



First notes about parasitization of *Cydia* spp. (Lepidoptera: Tortricidae) damaging Oaks (*Quercus* spp.) and Oriental Beech (*Fagus orientalis*) in the Northern Caucasus

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ABSTRACT

Species of *Mastrus* Förster (Ichneumonidae) attacking fruit-feeding *Cydia* species (Tortricidae) in gardens and stands of nut-bearing trees in the foothills and mountains of the Northern Caucasus are reported, including (1) *M. ridens*, (2) *M. gradibundus*, (3) *M. rufalus*, (4) *M. rufobasalis*, and (5) *M. sordipes*, from *Cydia* species: *Cydia amplana*, *C. fagiglandana* and *C. splendana*. The effectiveness of these *Mastrus* species as biocontrol agents of these *Cydia* species was studied on four oak species and on oriental beech.

Keywords: Parasitic wasps, moth, acorn, beech fruit, pests, species.

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Introduction

The species belonging to genus *Mastrus* (Hymenoptera, Ichneumonidae) are facultative parasitoids (mainly secondary, rarely primary, either solitary or gregarious) idiobiont ectoparasitoids of many lepidopterans. From a practical point of view, they are interesting as potential biocontrol agents of various species of moths. The successful introduction and establishment of *Mastrus ridens* Horstmann in the USA, Argentina, Chile, Australia and New Zealand [1] (Yazlovetsky and Djurich 2016) is an outstanding example of the biocontrol of the apple-feeding species, *C. pomonella*. The laboratory colony of *M. ridens* used in these programs was initiated with parasitoids from caterpillars collected by the trap-belts in the nut forests of the Tien Shan (Kazakhstan).

Species of *Mastrus* are known as the effective parasitoids of the apple-feeding moth *Cydia pomonella*, as well as the plum moth (*Grapholitha funebrana*), the grapevine moth (*Lobesia botrana*), and the vine moth (*Eupoecilia ambiguella*) [2].

Other, less well known species in *Cydia*, include *Cydia amplana* Hübner (hazelnut or red oak moth), *Cydia fagiglandana* Zeller (beech moth), *Cydia splendana* Hübner (acorn or gray oak moth) develop in oak acorns, beech fruits, hazelnut, chestnut seed, walnuts, apricots, apples, pears, plums, cherry plums, and quince [3] (Pribylova 1991).

In Georgia, stable forests occur that are composed of common oak (*Quercus robur*), sessile oak (*Q. petraea*), downy oak (*Q. pubescens*), strandzha oak (*Q. hatrwissiana*) and oriental beech (*Fagus orientalis*). The main *Cydia* pests of oak acorns and oriental beech fruits are *C. amplana*, *C. fagiglandana*, and *C. splendana*.

Our goal was to determine the distribution and trophic connections of species of the genus *Mastrus*, distributed in Northern Caucasus.

Material and Methods

Mastrus wasps were collected as a part of the program to study the biodiversity of beneficial or-

ganisms and the prospects for their application in biological plant protection, from May to October 2016-2017 in the foothills of North Caucasus, at four stationary points selected according to elevation from 250 to 1000 m above sea level, in apple and pear orchards, in areas surrounded by natural forest ecosystems. Parasitoids were collected in areas where chemical plant protection agents were not used.

To collect parasitoids for rearing, we used the cardboard boxes to rear hosts or parasitoids from fruits. Number of boxes deployed in the study varied from about 500 on the Maikop experiment station of the Federal Research Center the N. I. Vavilov All-Russian Institute of Plant Genetic Resources (Maikop ES of the VIR) to about 150 in St. Michael-Athos monastery, 70 in the village of Chibiy and 50 in the tract Planchenskaya Shchel'. The trapping bands were placed on the trunks of beech, oak, apple-tree, pear, cherry-plum and plum trees.

Cardboard boxes were 20-30 cm tall and the bottom of the box was covered with 3-5 cm of moistened forest soil. Fruits of beech and acorns, damaged by moths, were placed in boxes 7-15 cm in layer. Pupation of *Cydia* caterpillars took place in a layer of moistened forest soil on the bottom or on the boxes' walls. The material collected in this way was used to obtain *Mastrus* adults to initiate parasitoid rearing colonies. In total, a little more than two thousand beech fruits and around three thousand acorns damaged by *C. amplana*, *C. fagiglandana* and *C. splendana* were collected and used to rear parasitoids.

Parasitoids were determined to species using the collections of the Zoological Institute of the Russian Academy of Sciences (St. Petersburg), the collection of the All-Russian Institute of Biological Plant Protection (Krasnodar), identification keys published by the Zoological Institute of RAS [2] (Kasparian 1981) and keys to the parasitoids of pests, published by the All-Russian Research Institute of Biological Plant Protection [4,5] (Kostjukov et al. 2007; Kostjukov 2010).

