



## Occurrences of three *Phyllonorycter* Hübner species (Lepidoptera, Gracillariidae: Lithocolletinae) for the first time in Iran

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**ABSTRACT.** Three *Phyllonorycter* species namely, *Ph. coryli* (Nicelli, 1851), *Ph. millierella* (Staudinger, 1871) and *Ph. roboris* (Zeller, 1839) are newly reported for the fauna of Iran. These species are collected in Azarbaijan-e Sharghi, Tehran and Kordestan provinces, respectively. The first two species were collected as larvae while feeding on *Carpinus betulus* L. (Betulaceae) and *Celtis australis* L. (Cannabaceae), in the order, and the last one collected as adult in an Oak forest using light trap. The genus *Carpinus* L. and *C. betulus* are newly reported as larval host plant for *Ph. coryli*. Brief taxonomic characterizations of these species are provided and an updated list of the *Phyllonorycter* species occurring in Iran is presented.

**Key words:** Gracillariidae, *Phyllonorycter*, new record, new host plant, Iran

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### Introduction

The family Gracillariidae constitutes the main plant mining family of Lepidoptera (Davis, 1987) and includes almost 2000 known species in 100 genera (van Nieukerken *et al.*, 2011; De Prins & De Prins, 2017). The most species-rich genus of this family, *Phyllonorycter* Hübner, 1822 (syn., *Lithocolletis* Hübner, 1825) is assigned to the subfamily Lithocolletinae and comprises 401 described species (De Prins & De Prins, 2017). This genus has a worldwide distribution with the greatest diversity in the Palaearctic Region (257 species) (De Prins & De Prins, 2017). Most

of the *Phyllonorycter* species are strictly monophagous (Robinson *et al.*, 2001, 2002, 2010; De Prins & De Prins, 2005, 2017) and their larvae feed internally on living plant tissues. The larval instars are devouring the parenchyma cells, making tentiform mines on upper or lower surfaces and undergoing all their pre-imaginal stages including the pupa within a mine (Emmet *et al.*, 1985; Davis & Robinson, 1998). As our knowledge goes, 112 plant genera from 31 different families, 15 orders, and six subclasses have been recorded as food plants of the *Phyllonorycter* species (Lopez-

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Vaamonde *et al.*, 2003; De Prins & De Prins, 2017).

Little is known about the Gracillariidae of Iran and up to 20 species in 10 genera and five subfamilies namely, Acrocercopinae Kawahara & Ohshima, 2016, Gracillariinae Stainton, 1854, Lithocolletinae Stainton, 1854, Parornichinae Kawahara & Ohshima, 2016, and Phyllocnistinae Herrich-Schäffer, 1857 have been reported from Iran so far. The recorded species are belonging to the genera: *Acrocercops* Wallengren, 1881 (one species), *Aspilapteryx* Spuler, 1910 (three species), *Caloptilia* Hübner, 1825 (one species), *Calybites* Hübner, 1822 (one species), *Cupedia* Klimesch & Kumata, 1973 (one species), *Dialectica* Walsingham, 1897 (one species), *Parornix* Spuler, 1910 (two species), *Phyllocnistis* Zeller, 1848 (one species), *Phyllonorycter* Hübner, 1822 (seven species), and *Polymitia* Triberti, 1986 (two species) (Zerny, 1940; Amsel, 1959; Esmaili, 1971; Deschka, 1979; Abai, 1984; Triberti, 1985, 1986, 1990; Noreika, 1991; Puplesis *et al.*, 1996; Modarres Awal, 1997; Dimić *et al.*, 1997; Kuznetzov & Baryshnikova, 1998; Wieser *et al.*, 2001; Abivardi, 2001). Based on the available literature, as far as 10 *Phyllonorycter* species are known from Iran (Esmaili, 1971; Deschka, 1979; Abai, 1984; Noreika, 1991; Modarres Awal, 1997; Wieser *et al.*, 2001; Abivardi, 2001).

