

Family Opomyzidae with pests of cereal crops (Insecta: Diptera)

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Abstract

The Opomyzidae are a family of insects in the order Diptera, Suborder: Brachycera, Infra-order: Muscomorpha. This family includes phytophagous species subservient to plants of the Poaceae family (grasses). Some species are pests of cereal crops. Its biological cycle, adapted to the phenology of grasses with an autumn-spring cycle, determines the distribution of this family, represented almost exclusively in the temperate regions of the boreal hemisphere. The purpose of this manuscript is to mention the Family Opomyzidae with pests of cereal crops. Bibliographic verification of Family Opomyzidae was carried out from 1972 to 2022. Manuscripts published in scientific journals and digital platforms on the subject were examined. Only a few species of Opomyzidae cause significant damage to agriculture: the most important are *Opomyza florum* (Fabricius, 1794), *Opomyza germinationis* (Linnaeus, 1758) and *Opomyza petrei* Mesnil, 1934 in the genus *Opomyza*, and *Geomyza balachowskyi* Mesnil, 1934, *Geomyza combinata* (Linnaeus, 1767) and *Geomyza tripunctata* Fallen, 1823 in the genus *Geomyza*.

Keywords: Damage; Phytophagous; Poaceae; Grasses; Agriculture

1. Introduction

The Opomyzidae are a family of insects in the order Diptera, Suborder: Brachycera, Infra-order: Muscomorpha. This family includes phytophagous species subservient to plants of the Poaceae family (grasses). Some species are pests of cereal crops. Its biological cycle, adapted to the phenology of grasses with an autumn-spring cycle, determines the distribution of this family, represented almost exclusively in the temperate regions of the boreal hemisphere (Figures 1, 2 and 3) [1,2,3].



Source: Foto 5608858, (c) Miroslav Deml

Figure 1 Specimen of Opomyzidae Family

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Source: Foto 90745538, (c) Marie Lou Legrand

Figure 2 Specimen of Opomyzidae Family



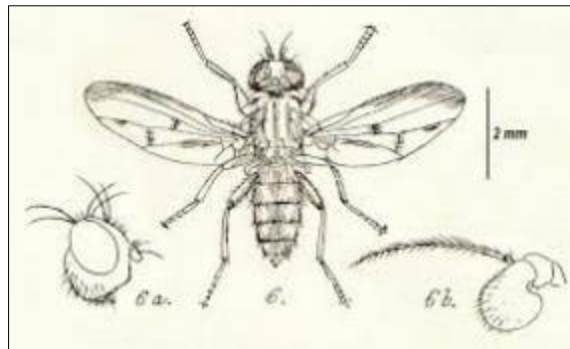
Source: <https://alchetron.com/Opomyzidae>

Figure 3 Specimen of Opomyzidae Family

1.1. Description

Adults, small in size, with a slender and elongated body, from 2 to 5 mm in length, have a color ranging from yellow to reddish-brown or blackish. The wings are generally hyaline, often speckled with spots, but always have at least one chromatic spot in correspondence with the apex.

The head is globular, characterized by a reduced chaetotaxies, but composed of particularly developed bristles. Only one pair of fronto-orbital bristles is present. They are lying down, arranged on the upper part of the forehead and accompanied by scattered interfrontal hairs. The outer and inner ocellar bristles and the vertical bristles are long and robust, the ocellar inserted into the anterior margins of the ocellar plate and directed forward (Figure 4).



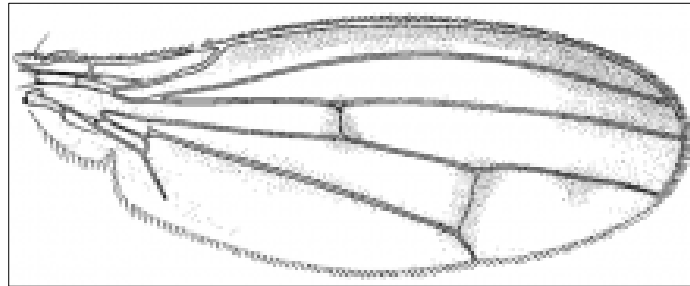
Source: From Walker (1853); Watson, L., and Dallwitz, M.J. 2003 onwards. Insects of Britain and Ireland. The families of Diptera. Version: 14th April 2022. delta-intkey.com

