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New species of the genus *Calycomyza* Hendel (Diptera, Agromyzidae) in the South Caucasus fauna

Nonna M. Grigoryan[1], Karine V. Balayan[2], Madina Z. Magomedova[3], Patimat D. Magomedova[3] and Vahram T. Hayrapetyan[1]

[1]Scientific Centre of Zoology and Hydroecology, National Academy of Sciences, Republic of Armenia, Yerevan, Armenia
[2]A. Takhtajyan Institute of Botany, National Academy of Sciences, Republic of Armenia, Yerevan, Armenia
[3]Dagestan State University, Makhachkala, Russia

Principal contact
Nonna M. Grigoryan, Ph.D., Scientific Centre of Zoology and Hydroecology, National Academy of Sciences, Republic of Armenia; 7 Paruyr Sevaki St, Yerevan, 0014 Armenia.
Tel. +37491297092
Email nonna.grigoryan.88@mail.ru
ORCID https://orcid.org/0000-0001-8079-8574

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Abstract
To study the diversity of agromizids (leaf miners) in the South Caucasus, the species external morphological features, their host plants, the development of larvae and pupae and to assess the degree of crop infestation by leaf-miners.
The study was carried out within the framework of the scs 21-002 scientific program “Leaf miners as pests of agricultural plants (Diptera: Agromyzidae): the latest control measures”. Type samples were fixed in 75 % ethyl alcohol and deposited in the Agrarian Scientific Research Laboratory of the Scientific Centre of Zoology and Hydroecology. Species were identified by examining the male genitalia. The degree of damage of the host–plant was determined based on intensity indicators.
As a result of this research, a new species of the *Calycomyza* genus was discovered in the South Caucasus fauna. Larvae of *C. jucunda* (Wulp, 1867) were found on the leaves of *Beta vulgaris*, a host plant mentioned for the first time here. As a Nearctic species, it was also first discovered in the southern Caucasus.
The study of the male genitalia indicates expansion of the biogeographical distribution of *Calycomyza* species, as most of them are found in the Nearctic and Neotropical regions. In terms of intensity, *C. jucunda* is classified as a less dangerous species for agricultural crops.

Key Words
Diptera, Agromyzidae, *Calycomyza* Hendel, new species, fauna, leaf miner, South Caucasus.

Новые виды рода *Calycomyza* Hendel (Diptera, Agromyzidae) в фауне Южного Кавказа

Нонна М. Григорян[1], Карине В. Балаян[2], Мадина З. Магомедова[3], Патимат Д. Магомедова[3], Ваграм Т. Айрапетян[1]

[1]Научный центр зоологии и гидроэкологии НАН РА, Ереван, Армения
[2]Институт ботаники им. А. Тахтаджяна НАН РА, Ереван, Армения
[3]Дагестанский государственный университет, Махачкала, Россия

Контактное лицо
Нонна М. Григорян, к.б.н., Научный центр зоологии и гидроэкологии; Национальная академия наук, Республика Армения; 0014 Армеия, г. Ереван, ул. Паруйра Севака, 7.
Тел. +37491297092
Email nonna.grigoryan.88@mail.ru
ORCID https://orcid.org/0000-0001-8079-8574

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Резюме
Для изучения разнообразия агромизид на Южном Кавказе оценивали внешние морфологические характеристики вида, растений-хозяев, развитие личинок и куколок, а также степень заражения посевов минирующими мухами.
Исследование проведено в рамках научной программы scs 21-002 «Минирующие мухи – вредители сельскохозяйственных растений (Diptera: Agromyzidae), новейшие меры борьбы». Типовые образцы были зафиксированы в 75%-ном этиловом спирте и переданы на хранение в Аграрную научно-исследовательскую лабораторию Научного центра. Вид был идентифицирован путем исследования гениталий самца. Степень заражения растения-хозяина определяли по показателям интенсивности.
В результате исследований в фауне Южного Кавказа обнаружен новый вид рода *Calycomyza*. Личинки *C. jucunda* (Wulp, 1867) обнаружены на листьях *Beta vulgaris* – растения-хозяина, упомянутого впервые. Кроме того, как неарктический вид, он впервые был обнаружен на Южном Кавказе.
Исследование гениталий самцов свидетельствует о расширении биогеографического распространения видов *Calycomyza*, поскольку большинство из них встречается в Неарктическом и Неотропическом регионах. По интенсивности заражения *C. jucunda* относится к менее опасным видам сельскохозяйственных культур.