During 2016-2017, symptoms of two *Phyllonorycter* species, *Ph. coryli* (Nicelli, 1851), and *Ph. millierella* (Staudinger, 1871) that occurred in Azarbaijan-e Sharghi and Tehran provinces, respectively were observed. The larvae of them were found while feeding on *Carpinus betulus* L. (Betulaceae), and *Celtis australis* L. (Cannabaceae), respectively. The adult female of another *Phyllonorycter* species was found in Lepidoptera collection of the Hayk Mirzayans Insect Museum (HMIM), Iranian Research Institute of Plant Protection (IRIPP) which had been collected in an Oak forest near to Marivan, Kordestan province

by the first author. This species was identified as *Ph. roboris* (Zeller, 1839). These three species are newly reported for the fauna of Iran. Moreover, this is the first record of the genus *Carpinus* and *C. betulus* L. as the larval host plant for *Ph. coryli*. In the present study brief characterizations of these species are provided and an updated list of the *Phyllonorycter* species occurring in Iran is presented.

### Material and methods

The specimens of *Ph. coryli* and *Ph. millierella* were collected as larvae in Arasbaran forest (Azarbaijan-e Sharghi province) and National Botanical Garden of Iran (Tehran province) in 2017, respectively, but *Ph. roboris* collected as adult using light trap in Kordestan province. The larvae were reared in small plastic containers at room temperature. The adults were examined externally using a stereomicroscope with maximum magnification 128×. The species were identified based on their external appearance and their male genitalia structure when necessary. Genitalia dissections were based on those described by Clarke (1941) and Robinson (1976). Photographs were taken using a digital Still camera DSC-F717 and a Dino-Eye Microscope Eye-piece camera. All of the examined specimens are deposited in the Hayk Mirzayans Insect Museum.

### Results

The adult examined specimens are briefly characterized as follows:

#### *Phyllonorycter coryli* (Nicelli, 1851) (Fig. 1A)

**Material examined:** Āzarbāijān-e Sharghi Prov.: 1 ♂ 1 ♀, Kaleybar, Arasbārān forest, N 38° 51' 44", E 46° 58' 4.0", 1867 m, 7.IX.2017, Farahāni leg. (GS: HA-2344).

**Diagnosis of the adults:** Wingspan 7.0–9.0 mm (Kimber, 2018); while wingspan of the

examined male 7.1 mm and that of the female 4.6 mm; antennae slightly shorter than the forewing, each flagellum shining dirty-cream and ochre at distal end which gives it a ringed appearance; ground colour of the forewing shining brownish-orange, with four and three white hooks at distal half of costal and dorsum margins, respectively which are dark-edged internally, an elongated black spot at apex of the wing, and a white longitudinal line extended from the base to first pair of the hooks; hindwing gray (Fig. 1A).

In the genitalia (Fig. 1H) of examined male uncus elongated and tapering apically; valvae symmetrical, relatively narrow at base and gradually broadened and slightly rounded distally, with a distinct bend medio-ventrally, bearing ventral and subdorsal setae at distal half and an sclerotized elongated large spine at mid-dorsal edge extended to slightly behind the apex of valva; transtilla well developed and sclerotized; vinculum rounded and small; saccus large and rounded; eighth abdominal sternite almost triangular and crenate laterally, with few fine hairs at the apex; phallus very long, slender and straight, without cornuti.

**Biology:** The larva makes a more or less round, white to silvery mine on the upper side of a leaf, over veins (Figs 1B, C) and causes the leaf to fold upwards. There are two generations per year (Kimber, 2018; Pitkin *et al.*, 2017).

**Host plants:** Betulaceae: *Corylus avellana* L., *C. colurna* L., *C. maxima* Mill., *Ostrya carpinifolia* Scop., *Sorbus aria* (L.) Crantz and *Ribes sanguineum* Pursch (De Prins & De Prins, 2017; Pitkin *et al.*, 2017). In this study the larvae were collected on *Carpinus betulus* L. The genus and species of the host plant are newly reported for *Ph. coryli*.

**Distribution:** Widespread in continental Europe. It has also been reported from Near East (De Prins & De Prins, 2017).

*Phyllonorycter millierella* (Staudinger, 1871) (Fig. 1D)

**Material examined:** Tehrān Prov.: 2 ♂♂ 2 ♀♀, Tehrān, Peykān Shahr, National Botanical Garden of Iran, N 35° 44' 30", E 51° 10' 49", 1275 m, 15.VI.2017, Farahāni leg. (GS: HA-2345).

**Diagnosis of the adults:** Wingspan 7–8 mm (Staudinger, 1871), wingspan of the examined males 6.2–7.1 mm and that of the females 5.8–6.8 mm; forewing (Fig. 1D) ochre-yellow with a short white basal stripe which according to Staudinger (1871) extended to one-fifth of the wing length, but in the examined specimens extended to one-fourth to slightly less than one-third (0.26–0.28) of the wing length. Also with two white oblique cross lines, first one standing in the middle and the second one close to termen, the first transverse white line thickens slightly in costal edge and edged with a few black dots outwardly, especially in the middle, the second white line ending shortly before apex of the wing in costal margin and edged with a few black dots both out- and inwardly; hindwing and fringes pale gray (Staudinger, 1871).