Results

From acorns of oak (common, sessile, downy, strandzha) and in oriental beech fruits, we reared three *Cydia* species: *C. amplana*, *C. fagiglandana* and *C. splendana*, from which five species of *Mastrus* were reared: *M. ridens* Horstmann, *M. gradibundus* Gravenhorst, *M. rufalus* Thomson, *M. rufobasalus* Habermehl, and *M. sordipes* Gravenhorst.

These *Mastrus* species are native in the Northern Caucasus region of Georgia, living in foothills, mountain orchards, and walnut forests.

Beech

On beech, the parasitization rate of *C. amplana* by *Mastrus* species was 9.3-12.7%, while the hosts *C. fagiglandana* and *C. splendana* were attacked at 8.7-11.3% and 12.3-14.7%, respectively. The lowest rate of parasitism occurred at the end of June, and the highest, at the end of October.

Parasitism rates of *C. fagiglandana* were slightly lower than those of *C. amplana* and *C. splendana*, and parasitization rate of *C. splendana* was higher compared to *C. amplana*. Significant differences in the parasitism rates of *C. amplana*, *C. fagiglandana* and *C. splendana* by *Mastrus* species at different study sites were found. At the St. Michael-Athos monastery, the level of infestation by *Cydia* species was about 15%; In the village of Chibiy and Maikop Experiment Station of the Federal Research Center the N. I. Vavilov All-Russian Institute of Plant Genetic Resources (ES of the VIR), was slightly more than 8.5%.

Damage to the fruits of the oriental beech (*Fagus orientalis*) by *C. amplana*, *C. fagiglandana*, and *C. splendana* was: in Maikop ES of the VIR, 7.8%; in the village of Chibiy, 8.5%; in the tract called Planchenskaya Shchel', and 12.3%; in the St. Michael-Athos monastery 18.7%.

Oak

On oaks, the picture was different: parasitism of *C. amplana* by *Mastrus* species during the vegetative period was 21.7-26.3%, and the maximum parasitization rates were recorded at the end of the period of emergence of adult parasitoids at the end of October. The parasitization rate of *C. fagiglandana* parasitoids of the genus *Mastrus* ranged from 24.7% at the end of June to 30.3% at the end of October. Pupae of *C. splendana* were parasitized with parasitoids of the genus *Mastrus* by 23.7% at the end of June and by 29.3% at the end of October.

Thus, parasitization of *C. amplana* by *Mastrus* species throughout the entire observation period was slightly lower than parasitism of *C. fagiglandana* or *C. splendana*. There were no significant differences in parasitism of *Cydia* species on *Quercus* species, at different points of observation. At the St. Michael-Athos monastery, parasitism was 24.7-30.3%, while in the tract Planchenskaya Shchel' it was 26.3-30.3%. In the village of Chibiy, parasitism was 23.7-29.3% and at the Maikop ES site of the

VIR, parasitism was 21.7 to 29.3%. It can only be noted that the lowest rate of parasitism in the tract Planchenskaya Shchel' was slightly higher (26.3%) than at other sites, and in the VIR Experimental Station, the minimal rate was slightly lower (21.7%) than at other sites.

Damage levels to acorns by *C. amplana*, *C. fagiglandana*, and *C. splendana* were as follows: on the Maikop ES of the VIR, 12.3-18.7%; in the village of Chibiy, it was 19.7-24.3%; in the tract Planchenskaya Shchel', 26.7-30.3%; and in the St. Michael-Athos monastery, parasitism was 31.3-52.7%.

Conclusion

This study of species of *Mastrus* Förster (Ichneumonidae) in the foothills, mountain gardens and the nut-bearing forests of the North Caucasus, found parasitism by five parasitoid species in this (*M. ridens*, *M. gradibundus*, *M. rufalus*, *M. rufobasalus*, *M. sordipes*) on caterpillars of *Cydia* moths (*C. amplana*, *C. fagiglandana* and *C. splendana*) developing in acorns and fruits of oriental beech: .

Parasitism of *Cydia* moths developing in the fruits of oriental beech, varied from 8.7 to 14.7%, the minimum level was recorded at the end of June, and the maximum at the end of October. The damage of the fruits of the beech by the moths *C. amplana*, *C. fagiglandana* and *C. splendana* ranged from 7.8 to 18.7%.

Parasitization of larvae of *Cydia* moths developing acorns of various oaks varied from 21.7 to 30.3%; The lowest level of parasitism was recorded at the end of June, and the highest level at the end of October. The damage of acorns by *C. amplana*, *C. fagiglandana*, or *C. splendana* varied from 12.3-18.7% in the Maikop ES of the VIR to 31.3-52.7% in the St. Michael-Athos Monastery.

The fruits of Oriental beech and acorns of several oaks that are infested by *C. amplana*, *C. fagiglandana*, or *C. splendana* are an important reserve of *Mastrus* species (*M. ridens*, *M. gradibundus*, *M. rufalus*, *M. rufobasalus* and *M. sordipes*).

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Conflicts of interest: Authors declare that there is no conflict of interest.

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