Figure 4 *Opomyza* sp., with side view of head (6a), and antenna (6b)

The chest is short but well developed in height compared to the rest of the body. In the dorsal sclerites there are short acrostic bristles, aligned in 4 to 10 irregular rows, 3 to 4 pairs of dorsocentral bristles, presutural for the first pair, post sutural for the others, 2 pairs of scutellar bristles, the basal ones quite weak.

The wings, narrow and elongated, are, in the resting phase, folded horizontally over the abdomen and reciprocally overlapping. The costal vein extends to the end of the median and presents a single fracture before the confluence of R 1. The subcostal is incomplete and fused with R1. The radial splits into three branches, with R1 relatively short and curved, R2 + 3 and R 4 + 5 long and more or less converging at the apex of the wing. The R1 rib always has an anterior mucosa at the time of the subcostal fracture. The anal rib is either short or completely absent (Figures 5, 6, 7 and 8) [4,5,6,7,8].

1.2. Opomyzidae



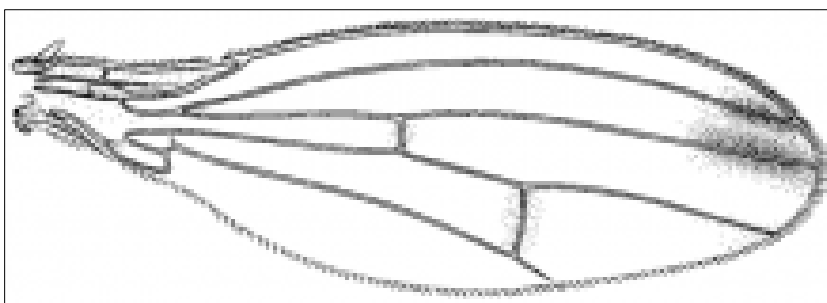
Source: <http://drawwing.org/insects/diptera/opomyzidae>

Figure 5 *Opomyza petrei* Mesnil, 1934, wing



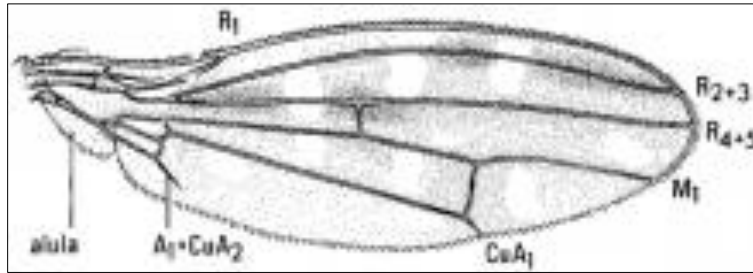
Source: <http://drawwing.org/insects/diptera/opomyzidae>

Figure 6 *Geomyza apicalis* (Meigen 1830), wing



Source: <http://drawwing.org/insects/diptera/opomyzidae>

Figure 7 *Geomyza lurida* (Loew, 1864), wing



Source: Source: <http://drawwing.org/insects/diptera/opomyzidae>

Figure 8 *Anomalochaeta guttipennis* (Zetterstedt, 1838), wing

1.3. Biology

The larvae are endophytic phytophagous and develop inside the stems of herbaceous plants, most often belonging to the Poaceae family (grasses). They cause damage that leads to the destruction of the vegetative point (Figures 9, 10 and 11).



Source: <https://www.mindat.org/paleoimg.php?id=1327299>

Figure 9 Opomyzidae Family: Herbaceous plants



Source: <https://bugguide.net/node/view/2158509/bgimage>

Figure 10 Damage that leads to the destruction of the vegetative point

Females usually lay a single egg per plant, at the base of the stem, and the larva penetrates the leaf, migrating to the center of the stem. The damage appears first on the central leaves, which first turn yellow before dying. A female lays about 40 eggs in two months. Adults live especially long, their life expectancy varying from three to six months [8,9,10,11].

