., household plot, everbearing raspberry, *Rubus* sp., 5.VIII.2020, 9—10.VIII.2020, T.O. Markova leg. — 2♀♀, 1 instar V; vicinities of Kamenushka vill., road along vegetable garden plots, wormwood, *Artemisia* sp.,

4—10.VII.2020, T.O. Markova leg. — 2♂♂, 6♀♀, idem, riverside forest, side of forest road, common ragweed, *Ambrosia artemisiifolia* L., 11.VII—27.VII.2020, T.O. Markova, M.V. Maslov leg. — 2♂♂, floodplain forest along the Barsukovka River, side of forest road, *A. artemisiifolia*, 5—19.VIII.2020, T.O. Markova, M.V. Maslov leg. — 1♂♂, 2♀♀.

Notes. In addition to grapes, bugs were found on the everbearing raspberry *Rubus* sp. (Rosaceae), the common ragweed *Ambrosia artemisiifolia* L., and the wormwood *Artemisia* sp. (Asteraceae).

Economical significance. Polyphagous bug, indicated as a pest for a number of agricultural plants: cotton, tobacco, and beetroot. In natural conditions inhabits a variety of herbaceous plants [Putshkov, 1972]. In Kunashir Island, it was collected from *Artemisia* [Kerzhner, 1978; 1988a]. We have found this bug on a native grape only once.

Differential characters. In *A. lucorum*, clavus light, without brown color; cuneus (leathery apex of fore wing) always without black dot at apex. Clypeus entirely or in the apical half black or dark brown.

Distribution. Trans-Eurasian, distributed from West Europe to Japan, introduced to North America [Kerzhner, Josifov, 1999].

Apolygus spinolae (Meyer-Dür, 1841)

Material. **Primorskii Krai, *Kirovskii District*:** Gornye Kluchi vill., Holy Trinity Nikolaevskii Monastery, grape variety Khasanskii Bousa, 24.VI.2020, S.A. Makarevich leg. — 1♂, 5♀♀; ***Ussuriyskii Urban Okrug*:** Kaymanovka vill., household plot, LPKh Makarevich fruit nursery, grape variety Alpha, Amur grape *V. amurensis*, grape variety Tayozhnyi izumrud, 23.VI.2020, 27.V.2021, 13.VI.2021, T.O. Markova, M.V. Maslov leg. — 3♂♂, 2♀♀, 3 instar V.

Economical significance. Polyphagous bug that damaged vines and hops in Europe. It inhabits herbaceous plants and shrubs [Putshkov, 1972]. In Kunashir Island it was collected from large grasses and shrubs, in particular rosaceans [Kerzhner, 1978; 1988a]. We have collected this bug only from Amur grape *V. amurensis*.

Differential characters. In *A. spinolae*, clavus light without brown color; the apex of cuneus usually brownish, rarely light, with black dot at apex (Fig. 4). Clypeus always light.

Distribution. Trans-Eurasian, distributed from West Europe to Japan [Kerzhner, Josifov, 1999].

Distribution. Trans-Eurasian, distributed from West Europe to Japan [Kerzhner, Josifov, 1999].

Neolygus aceris Kerzhner, 1988

Material. **Primorskii Krai, *Ussuriyskii Urban Okrug*:** Zarechnoye vill., household plot, Amur grape, *V. amurensis*, 23.VI.2020, T.O. Markova leg. — 1♀; Kaymanovka vill., household plot, Amur grape *V. amurensis*, 20—24.VI.2020, 13.VI.2021, T.O. Markova, M.V. Maslov leg. — 11♂♂, 1♀♀, 3 instar V; Gornotaezhnoye vill., Amur grape *V. amurensis*, 27.V.2021, 7.VI.2021, T.O. Markova leg. — 2♂♂, 2♀♀.

Economical significance. *N. aceris* was described from Amur maple, *Acer ginnala* (Maxim.) Maxim., collected on July 10, 1982 in Khasanskii District [Kerzhner, 1988b], but its biology and feeding relationships remained unstudied so far. Now it has become clear that the individuals collected by the authors were winged new-generation adults. We have collected this bug only from Amur grape, *V. amurensis*.

Differential characters. In *N. aceris*, elytrae often with a brownish band on clavus behind scutellum and with dark brown spots in form of a cross-belt, anteriorly of membrane (at the inner corner of corium) (Figs 4–5). Top of clypeus not blackened; head without dark pattern.

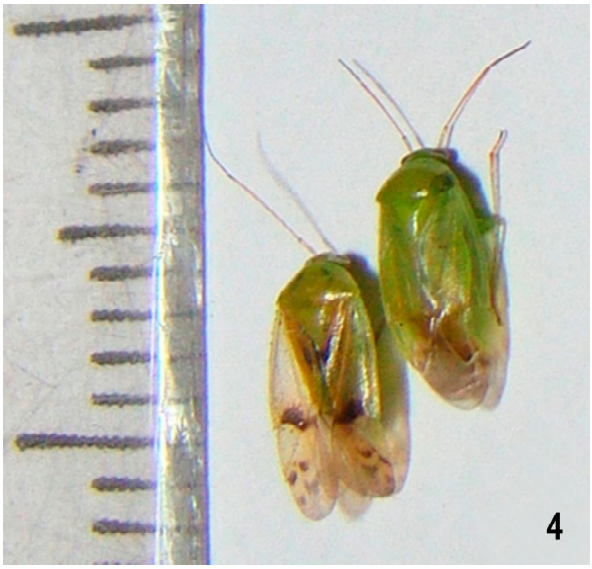


Fig. 4. Bugs *Neolygus aceris* (left) and *Apolygus spinolae* (right).