In the genitalia of examine male (Fig. 1I), uncus almost triangular and slightly constricted behind the apex; valvae almost symmetrical, slightly narrowed apically, with ventral setae concentrated at distal half behind the apical part, and a large and relatively short sclerotized spine at mid-dorsal edge; vinculum small; eighth abdominal sternite elongated, with two lateral rounded projections apically, bearing few fine hairs; phallus hook-shaped with a spindle like cornutus at apical two-thirds.

**Host plants:** Cannabaceae: *Celtis australis* L. and *C. caucasica* Willd. (De Prins & De Prins, 2017). In the present study it was found on the former host plant.



**Biology:** The larvae making tentiform mines at the lower surface of the leaves without visible wrinkles (Fig. 1E) which is visible at the upper surface (Fig. 1F), and pupate within the mines. The species has at least two generations per year (Jurc *et al.*, 2016; Ellis, 2001–2017). Often more than one mine can be found on a single leaf (Csóka, 1995).

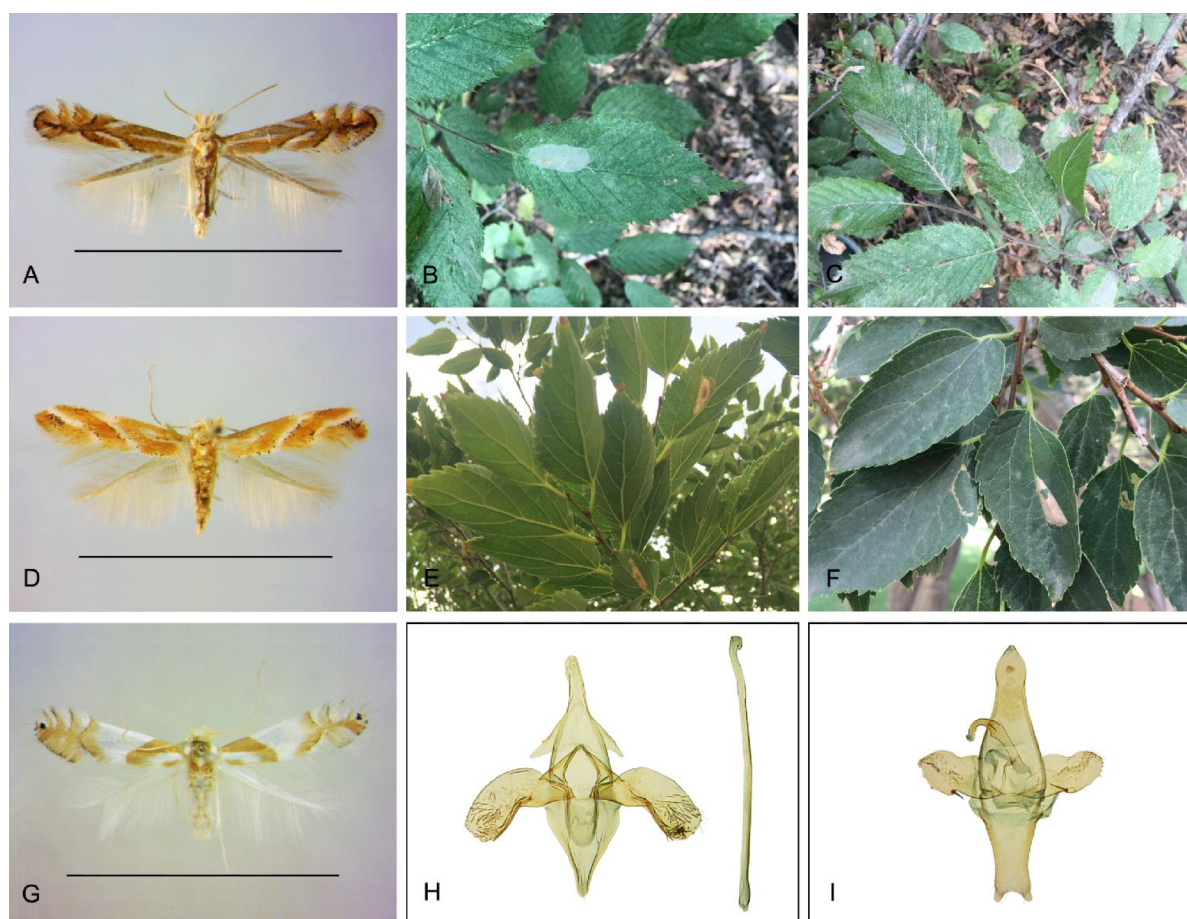
**Distribution:** Switzerland, Spain, Slovenia, Russian Federation (European part), Portugal, Macedonia, Italy, Sicily, Israel, Georgia, France, Corsica, Croatia, Bosnia & Herzegovina, Kazakhstan, Turkmenistan, Tajikistan, Turkey,