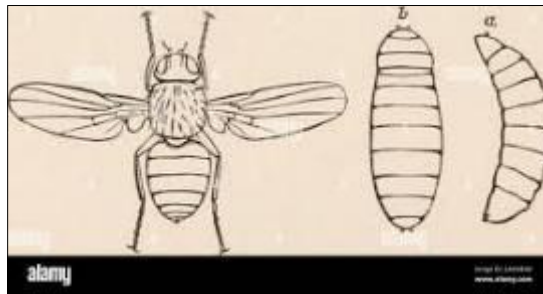


Source: <https://bugguide.net/node/view/2158509/bgimage>

Figure 11 The destruction of the vegetative point

1.4. Life cycle

The life cycle is univoltine or multivoltine, with hibernation occurring in the egg or larval stage. In univoltine species, laying occurs in autumn and the birth of larvae occurs in spring or between autumn and spring. In multivoltine species, spawning occurs according to more complex patterns related to the phenology dynamics of various grasses during the year (Figure 12).



Source: Alamy Stock Photo

Figure 12 Adult, a larva, b pupa Opomyzidae: Young folks, fruit growers, farmers, and gardeners; palpi exceedingly small or wanting Abdomen tapering towards the base. Middle tibiae with distinct spurs; claws and pulvilli small; venation of the wings complete; the auxiliary vein distinctly separated from the first longitudinal vein; the two posterior basal cells rather large. Macquart: Family Opomyzidae

Larval development usually takes 30 to 40 days, and at the end of its last developmental stage the larva leaves the plant to pupate on the soil surface. Pupation lasts from 3 to 4 weeks, the hatching date of adults varies according to the cycle: in univoltine species, adults are born in late spring and early summer, in multivoltine species, adults of the first generation are born more or less least in early spring and those of succeeding generations during summer [10,11,12].

1.5. Habitat



<https://en.wikipedia.org/wiki/Opomyzidae>

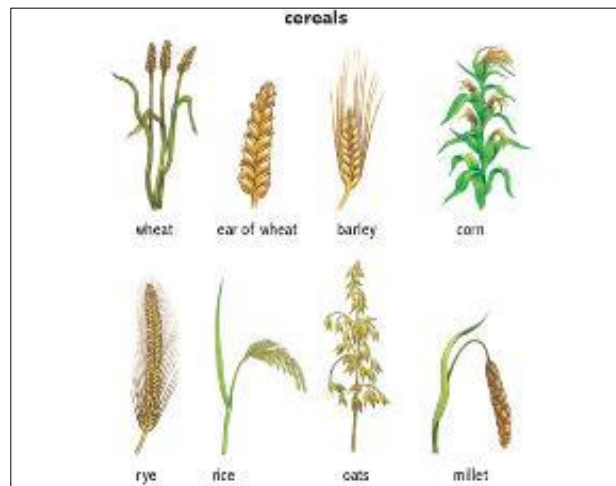
Figure 13 Opomyzidae Family: Herbaceous vegetation

They frequent grassy areas, usually open, such as meadows, pastures, and forage and cereal grasses. They are less often found in undergrowth or along its banks. Its behavior would be complex because part of its life would be spent in shrubby vegetation and the rest in herbaceous vegetation (Figures 13, 14 and 15) [12,13,14].



Source: <https://classhall.com/lesson/grasses-legumes-commonly-found-natural-pastures-west-africa/>

Figure 14 Grasses-legumes-commonly (Africa)



Source: <https://ecosystemsunitied.com/2016/03/14/the-importance-of-annual-grasses/>

Figure 15 Poaceae (cereal grasses) plants also provide forage, building materials [bamboo, thatch, straw] and fuel [ethanol]

1.6. Damage



Source: https://commons.wikimedia.org/wiki/File:Opomyza_florum_06.JPG

Figure 16 *Opomyza florum* (Fabricius, 1794)

Only a few species of Opomyzidae cause significant damage to agriculture: the most important are *Opomyza florum* (Fabricius, 1794), *Opomyza germinationis* (Linnaeus, 1758) and *Opomyza petrei* Mesnil, 1934 in the genus *Opomyza*, and *Geomyza balachowskyi* Mesnil, 1934, *Geomyza combinata* (Linnaeus, 1767) and *Geomyza tripunctata* Fallen, 1823 in the genus *Geomyza* (Figures 16, 17, 18, 19, 20 and 21) [12,13,14].



