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Phycitodes subcretacella (Ragonot) (Lepidoptera: Pyralidae: Phycitinae)—A New Phytophage of the Quarantine Species *Ambrosia artemisiifolia* L. in the South of the Far East of Russia

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Abstract—A species of narrow-winged pyralid moth *Phycitodes subcretacella* (Ragonot, 1901) (Lepidoptera: Pyralidae: Phycitinae), which is an invasive naturalized species, was found for the first time in the Primorsky Territory on ragweed (Asteraceae: *Ambrosia artemisiifolia* L.), which expands the range of food plants of the moth species and the list of phytophages of this weedy plant. New data on the biology of *Ph. subcretacella* and the first images of the genitalia of both sexes are given with indication of diagnostic characters that make it possible to distinguish the species from closely related taxa. It has been found that the larvae of *Ph. subcretacella* damage the apical parts of the stems, on which the generative organs of the plant are located, which can significantly reduce the reproductive potential of ragweed.

Keywords: *Ambrosia artemisiifolia*, *Phycitodes subcretacella*, Pyralidae, Phycitinae, new host plant, phytophage, Primorsky Territory

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INTRODUCTION

Currently, species of the genus *Ambrosia* L. are widely distributed in anthropogenically disturbed areas and in agrocenoses (Iamonico, 2023). Ragweed (*Ambrosia artemisiifolia* L.), which is a quarantine species in many countries and is included in the Unified List of Quarantine Objects of the Eurasian Economic Union, is among the most aggressive of them (Unified list..., 2016). The great harm of this adventitious plant, which is of North American origin, lies not only in the displacement and oppression of cultivated plants by worsening their growth conditions owing to the drying up of the soil layer but also in reducing the quality of life of people suffering from hay fever.

In Primorsky Territory, this weed is widely distributed in field crops, in wastelands, along roadsides, and in cities and rural settlements. *Ambrosia* was first discovered in the Spassky district in 1963 (Nedoluzhko, 1984; Nechaeva, 1984). The species has been found in specially protected natural areas: the species has been recorded in the Khankai Reserve since 1972 and in the Ussuri Reserve since 1988 (Fedina, 1990).

In the period from 1985 to 1987, biological control specialists introduced three species of phytophagous insects: *Zygogramma suturalis* (Fabricius) and *Z. disrupta* (Rogers) (Coleoptera, Chrysomelidae) and *Acontia candefacta* (Hübner) (Lepidoptera, Noctuidae), in order to reduce the abundance of this weed and seasonal allergen in Primorsky Territory. The study of the results of the introduction of natural enemies of ragweed showed that only *Z. suturalis* naturalized in several areas of the region (Kuznetsov and Esipenko, 1991; Esipenko, 1998, 2018; Kuznetsov and Storozhenko, 2010; Kovalev et al., 2013; Aistova et al., 2014; Aistova and Bezborodov, 2015).

Because of the lack of specialized phytophages, native insect species can be used against adventitious plant species. Studies on the identification of species trophically associated with *A. artemisiifolia* in the south of the Russian Far East have been carried out by local entomologists since 1985. In the region, 28 species of insects belonging to 12 families of four orders (Orthoptera, Heteroptera, Coleoptera, Lepidoptera) and using vegetative and generative parts of ragweed in nutrition were found (Aistova et al., 2014, 2–19; Aistova and Bezborodov, 2015; Markova et al., 2019, 2020a, 2020b, 2021; Markova and Maslov, 2020, 2022).

Fig. 1. The location of *Phycitodes subcretacella* larvae on *Ambrosia artemisiifolia* in Primorsky Territory is shown by a triangle on the enlarged fragment of the map.