Uzbekistan (Puplesis *et al.*, 1996; De Prins & De Prins, 2017).

***Phyllonorycter roboris* (Zeller, 1839)**  
(Fig. 1G)

**Material examined:** Kordestān Prov.: 1 ♀, Marivān- Chenāreh Rd., 9 km. E. Marivān (Oak forest), N 35° 31' 51.8", E 46° 16' 51.6", 1371 m, 3.VI.2012, Ālipanāh leg.

**Diagnosis of the adults:** This species can easily be distinguished from the remaining *Phyllonorycter* species based on its wing. Wingspan 6–9 mm (Lemurell, 2013–2018), and that of the examined specimen 7.3 mm.



**Figure 1.** A. *Phyllonorycter coryli* adult male and its mines on the upper surfaces of the *Carpinus betulus* leaves (B, C), Azarbaijan-e Sharghi province; D. *Ph. millierella* adult male, its mines on the lower surfaces of *Celtis australis* leaves (E), Tehran province, and symptoms at the upper surfaces of them (F); G. *Ph. roboris* adult female, Kordestan province; H. Male genitalia and phallus in *Ph. coryli*; I. Male genitalia and phallus in *Ph. millierella*. The scale bar in the figures of adult specimens indicates 0.5 cm.

inner one-third of the forewing golden-brown with a distinct white dash, middle part white and the outer part golden-brown with three black-edged white hooks at costal area and one black-edged white one at dorsal edge. Apex of the forewing with a black spot, and an extended tail out of the tip (Lemurell, 2013–2018).

**Host plants:** Fagaceae: *Quercus cerris* L., *Q. dalechampii* Ten., *Q. frainetto* Ten, *Q. ilex* L., *Q. pedunculiflora* C. Koch, *Q. petraea* (Matt.) Liebl., *Q. polycarpa* Schur., *Q. pubescens* Willd., *Q. pyrenaica* Willd., *Q. robur* L., *Q. streimii* Heuff. (De Prins & De Prins, 2017).

**Biology:** The larvae create large tentiform blister mines at the lower surface of the leaves. The lower epidermis seems smooth but has fine length folds (Pitkin *et al.*, 2017; Kimber, 2018). This species has one generation per year (Kimber, 2018).

**Distribution:** Widespread in Europe. Also recorded in Near East (Pitkin *et al.*, 2017).

### Discussion

For many of the world's genetic resources, Iran is considered as the centre of origin (Makhdoum, 1990). The Irano-Touranian region is rich in endemic species and the Hyrcanian district is the home of relict species of the Tertiary era. Meanwhile, in the south of Iran, the Saharo-Sindian region, subtropical species thrive (Zohary, 1973, 1981; Frey & Probst, 1986). Poor sampling of *Phyllonorycter* specimens in Iran, which is mostly because of difficult collecting of the mines and rearing of the larvae, cannot adequately represent the true situation of their species in Iran. Considering the species reported from the adjacent countries (unpublished data of Jaroslaw Buszko), and diverse flora and habitats in Iran, it seems that the number of the gracillariid species occurring in Iran be much more than the species reported so far.

Due to their ability to feed within leaves, some lithocolletine species are well-known

pests, such as *Phyllonorycter blancardella* (Fabricius, 1781) on *Malus* spp. (De Prins & Kawahara, 2012) that can also be found in Iran (Modarres Awal, 1997).

According to De Prins & Kawahara (2012), species of most genera of the family Gracillariidae feed only on one or two host families, and only *Cameraria* and *Phyllonorycter* species are known to be true polyphagous ones and feeding on multiple plant families. In most cases, closely related moths feed on closely related host plants, and these usually belong to either the same plant genus or to closely related plant genera belonging to the same family (Lopez-Vaamonde *et al.*, 2003; De Prins & De Prins, 2005). In the present study, *Carpinus betulus* was found as a new larval host plant for *Ph. coryli*. This host species is not reported for *Ph. coryli* so far; however, it belongs to the family Betulaceae which embraces all the presently known host plants of *Ph. coryli*.