Source: <https://www.flickr.com/photos/cyprinoid/4130221545>

Figure 17 *Opomyza germinationis* (Linnaeus, 1758)



Source: https://en.wikipedia.org/wiki/Opomyza_petrei

Figure 18 *Opomyza petrei* Mesnil, 1934



Source: <https://bugguide.net/node/view/1436311>

Figure 19 *Geomyza balachowskyi* Mesnil, 1934



Source: David Nicholls, Stanton, Cliffe Hill, 19 August 2021

Figure 20 *Geomyza combinata* (Linnaeus, 1767)



Source: https://en.wikipedia.org/wiki/Geomyza_tripunctata

Figure 21 *Geomyza tripunctata* Fallen, 1823

1.7. Distribution

The family Opomyzidae has a predominantly Palearctic distribution and is totally absent in the Australasia and Neotropical regions. Two-thirds of the species are found exclusively in the Palearctic, five are Holarctic, and eight are exclusively Nearctic. The family is also represented in the Indomalaya and Afrotropical regions, with one and five species respectively. The monotypic genus *Scelomyza* is unique to the Afrotropical region. In Europe, the family is represented by the genera *Anomalochaeta*, *Geomyza* and *Opomyza* [14,15].

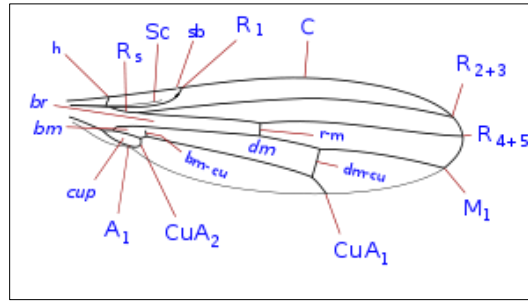
1.8. Taxonomy

The Opomyzidae family is a small family with about 40 species grouped into four genera: *Anomalochaeta*, *Geomyza*, *Opomyza* and *Scelomyza* (Figures 22, 23, 24 and 25).



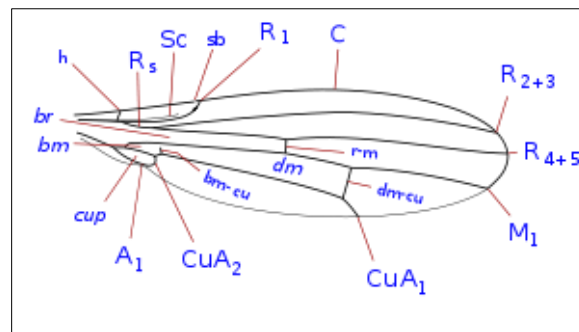
Source: <https://www.semanticscholar.org/paper/First-record-of-Anomalochaeta-guttipennis-1838/Kvifte/cf9fda6e4bd2b6e1f8061065b93bb24b2483abea/figure/0>

Figure 22 *Anomalochaeta guttipennis* (Zetterstedt, 1838). Wing



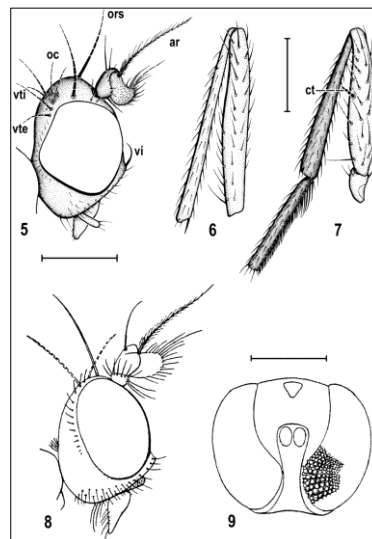
Source: <https://pt.frwiki.wiki/wiki/Opomyzidae>