Currently, the search for insects that have adapted to development on this plant and are promising for use as natural enemies of ragweed, including representatives of the Lepidoptera order, continues. In the south of the European part of Russia and Eastern Europe, species from the families Noctuidae, Sphingidae, Lymantriidae, Geometridae, and Crambidae are developing on ragweed (Maceljski and Igrc, 1989; Esipenko, 2018; Nezilik and Tsitsyura, 2020). In the Far East of Russia (Primorsky Territory), larvae from the following families were noted to feed on ragweed: Geometridae—*Ectropis excellens* (Butler), *Phthonosema tendinosaria* (Bremer), *Chlorissa obliterata* (Walker), *Eupithecia* sp.; Erebidae—*Mocis annetta* (Butler); Noctuidae—*Helicoverpa armigera* (Hübner) (Markova and Maslov, 2022); and Crambidae—*Sitochroa verticalis* (Linnaeus) (Esipenko, 2018). It has been shown that larvae of lepidoptera, colonizing ragweed, are located mainly in the apical part of inflorescences and gnaw flowers and fruits, as well as leaf blades of the plant (Esipenko, 2018; Markova and Maslov, 2022).

In the middle of the last century, narrow-winged pyralid moth (Pyralidae, Phycitinae) were of interest to plant protection specialists mainly as garden and forest pests (Mishchenko, 1957). Modern researchers are increasingly interested in the species of this subfamily in terms of the use of some of them as biological control agents for the suppression of invasive weeds of the family Asteraceae Bercht. et Presl. Thus, *Tanacetum vulgare* L. has become a serious alien weed in some regions of North America. Researchers in Central Europe conducted a preliminary selection of phytophages promising for biological control of this plant. On the basis of the results of these studies, a list of insects for which *T. vulgare* is a host plant was compiled. In this list, the moth *Phycitodes binaevella* (Hübner), a member of the phycitin subfamily, is indicated as an active pest of *T. vulgare* that damages flower baskets (Schmitz, 1998). Madagascar ragwort (*Senecio madagascariensis* Poiret) is an invasive grassland weed in Australia and Hawaii. Existing control strategies have proven uneconomical, and biological control of this ragwort has been proposed by scientists as a long-term solution. Research on Madagascar identified 14 potential biocontrol agents, of which *Lobesia* sp. (Tortricidae) and *Phycitodes* sp. were named as the most promising (McFadyen and Sparks, 1996).

In this paper, we present for the first time information on the feeding of *Ph. subcretacella* on ragweed in Primorsky Territory.

MATERIALS AND METHODS

Field studies were carried out in August 2022 in the Nadezhdinsky district of Primorsky Territory (De-Friz Peninsula), 43°16′40″ N, 131°59′25″ E, on a coastal bulk terrace made of rock (equipped in 2012 during the construction of a low-water bridge across the Amur Bay) (Fig. 1).

Significant damage by pests to the apical parts of plants, mainly inflorescences, was noticed in a monodominant community of *A. artemisiifolia* with an area of 30 m^2 on three plants from 70 to 80 cm high with a well-developed vegetative mass in the first ten days of August. For further observations of the development and nutrition of phytophages under stationary conditions, these plants were dug out together with the root and planted in a container with soil, which was covered with a fine mesh cage. Some of the damaged inflorescences with larvae were placed in glass containers for rearing the imaginal stage.

Photographs of larvae and adults were taken with a Carl Zeiss Stemi 2000-C stereoscopic microscope. To identify emerging adults, temporary genital preparations were made by macerating the soft tissues of the abdomen in a 10% KOH solution. For photography, genital preparations were stained with Chlorazol Black and mounted on glass slides in Euparal according to standart method (Robinson, 1976); photographing was carried out using an Olympus SZX16 stereomicroscope equipped with a Nikon DP74 digital camera.

The identification of moth specimens and the preparation of permanent preparations in Euparal was carried out by M.G. Ponomarenko (MP). The material is stored in the personal collection of the first author.