Ключевые слова
Diptera, Agromyzidae, *Calycomyza* Hendel, новый вид, фауна, минирующая муха, Южный Кавказ.

INTRODUCTION

The *Calycomyza* Hendel (1931) genus, belonging to the subfamily Phytomyzinae, was classified by Hendel as a subgenus of the *Dizygomyza* genus. Consequently, Nowakowski (1962) separated it as a full genus [1; 2]. Species belonging to the genus usually have yellow frons and notopleural areas, an entirely black scutellum, and a lack of presutural dorsocentral bristles.

Calycomyza is a small genus with 90 % of its species being distributed in the Nearctic and Neotropical regions. Only 5 species of the *Calycomyza* genus have been found in Europe [3].

C. jucunda was first described as *Agromyza jucunda* (Wulp, 1867). According to Frick (1956), the species' synonyms are *Agromyza jucunda* Wulp, *Dizygomyza (Calycomyza) jucunda* (Wulp), *Agromyza platyptera* Thomson, *Agromyza coronata* Loew, and *Phytobia (Calycomyza) coronata* (Loew) (Stegmaier, 1967) [4]. Species distinction based on external morphological features is difficult, but species affiliation is easy to determine by studying the male genitalia. Steyskal (1973) first studied the *C. jucunda* species male genitalia structure and revealed that the distyphallus of all the above-mentioned species has very minor changes [5].

Adults infect a number of plants of the Asteraceae family: *Ambrosia trifida* L., *Arctium* sp., *Artemisia douglasiana* Bess., *A. vulgaris* L., *Baccharis viminea* Dc., *Erigeron canadensis* L., *Grindelia squarrosa* (Pursh.) Dunal, *Helianthus annuus* L., *Heterotheca grandiflora* Nutt., *Solidago* sp., *Xanthinum* sp. and *Zinnia* sp. [6].

MATERIAL AND METHODS

The research was carried out in 2022 within the framework of the scs 21–002 scientific program. The study materials were gathered from the South Caucasus region in the South Caucasus. The mined leaves were stored in glass containers filled with wet sand at a temperature of 27±1 °C and 75±5 relative humidity. To determine the intensity of plant infection, the number of infected plant leaves was counted. The study of external morphological features was carried out using the ADSM302 and Optika B–290 digital binocular microscopes. Data collection and statistical analysis were made using the methods accepted for the family [7–9]. For species identification, male genitalia were kept in 10 % KOH for about 8 hours. Various guides have been used for differentiating mining flies [10; 11]. The article presents the species' quantitative data, including dates and GPS data.

Abbreviations: acr – acrostichal bristle, dc – dorso-central bristle, a – anterior, ad – anterodorsal, av – antero-ventral, d – dorsal, p – posterior, pd – posterodorsal, pv – posteroventral, v – ventral.

RESULTS AND DISCUSSION

Material examined: 1♂, 1♀, *Beta vulgaris* L. (Amaranthaceae), South Caucasus region (39º54'45.99''N 46º47'28.19''E), 24–VII–2022.

According to external morphological features, *C. jucunda* was very close to *C. humeralis* (Fig. 1). Previously, *C. humeralis* and *C. cynoglossi* species were also found and studied in the South Caucasus [12].