Figure 23 Rib fractures: sb: subcostal fracture. Longitudinal ribs: C: costal; Sc: subcostal; R: radial; M: median; Cu: ulnar; A: anal. Transverse veins: h: humeral; rm: radio-average; bm-cu: basal midcubital; dm-cu: mid-ulnar disk. Cells: dm: disk; lg: 1 r basement; BM: 2nd basal; cup: cup cell



Source: <https://pt.frwiki.wiki/wiki/Opomyzidae>

Figure 24 Rib fractures: sb: subcostal fracture. Longitudinal ribs: C: costal; Sc: subcostal; R: radial; M: median; Cu: ulnar; A: anal. Transverse veins: h: humeral; rm: radio-average; bm-cu: basal midcubital; dm-cu: mid-ulnar disk. Cells: dm: disk; lg: 1 r basement; BM: 2nd basal; cup: cup cell

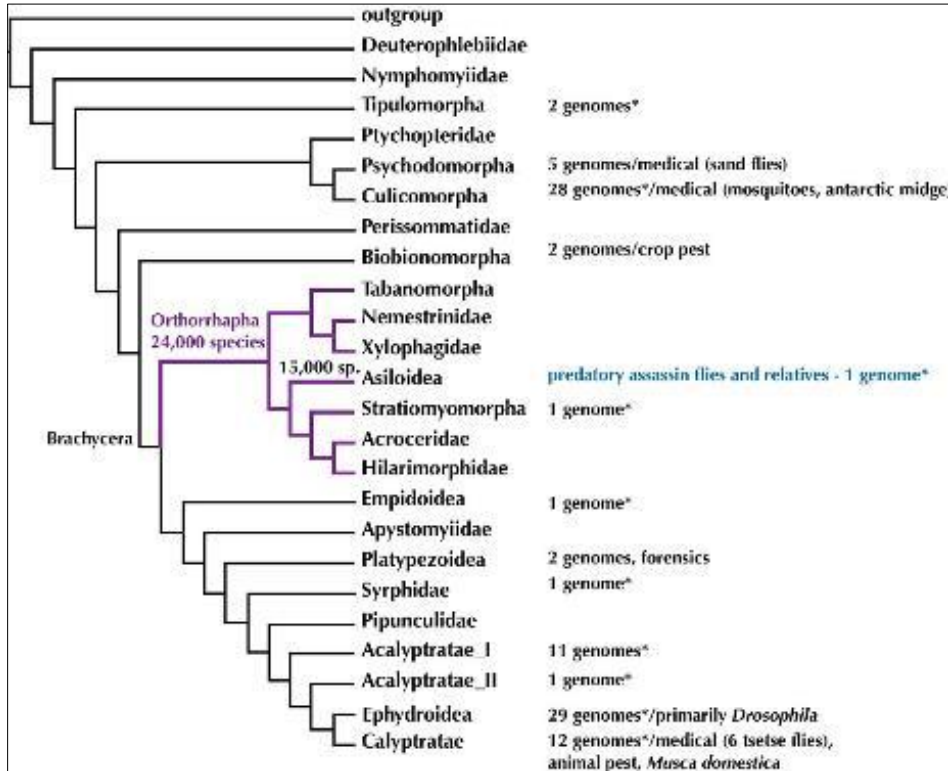


Source: https://www.researchgate.net/figure/9-Scelomyza-hirticornis-Séguy-1938-female-holotype-5-head-sublaterally_fig1_276885945

Figure 25 *Scelomyza hirticornis* Séguy, 1938, female holotype. 5-head sublaterally, reconstruction; 6-left mid femur and tibia, posteriorly; 7-left fore trochanter, femur, tibia and basitarsus, posteriorly, chaetotaxy of femur reconstructed; 8-original illustration of head by Séguy (1938), laterally; 9-ditto, frontally. All scales = 0.25 mm. For abbreviations see text (p. 385)

Postocellar bristles, absent in the most representative genera (*Geomyza* and *Opomyza*), however, are present and divergent in the genus *Anomalochaeta*. The vibrissae proper are absent, but there are a number of sub-vibrissae bristles, the first pair being particularly developed and robust, simulating a pair of vibrissae (*Geomyza*).