TAXONOMIC AND BIOLOGICAL PECULIARITIES OF A NEW PHYTOPHAGE *AMBROSIA ARTEMISIIFOLIA*

Order Lepidoptera

Family Pyralidae

Subfamily Phycitinae

Tribe Phycitini

Phycitodes subcretacella (Ragonot, 1901)

Material. Russia. 4 ♂, 1 ♀, Primorsky Territory, Nadezhdinskiy district, De-Friz Peninsula, 43°16′40″ N, 131°59′25″ E, reared from *Ambrosia artemisiifolia*, Aug. 20–25, 2022 (collector Malysheva); genit. prep. 195 (♂), 196 (♂), 197 (♀), Euparal, MP.

Diagnosis. According to the wing pattern, the species is similar to the trans-Palaearctic *Ph. binaevella* (Hübner, 1813) also presents in the south of the Russian Far East and to the Euro-Siberian *Ph. maritima* (Tengström, 1848) (see Lepiforum, 2008–2023a, 2008–2023b). *Ph. subcretacella* differs from the first species in the isolation of three dots located in a transverse row on the basal half of the wing before the middle, and it differs from the second species in the absence of a row of black dots parallel to the outer edge in the distal 5/6 of the wing. In male genitalia, the species is very similar to the Euro-Siberian species *Ph. maritima* and can be distinguished by a narrower uncus, a sacculus wider at the base, and a juxta with