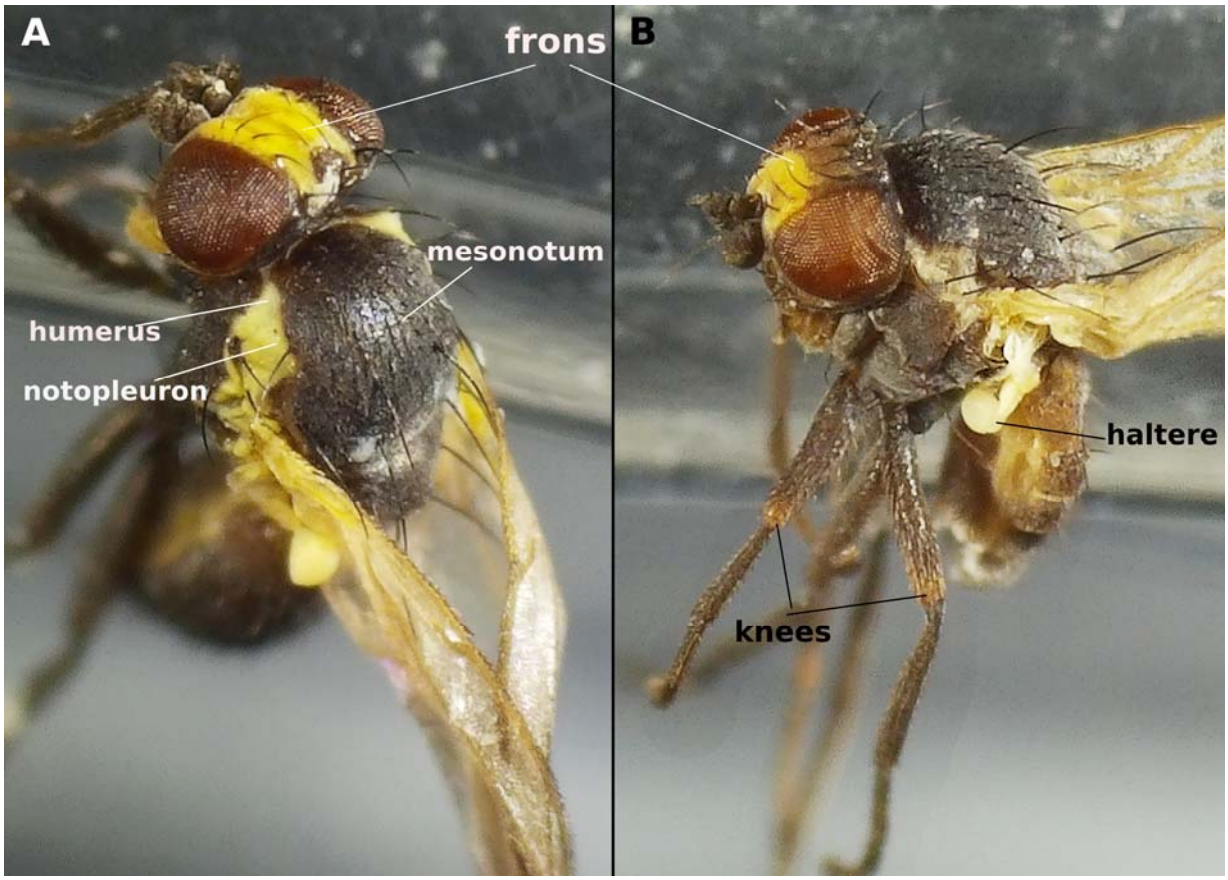

Figure 1. External characters: A – *C. humeralis*, B – *C. jucunda*
Рисунок 1. Внешние характеристики: A – *C. humeralis*, B – *C. jucunda*

The first instar larvae found on the leaves of *Beta vulgaris* formed linear mines between leaf veins, which were later replaced by broad white blotch mines during development. Plant intensity was 10–15 %. Larval development lasted 4 days (26 °C). Pupation takes place inside the mine. Unlike the larvae of *C. humeralis*, the larvae frass of *C. jucunda* didn't stick to the end of the pupa but were scattered around the pupa in the form of small dots. Pupal development takes 10–11 days (25±1 °C).