Normally up to 70% of the larvae are parasitized by Braconidae, Eulophidae, Ichneumonidae, or Pteromalidae (Fulmek, 1962; Vidal & Buszko, 1990; Davis & Deschka, 2001; Noyes, 2003). The newly reported species in the present study are parasitized by Eulophidae species.

### List of the *Phyllonorycter* species reported from Iran

#### *Ph. blancardella* (Fabricius, 1781)

**Distribution in Iran:** Azarbaijan-e Sharghi, Tehran, Markazi, Lorestan, Hamedan, Esfahan, Chaharmahal va Bakhtiari and Khorasan (unstated provincial division) provinces (Modarres Awal, 1997).

#### *Ph. coryli* (Nicelli, 1851)

**Distribution in Iran:** Azarbaijan-e Sharghi Prov.: Arasbaran forest.

#### *Ph. corylifoliella* (Hübner, 1796)

**Distribution in Iran:** Azarbaijan-e Sharghi, Tehran, Markazi, Fars, Esfahan, Khorasan (unstated provincial division) (Modarres

Awal, 1997) and Golestan (Golestan National Park: Tang-e Gol) (Wieser *et al.*, 2001).

*Ph. iranica* Deschka, 1979

**Distribution in Iran:** Khorasan-e Razavi Prov.: Mashhad (Deschka, 1979).

*Ph. maestingella* (Müller, 1764)

**Distribution in Iran:** Northern provinces (Abai, 1984).

*Ph. millierella* (Staudinger, 1871)

**Distribution in Iran:** Tehran Prov.: Peykan Shahr.

*Ph. platani* (Staudinger, 1870)

**Distribution in Iran:** With general distribution (Modarres Awal, 1997), Golestan Prov.: Golestan National Park (Tang-e Gol) (Wieser *et al.*, 2001).

*Ph. populi* (Filipjev, 1931)

**Distribution in Iran:** With general distribution (Modarres Awal, 1997).

*Ph. populifoliella* (Treitschke, 1833)

**Distribution in Iran:** With general distribution (Modarres Awal, 1997).

*Ph. rajella* (Linnaeus, 1758)

**Distribution in Iran:** Caspian Sea areas (Modarres Awal, 1997)

*Ph. roboris* (Zeller, 1849)

**Distribution in Iran:** Kordestan Prov.: Marivan.

*Ph. salicicolella* (Sircom, 1848)

**Distribution in Iran:** With general distribution (Modarres Awal, 1997)

*Ph. turanica* (Gerasimov, 1931)

**Distribution in Iran:** Tehran, Fars, Esfahan, Chaharmahal va Bakhtiari and Khorasan (unstated provincial division) provinces (Modarres Awal, 1997).

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#### Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

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## گزارش وجود سه گونه از جنس *Phyllonorycter* Hübner (Lepidoptera, Gracillariidae) Lithocolletinae برای اولین بار در ایران

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**چکیده:** سه گونه از جنس *Phyllonorycter* به نام‌های *Ph. coryli* (Goeze, 1783)، *Ph. millierella* (Staudinger, 1871) و *Ph. roboris* (Zeller, 1839) برای اولین بار از ایران گزارش می‌شوند. این گونه‌ها به ترتیب در استان‌های آذربایجان شرقی، تهران و کردستان جمع‌آوری شده‌اند. دو گونه اول به صورت لارو و به ترتیب در حال تغذیه از برگ درختان ممرز، *Carpinus betulus* L. (Betulaceae) و داغداغان، *Celtis australis* L. (Cannabaceae) و گونه سوم به صورت حشره کامل در جنگل بلوط و به کمک تله نوری جمع‌آوری شده‌اند. جنس *Carpinus* L. و گونه *C. betulus* L. به عنوان میزبان جدید برای *Ph. coryli* معرفی می‌شوند. در این مقاله، این سه گونه به اختصار معرفی شده‌اند. همچنین فهرست گونه‌های متعلق به جنس *Phyllonorycter* در ایران ارائه شده است.

**واژگان کلیدی:** *Phyllonorycter*, Gracillariidae، گزارش جدید، میزبان جدید، ایران.