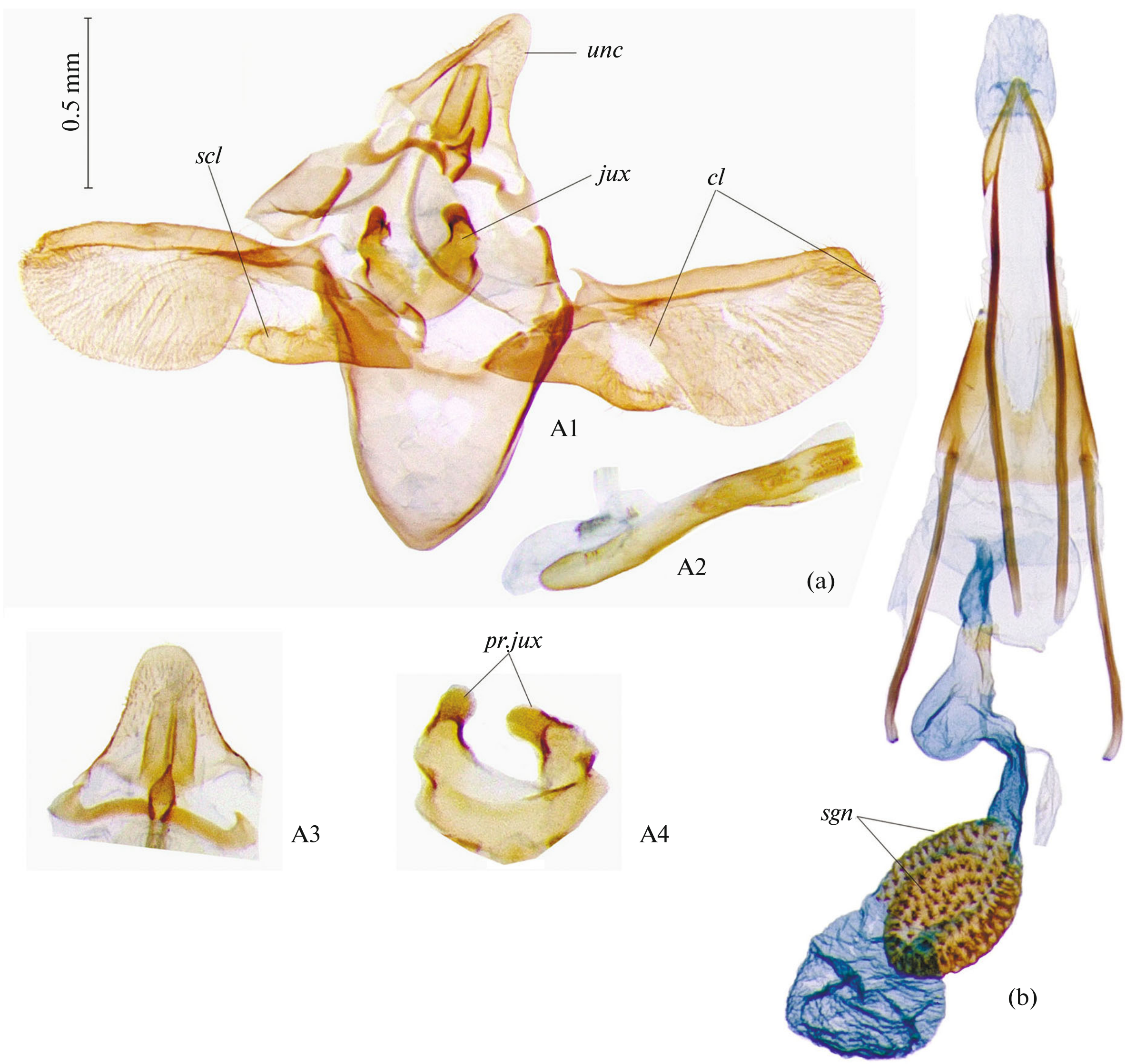

Fig. 2. *Phycitodes subcretacella*, genitalia: (a) male genitalia (A1, ventral view; A2, aedeagus, lateral view; A3, uncus, ventral view; A4, juxta, ventral view); (b) female genitalia, ventral view. Designations: *cl*, cucullus; *jux*, juxta; *pr.jux*, outgrowths of juxta; *scl*, sacculus; *sgn*, signa (photographs by M.G. Ponomarenko).

wider outgrowths at the posterior margin (Fig. 2a). The revealed species is reliably distinguished from *Ph. binaevella* by a shorter rounded cucullus (about 3/5 of the total length of the valva) in the male genitalia, while the cucullus in a closely related species is rectangular and more than 4/5 of the total length of the valva. *Ph. subcretacella* differs from both mentioned species in the female genitalia, in which the spiny, rounded ventral and dorsal signa are brought together in the lateral region and almost annularly cover the distal half of the copulatory bursa (Fig. 2b), while in the compared species they are divided into two well-separated parts.

Distribution. Russia (Amurskaya Region, Jewish Autonomous Region, southern Khabarovsky Territory, southern Primorsky Territory, Sakhalin, South Kuril Islands (Kunashir Island)) (Kirpichnikova and Yamanaka, 1999; Dubatolov and Streltsov, 2010; Streltsov et al., 2012; Streltsov, 2016; Sinev and Streltsov, 2019), South Korea (Paek et al., 1999), and Japan (Hokkaido, Honshu, Izu, Shikoku, Kyushu, Tsushima, and Yakushima) (Yamanaki and Sasaki, 2013).

Host plants. In the south of the Russian Far East, larvae feed on inflorescences of ragweed (according to the authors); in Japan, they are developing on