Body length was 1.5mm (♂) and 2.0mm (♀), frons yellow, normally darkened to level of upper ors, which differs from *C. humeralis* species. They had 2 ors, 2 ori, and all antennal segments were black. Notopleuron, rear of humerus, upper margin of mesopleuron yellow, squama, and fringe whitish yellow. Mesonotum was moderately shining black, with 3+1 dc and acr randomly arranged. Scutellum was black. The legs were completely black, and all the knees were yellow. Halteres yellow.

Wing length was 1.4mm (♂) and 1.9mm (♀), the costa extended to vein M1+2, the discal cell was small and the last section (a) of M3+4 was 3–3.5 times longer than the penultimate (b), which was also observed in *C. humeralis* (Fig. 2). In the literature, the unique holotype had a 2.2 mm wing length, and the last section of M3+4 was 2–2.5 times the length of the penultimate [11]. Compared to Spencer's data, the wing length is short, probably due to the region's mountainous topography.

Male genitalia with aedeagus had distiphallus only slightly extended at rear, short anterior ventral lobes distinctly broadened, posterior lobes narrow and fully fused, and mesophallus not greatly widening toward rear. The sperm pump was large, almost equal to the aedeagus, while in *C. humeralis* it was 1/3 of the aedeagus (Fig. 3).

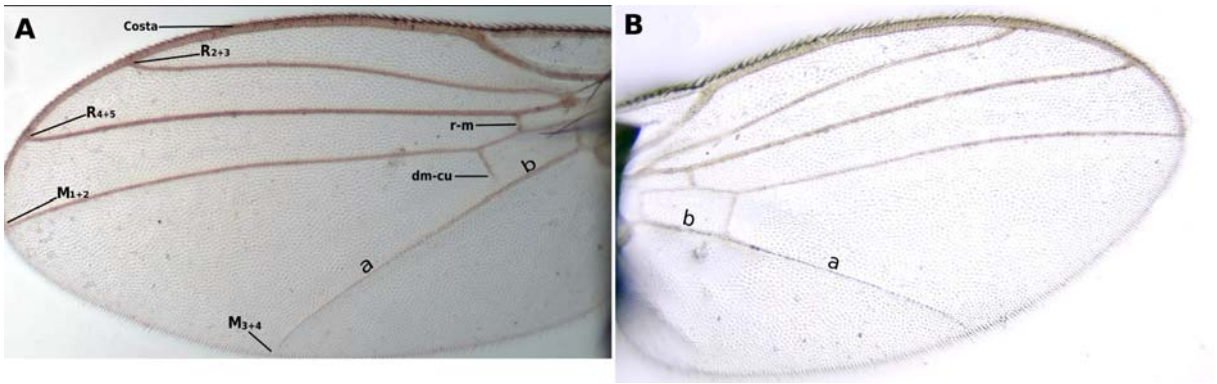

Figure 2. Wing structure: A – *C. humeralis*, B – *C. jucunda*
Рисунок 2. Структура крыла: A – *C. humeralis*, B – *C. jucunda*