Рис. 4. Клопы *Neolygus aceris* (слева) и *Apolygus spinolae* (справа).

Distribution. Primorskii Krai, Korean Peninsula [Kerzhner, Josifov, 1999].

Development of *A. spinolae* and *N. aceris* on Amur grape, *V. amurensis*

Bugs of the family Miridae typically lay eggs by embedding them in plant tissues, or behind bud scales [Putshkov, Putshkova, 1956]. Diapausing eggs overwinter in dormant grape buds. In the cages installed in April 2021 on a still bare grape vine, adults of both

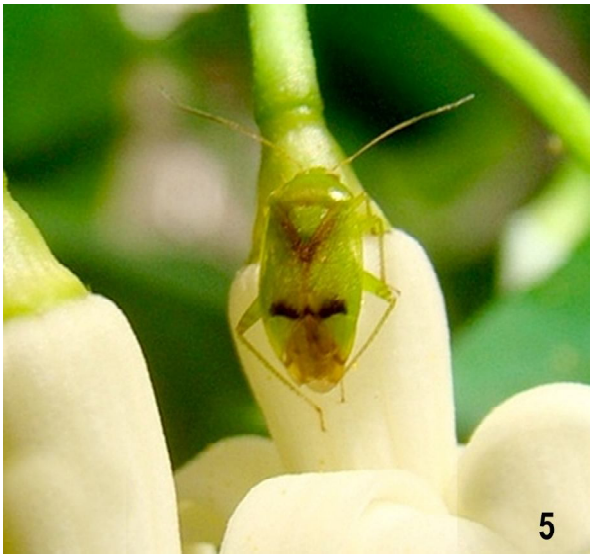


Fig. 5. *Neolygus aceris* bug feeding on grape ovary. Photo by M. Maslov.

Рис. 5. Питание на завязи винограда клопа *Neolygus aceris*. Фото М. Маслова.

species were reared, *A. spinolae* and *N. aceris*, which confirmed the overwintering of eggs of these species on grape. In spring, instar I nymph begins to feed, remaining inside the growing bud. This is confirmed by the report received from a winegrower, who observed bug nymphs on grape cuttings (made in autumn and stored in a cellar) since early April, after which young leaves on them appeared affected.

Under natural conditions, we found instar I nymphs of *A. spinolae* and *N. aceris* simultaneously on a grape vine in early May. Early instars (I–III) develop during May; instar IV–V nymphs were found by the end of the month. According to our data, the body size of instar IV nymphs is 2–3 mm and instar V nymphs 3.3–3.6 mm.

New-generation adults of both species molt into adults since early June. The mass dispersal of adults in nature is observed after mid-June (according to our data, during a period of June 16–20, 2020). However, the timing of bugs' development is stretched, and not all individuals disperse at the same time. We found a small number of instar IV nymphs by late June and instar V nymphs by the end of the first ten days of July. Single older new-generation adults of *A. spinolae* and *N. aceris* were observed on grapes, where they kept on feeding actively, until the end of the first ten days of July.

Subsequently, bugs disperse in search of additional food supplies for the development of gonads, changing forage plants. According to researchers from South Korea [Kim et al., 2002], the second generation of *A. spinolae* develops on herbaceous plants. In late autumn, the adults return to vines and lay overwintering eggs. Probably, *A. spinolae* and *N. aceris* in our region behave in the same way.

Damage caused to Amur grape *V. amurensis*, by the bugs *A. spinolae* and *N. aceris*

Both species, *A. spinolae* and *N. aceris*, after invading a grape, spread all along the vine, regardless of its length and height. According to our observations, small bug nymphs hide in the «crown» (tip) of a green shoot. As the shoot grows and young leaves unfold, gray-brown dots and puncture traces appear on them. Nymphs and adults suck both inflorescences and infructescences set (Fig. 5). When older instar nymphs were reared until the adult stage and the adults were observed in the cages, numerous traces of punctures of leaf blades, subsequently turning into dried crusts, were also found on the grapes (Figs 1–2). As leaf blades grew, the damaged areas fell off, leaving holes with dried edges (Fig. 3). A single pest does not cause significant harm, damaging only three to five leaves. However, when generative buds are damaged by nymphal and adult bugs, the development of inflorescences is disturbed, which affects the yield of grapes. In portable cages, we managed to observe adult *A. spinolae* and *N. aceris* additionally feeding on offered currant, raspberry, and strawberry fruits.

According to the reports from practicing gardeners of the Ussuriyskii Urban Okrug and Kirovskii and Shkotovskii districts, bugs of both species did not show any selection of varieties of grapes when occupying them: not only European grape varieties with more tender leaves were damaged, but also hybrids, American varieties, which are characterized by thicker leaf cuticle, and local Amur grape. Denser aggregations of bugs of both species were observed in the peripheral and corner parts of vineyards located near the surrounding grassy vegetation. It is probable that new-generation adults flew from there in the autumn for laying egg on grape vines.

Conclusion

In contrast to the results obtained by researchers from the south of the Korean Peninsula [Kim et al., 2000], grape pests in the south of the Russian Far East has formed a complex consisting of two species, *A. spinolae* and *N. aceris*. In the cages installed in April 2021 on Amur grape (*V. amurensis*) vines, adults of both bug species were reared simultaneously. They coexisted, with almost equal proportions, on native grapes; on varietal grapes, only the trans-Eurasian *A. spinolae* was found. The bug *A. lucorum* has been recorded in single cases only from the Amur grape *V. amurensis*; however, it is not a pest for this plant.

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