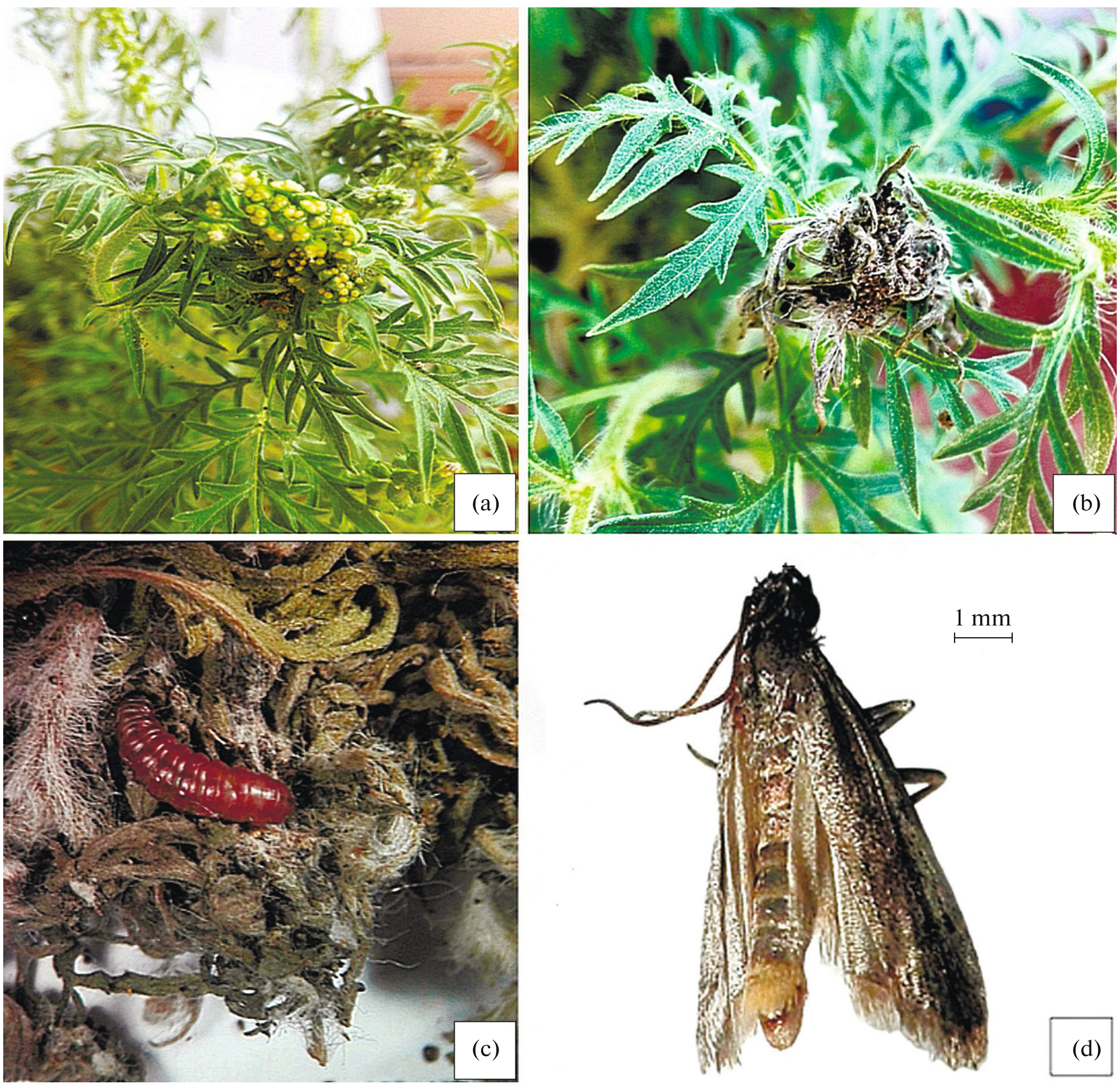

Fig. 3. Damage to ragweed by larvae and stages of development of *Ph. subcretacella*: (a) damaged apical parts of shoots during flowering; (b) bundle of twisted leaves; (c) larva of the last instar before pupation in a dried lump of leaves and remnants of inflorescences; (d) imago of *Ph. subcretacella*, male (image by S.K. Malysheva, Ed. M.V. Maslov).

