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Gall midges (Diptera: Cecidomyiidae) of Morocco

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Abstract. The known gall midge fauna of Morocco is composed of 57 valid species belonging to 31 genera, and four undescribed species. The fauna is relatively rich in comparison with other countries spread along the Mediterranean Sea in North Africa. The two most species rich genera are *Dasineura* Rondani, 1840, with nine species, and *Asphondylia* Loew, 1850, with five species. Most of the species occurring in Morocco are phytophagous (86.2%) and their larvae cause galls on various host plants; five species (8.6%) are mycophagous and their larvae feed mainly on fungal hyphae; three species (5.2%) are zoophagous and their larvae attack various small arthropods. Phytophagous species are associated with 52 plant species which belong to 22 plant families. About two third of host plant species are herbaceous plants and one third trees or shrubs. Usually only one species of gall midge is associated with one host plant species; two species of gall midge are associated with four host plant species. *Quercus ilex* is the host plant with the highest number of gall midges – with three gall midge species: *Contarinia ilicis* Kieffer, 1898, *C. luteola* Tavares, 1902 and *Dryomyia lichtensteinii* (Löw, 1878). Zoogeographical analysis: most species, 34 (58%) are Mediterranean, 18 species (32%) European or Eurosiberian, four species are Holarctic and two cosmopolitan. Horizontal distribution: *Psectrosema tamaricum* (Kieffer, 1912), recorded in six bioclimatic zones, is the most frequent species in Morocco. Vertical distribution: five species were found in the Atlas Mountains at altitudes between 1600 m and 2800 m a. s. l.: *Dryomyia lichtensteinii* (Löw, 1878) at 1600 m a. s. l., *Rhopalomyia navasi* Tavares, 1904 at 1800 m a. s. l., *Dasineura plicatrix* (Loew, 1850) and *Asphondylia cytisi* Frauenfeld at 2000 m a. s. l., and *Bayeriola thymicola* (Kieffer, 1888) at 2800 m a. s. l. Economic importance: *Mayetiola destructor* (Say, 1817), *M. hordei* Kieffer, 1909 and *M. avenae* (Marchal, 1895) cause serious damage to cereals; of them *M. destructor* is the most important pest. *Contarinia nasturtii* (Kieffer, 1888), *Dasineura napi* (Loew, 1850), *Contarinia pyrivora* (Riley, 1886), *Dasineura plicatrix* (Loew, 1850) and *Lasioptera rubi* (Schrank, 1803) are potential pests of agricultural plants. An annotated list of species of gall midges, a list of host plant species with associated gall midge species and illustrations of galls of 52 species of gall midges found in Morocco are given.

Key words. Faunistics, zoogeography, biogeography, species richness, distribution, plant-animal interactions, economic importance, Diptera, Cecidomyiidae, Morocco, North Africa, Mediterranean, Palaearctic Region.

INTRODUCTION

At the beginning of the year 2015 Kawtar Kettani invited us to collaborate on the preparation of the list of the family Cecidomyiidae for the project "Catalog of Diptera of Morocco". She addressed us just in the time when we have worked on the manuscript devoted to this subject. Our cooperation led to publication of two articles: a short review of the family Cecidomyiidae in her project, including data on the occurrence of each species in one of seven parts of Morocco, and the present article including data on the biology, shape of the gall and host plant of each gall midge species together with zoogeographical analysis of all obtained data.

The family Cecidomyiidae (Diptera: Nematocera) is one of the largest families of Diptera. Gagné & Jaschhof (2017) list 6,590 valid species belonging to 812 genera of living and fossil gall midges in the world. The Cecidomyiidae are currently classified under six subfamilies: Catotrichinae, Lestremiinae, Micromyinae, Winnertziinae, Porricondylinae and Cecidomyiinae; the last is the

most species rich subfamily. Only the larvae of Cecidomyiinae are able to induce galls on host plants, larvae of other subfamilies are mycophagous or mycosaprophagous. Adults are usually very small, inconspicuous flies but the galls (in Latin: cecidium) that are caused by their larvae on various organs of host plants are often strange and striking formations (hence the common name "gall midges"). Larvae of some species live free in flower heads or stems of plants without making galls and others are mycophagous or saprophagous. Zoophagous larvae are predators of larvae of other gall midges, of aphids, mites, coccids, or other small arthropods and some of them may be used in biological control of pests. Larvae of some species live as inquilines in galls of other gall midges or other insects. The biology of many species of gall midges caught as adults in nature is completely unknown (Skuhravá 1986, 1997, Skuhravá et al. 1984a, b, Skuhravá & Skuhravý 2010). In Europe about sixty gall midge species are economically important, of these forty species cause damage to agricultural plants (Darvas et al. 2000) and twenty to forest trees (Skuhravá & Roques 2000). More than 3,113 gall midge species are known in the Palaearctic region (Skuhravá 2006).

The first summary of scattered data on the occurrence of gall midges and their galls in Morocco was made by Skuhravá (1986) in the Catalogue of Palaearctic Diptera. She listed 14 species of gall midges known to occur in Morocco up to that time in accessible literature. Since then several new records of gall midge species have been found in old papers of C. Houard and J. M. Mimeur and several Moroccan researchers. Nevertheless, the fauna of the gall midges of Morocco is still poorly known. We hope that our paper will attract the attention of entomologists to this interesting group of insects inducing galls on host plants.

HISTORY OF RESEARCH

Five European and several Moroccan researchers contributed to knowledge of the family Cecidomyiidae in Morocco in the past.