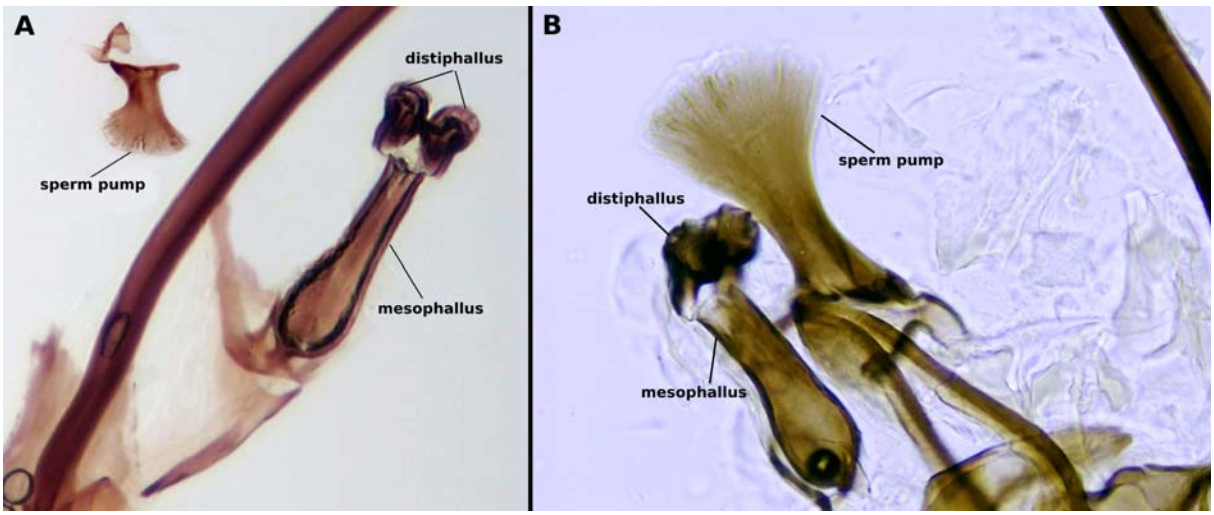

Figure 3. Male genitalia: A – *C. humeralis*, B – *C. jucunda*
Рисунок 3. Гениталии самца: A – *C. humeralis*, B – *C. jucunda*

CONCLUSION

The species *C. jucunda* of the genus *Calycomyza* Hendel is described in the South Caucasus for the first time. Studies of host plants showed that *C. jucunda*, a pest of the Asteraceae family, was first detected on the leaves of *Beta vulgaris* (Amaranthaceae). On considering the number of cultivated plants infected by the leaf miner as well as plant intensity indicators, it can be concluded that *C. jucunda* is a less common and harmful species for agricultural crops.

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AUTHOR CONTRIBUTIONS

Nonna M. Grigoryan collected the material, identified leaf miners and wrote the draft article. Vahram T. Hayrapetyan analysed the data and carried out morphometric measurements. Karine V. Balayan carried out plant recognition. Madina Z. Magomedova and Patimat D. Magomedova participated in the writing of the draft. All authors are equally participated in the writing of the manuscript and are responsible for plagiarism, self-plagiarism and other ethical transgressions.

КРИТЕРИИ АВТОРСТВА

Нонна М. Григорян собрала материал, определила минирующих мух и написала черновик. Ваграм Т. Айрапетян проанализировал данные и провел морфометрические измерения. Карине В. Балаян провела идентификацию растений-хозяев. Мадина З. Магомедова и Патимат Д. Магомедова помогали в написании работы. Все авторы в равной степени участвовали в написании рукописи, и несут ответственность при обнаружении плагиата, самоплагиата или других неэтических проблем.

NO CONFLICT OF INTEREST DECLARATION

The authors declare no conflict of interest.

КОНФЛИКТ ИНТЕРЕСОВ

Авторы заявляют об отсутствии конфликта интересов.

ORCID

Nonna M. Grigoryan / Нонна М. Григорян https://orcid.org/0000-0001-8079-8574
Karine V. Balayan / Карине В. Балаян https://orcid.org/0009-0002-7875-1085
Madina Z. Magomedova / Мадина З. Магомедова http://orcid.org/0000-0001-8425-1664
Patimat D. Magomedova / Патимат Д. Магомедова http://orcid.org/0000-0001-6072-1094
Vahram T. Hayrapetyan / Ваграм Т. Айрапетян https://orcid.org/0009-0006-4280-3962