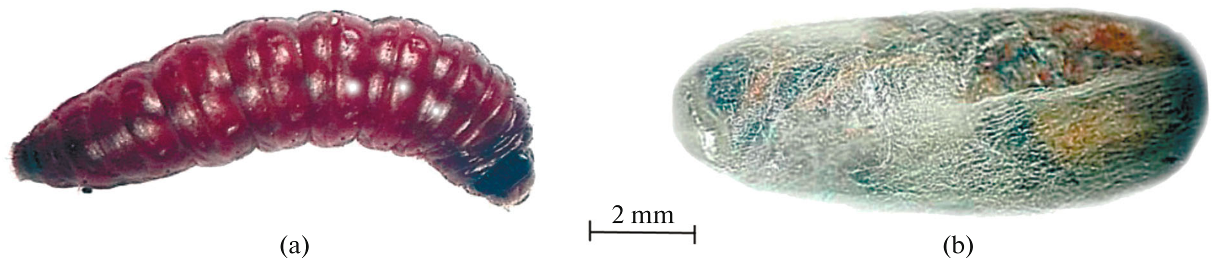

Fig. 4. Preimaginal stages of *Ph. subcretacella*: (a) larva of the last instar before pupation; (b) pupa in a silky cocoon (image by S.K. Malysheva, Ed. M.V. Maslov).

Tephroseris kirilowii (Turcz. ex DC.) Holub (Yamanaki and Sasaki, 2013).

Observation results. In Primorsky Territory, larvae of older instars of *Ph. subcretacella* were found in the first ten days of August feeding on ragweed in a clump formed from inflorescences and surrounding leaves attached to them by silk threads (Fig. 3a). Shortly before pupation, the larvae gnawed the stem with a lump formed at the top and thereby dried it out by the end of their development. Larvae of the last instar had a dark brownish red color of the body, black head capsule, and prothoracic shield (Fig. 4a). Pupation took place in a dried lump (Figs. 3b, 3c), in which the pupa was in a silky cocoon (Fig. 4b). The development of the pupa lasted 10–12 days. Observations were carried out from the time of detection of larvae on August 6–12 until the emergence of adults on August 20–25. It should be noted that, during the period of development, the larvae preferred to feed mainly on the generative organs of the host plant.

DISCUSSION

The nutrition and development of larvae *Ph. subcretacella* on *A. artemisiifolia* was not previously noted in domestic literature. Senecio sp. was indicated as a host plant for the revealed species of phycitin moth without species identification of the plant (Kirpichnikova and Yamanaka, 1999; Kirpichnikova, 2009). At present, a number of independent taxa of a generic rank have been isolated from this large botanical genus, including the genus *Tephroseris* (Rchb.) Rchb., which is distributed in Eurasia and North and Central America. This botanical genus includes the species *Tephroseris kirilowii* (Turcz. ex DC.) Holub, widely distributed in East Asia and indicated as a food plant for *Ph. subcretacella* in Japan (Yamanaki and Sasaki, 2013). The dates of flight of adults from May to September, indicated for Japan, suggest the presence of several generations. The life cycle of *Ph. subcretacella* on the territory of the Russian Far East has not yet been studied in detail; accordingly, the number of generations per year in this species is also unknown. With two generations in *Ph. subcretacella*, larvae of the first generation can feed, as in Japan, on *Tephroseris kirilowii*, which blooms on the territory of the Russian Far East earlier, in May–June, and the second generation can feed in August on *A. artemisiifolia*. On the other hand, *Ph. subcretacella* is a thermophilic species; most of its range is located much to the south, covering the subtropical islands of Japan. Therefore, it is possible that, in the Russian Far East the species develops in one generation, as in many representatives of the more southern subtropical fauna, and its larvae could master *A. artemisiifolia*, a plant with large inflorescences that blooms massively in the second half of summer, as a widely available food resource.

CONCLUSIONS

Thus, with en expansion of *A. artemisiifolia* in the south of the Russian Far East (Primorsky Territory), both phenomena are observed: an increase in the list of phytophagous species using this plant as a host plant, and the formation of new trophic associations in the local entomofauna with this invasive botanical species. Further monitoring of *A. artemisiifolia* as a potential host plant for phytophages of various taxonomic groups in the study region is required. The revealed species of *Ph. subcretacella* should be considered as a new phytophage of ragweed and should be included in the list of possible biological agents for control of ragweed *A. artemisiifolia*.

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COMPLIANCE WITH ETHICAL STANDARDS

Conflict of interest. The authors declare that they have no conflicts of interest.

Statement of the welfare of animals. The article does not contain any studies involving animals in experiments performed by any of the authors.

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