The antennae are short, domed-like, with a pedicel with bristles and a pectinate or bipectinate awn in species of the genus *Geomyza* or pubescent in the genus *Opomyza* (Figure 26) [16,17,18].



Source: Dikow R, Frandsen I, Turcatel M, Dikow T (2017): Phylogeny of Diptera (summary tree of hypothesis with higher taxa by Wiegmann et al. 2011) with number of completed genomes and position of Asiloidea (Fig. 1). National Museum of Natural History. Figure. <https://doi.org/10.6084/m9.figshare.4056057.v2>

Figure 26 Phylogeny of Diptera (summary tree of hypothesis with higher taxa by Wiegmann et al. 2011) with number of completed genomes and position of Asiloidea. * = includes low-coverage genomes published recently in Vicoso and Bachtrog 2015

Objective

The purpose of this manuscript is to mention the Family Liopteridae with pests of cereal crops.

2. Methods

For this, a bibliographic survey of Omomyzidae was carried out in the years 1972 to 2021. Only complete articles published in scientific journals and expanded abstracts presented at national and international scientific events were considered. Data were also obtained from platforms such as Academia.edu, Frontiers, Qeios, Biological Abstract, Publons, Dialnet, World, Wide Science and Springer.

3. Studies conducted and selected

3.1. Study 1

3.1.1. Genus *Geomyza*

Agriculturally important *Geomyza* species are generally associated with various forage grasses and only secondarily with cereals. *Geomyza* Balachowski preys on the woolly curl *Holcus lanatus* L. (Poaceae) and other species of the same genus. *Geomyza combinata* (Linnaeus, 1767), *Geomyza balachowskyi* Mesnil, 1934 and *Geomyza tripunctata* Fallen,

1823, are associated with several species of the genera *Holcus*, *Festuca*, *Agrotis*, *Lolium* and winter cereals (Figures 27,28,29,30 and 31).



Source: David Gould, Aylestone Meadows, Spearwort Fields, 04 September 2021

Figure 27 *Geomyza combinata* (Linnaeus, 1767)



Source: <https://bugguide.net/node/view/738852>

Figure 28 *Geomyza balachowskyi* Mesnil, 1934



Source: <https://jessica-joachim.com/insectes/dipteres/opomyzidae/mouche-des-graminees-geomyza-tripunctata/>

Figure 29 The Grass Fly *Geomyza tripunctata* Fallen, 1823 has a thin, elongated body. Its wings are adorned with 3 black spots. Its abdomen is black. Its head and thorax are variable in color, ranging from black to orange. The eyes are red



Source: <https://myloview.com.br/adesivo-holcus-lanatus-espigas-de-la-planta-de-heno-blanco-en-la-pradera-no-C65813B>

Figure 30 *Holcus lanatus* L. (Poaceae)



Source: <http://www.agronegocios.eu/noticias/festuca-alta-festuca-arundinacea-schreb-familia-poaceae/>

Figure 31 Tall fescue: *Festuca arundinacea* Schreb. (Family: Poaceae)

However, the behavior of *G. tripunctata* observed in Brittany is unique, the species has in fact adapted secondarily to a summer cereal and maize (Figure 32) [16,17,18].



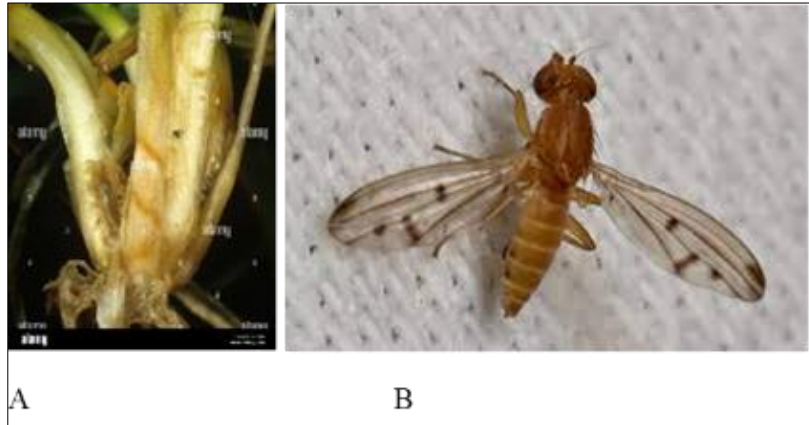
Source: Doikanoy

Figure 32 *Lolium perenne* L. or perennial ryegrass, Italian ryegrass

3.2. Study 1

3.2.1. G nero *Opomyza*

The damage manifests itself during larval development. The three species are polyphagous, but always subservient to grasses, with the number of host species being higher in the case of *Opomyza florum* (Fabricius, 1794). The attacked plants are mainly voluntary grasses present in meadows and permanent pastures, among which important forage plants widely cultivated in temporary meadows and in pastures, such as cattail (Poacea) (Figures 33A and 33B).



Source: Jan Willem van Zuijlen

Figure 33A Cereal fly *Opomyza florum* (Fabricius, 1794) spiral feeding trail entry hole in wheat bulb. Source: Contributor: Nigel Cattlin / Alamy Stock Photo / hotographer: Nigel Cattlin. **Figure 33B** *Opomyza florum* (Fabricius, 1794)

Opomyza florum is also phytophagous to the detriment of winter cereals (wheat, barley, oats, rye, triticale). Sporadic attacks on winter grains by *Opomyza germinationis* (Linnaeus, 1758) (Figure 34) [18,19,20].



Source: <https://www.flickr.com/photos/cyprinoid/3781725371/>

Figure 34 *Opomyza germinationis* (Linnaeus, 1758)

3.3. Study 3

3.3.1. *Geomyza tripunctata* Fallen, 1823

The life cycle of *G. tripunctata*, whose generations develop throughout the year, is more complex and more variable. Its secondary adaptation to maize phytophagy has aroused the interest of some authors, with the aim of identifying favorable conditions for this fly to attack cereals (Figure 35).



Source: Geomyza tripunctata-Domaine des oiseaux 29.04.2016

Figure 35 *Geomyza tripunctata* Fallen, 1823

In fact, unlike straw cereals and forage grasses, which can react to the first tillering attacks, making it possible to at least partially compensate for the damage caused before emergence, corn does not tiller and the attacked plant suffers greater damage. Corn is more predisposed to macrosystems in which corn cultivation is accompanied by diversified crops of cereals and forage plants: the fly, in fact, shows a preference for grasses. Meadows, however using early spring sowing corn crops as secondary sites (Figure 36).



Source: <https://www.flickr.com/photos/30063276@N02/3190711241/>

Figure 36 Damage caused by the species *Geomyza tripunctata* Fallen, 1823

Chemical control against *G. tripunctata* can also be carried out by chemical treatments aimed at controlling worm larvae (*Agriotes* spp.) and black oat (*Oscinella frit*), using phosphoric esters and carbamates. However, the use of chemical control, in these contexts, has the disadvantage of drastically reducing the presence of natural antagonists (Figure 37). [21,22].



Source: <http://www.eakringbirds.com/eakringbirds2/insectinfocusgeomyzatripunctata.htm>

Figure 37 Damage caused by the species *Geomyza tripunctata* Fallen, 1823

4. Conclusion

The larvae are endophytic phytophagous and develop inside the stems of herbaceous plants, most often belonging to the Poaceae family (grasses). They cause damage that leads to the destruction of the vegetative point. Only a few species of Opomyzidae cause significant damage to agriculture: the most important are *Opomyza florum* (Fabricius, 1794), *Opomyza germinationis* (Linnaeus, 1758) and *Opomyza petrei* Mesnil, 1934 in the genus *Opomyza*, and *Geomyza balachowskyi* Mesnil, 1934, *Geomyza combinata* (Linnaeus, 1767) and *Geomyza tripunctata* Fallen, 1823 in the genus *Geomyza*.

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