Alessandro Trotter (1874–1967), the Italian cecidologist, was the first to publish a paper dealing with galls of Morocco. Trotter (1904) recorded galls of 11 species of gall causers, belonging to various taxonomical groups, that caused galls on six host plants. Two species belong to gall midges: a gall on *Arthrocnemum glaucum* (now correctly: *Arthrocnemum macrostachyum*) caused by a "Cecidomyid", which was later described as *Houardiella salicorniae* Kieffer, 1912, and galls on leaves of *Quercus coccifera* which are caused by *Phyllodiplosis cocciferae* (Tavares, 1901).

Clodomir Houard (1873–1943), the excellent French botanist and cecidologist, first worked at the Institute of Botany in Caen, and later was the head of the Chair of Botany and of the Institute of Botany at Strasbourg. Houard collected plant galls in various parts of the world and identified galls on plants found by various researchers in Africa, Indonesia, India, North and South America. He summarized his knowledge of plant galls in several large publications (Houard 1909, 1912, 1913a, b, 1922–1923). In addition, he was able to draw the shape of galls according to fresh collected material. He influenced importantly many researchers in all the world in the twentieth century.

Houard (1912) summarized knowledge about galls on plants recorded in Africa, obtained till that time. Only three species of gall midges were known at that time in Morocco*: Dasineura ericaescopariae*, *Houardiella salicorniae* and *Phyllodiplosis cocciferae*. Later Houard (1913a, b) published articles devoted to the galls found in Morocco that are now deposited in the collections of galls in the National Museum of Natural History in Paris. He gave 14 species that cause galls on various organs of four host plants: *Quercus lusitanica*, *Q. humilis*, *Salix pedicellata* and *Vitex agnus-castus*. Nine species belong to Cynipidae (Hymenoptera), four to Eriophyidae (Acarina) and one to Coccoidea (Hemiptera). After several years Houard (1917) recorded ten species inducing galls on twenty one host plants collected in North Africa – in Algeria and Morocco. Of them only

one species belonged to gall midges – *Schizomyia buboniae*. Houard (1919) in his report on galls deposited in the Natural History Museum in Paris gave one species of gall midge – *Contarinia ilicis* galls of which were recorded by J. Pitard in Morocco. Later Houard (1921) recorded galls of two other species of gall midge from Morocco: *Asphondylia capparis* and *Lasioptera carophila*. Houard (1922) summarized results of investigations of C. J. Pitard in Morocco during the years 1912 and 1913. He found galls of 34 species belonging to various taxonomical groups in various parts of Morocco. These galls are deposited in the Natural History Museum in Paris. C. J. Pitard found in Morocco galls of thirteen species of gall midges. The identity of four of mthese species is not known and they remain undescribed till present. Later Houard (1923) identified galls that were collected in Algeria and Morocco by two researchers, M. René Maire and M. L. Ducellier, and published results in a contribution where galls of five species of gall midges are recorded from Morocco.

Jean Marie Mimeur (1898–1946), an entomologist at the Institute of Science, Laboratory of Colonial Agricultural Entomology and National Museum of Natural History in Paris, collected galls in various parts of Morocco and summarized results of his investigations in a manuscript. The book of J.-M. Mimeur summarizing knowledge of galls caused by various animals on plants in Morocco was published four years after the death of the author (Mimeur 1949). Among many causers of galls belonging to various groups of animals, he gave 33 species of the family Cecidomyiidae causing galls on host plants in Morocco.

Edwin Möhn (1928–2008), the outstanding German entomologist, the chief curator at the Staatliches Museum für Naturkunde in Stuttgart, described three species of gall midges originated from Morocco on the basis of larvae only (Möhn 1971). Adults of these species remain unknown till present.

Mathias Jaschhof (1998) in his book recorded five species of the subfamily Lestremiinae which were found in Morocco.

Several Moroccan researchers contributed to the knowledge of gall midges, mainly to the knowledge of economically important species. Hafraoui (1968) as the first recorded *Resseliella oleisuga*, a pest of olive trees. Mouna (1998) gave a list of 14 species of gall midges. Amri et al. (1992), Azzam et al. (1997) and mainly El Bouhssini et al. (1988–1999) studied resistence and possibilities of supressing the serious pest of cereals - *Mayetiola destructor* using genetic methods. Naber et al. (2000, 2003) studied genetic variation among populations of *Mayetiola destructor*. Lhaloui et al. (1992, 2001) have studied for several years the complex of gall midges of the genus *Mayetiola* and their influence on the production of cereals in Morocco. They summarized results of their studies in a comprehensive paper (Lhaloui et al. 2005).

STUDY AREA

Morocco, officially the Kingdom of Morocco, is the country in North Africa surrounded by the Atlantic Ocean in the west and by the Mediterranean Sea in the north. It is bordered by Algeria in the east and by Sahara in the south. Since Morocco controls most of Sahara, its southern boundary is with Mauritania. Morocco occupies an area of 446,550 km^2. It spans from the Atlantic Ocean, to mountainous areas, to the Sahara desert. The Atlas Mountains are located mainly in the center and the south of the country, the Rif Mountains in the north of the country. The highest peak is the mount Toubkal, 4,167 m a. s. l., located in southwestern Morocco in the Toubkal National Park. It is the highest peak in the Atlas Mountains and of the North Africa. Most of the southeast part of the country is in the Sahara Desert. Forests cover about 12% of the land, arable land accounts for 18% and about 5% of the land is irrigated. Morocco has eleven national parks that preserve the biodiversity of this country.

Morocco is situated at the floristic crossroads between the coastlines of the Atlantic Ocean and the Mediterranean Sea. This has resulted in a high diversity of ecoregions related to Mediterranean-type climates occurring along the coast; the moist oceanic climate of the north contrasts with the desert Saharan environments in the south. The flora of Morocco contains about 3,913 taxa including 1,298 subspecies in 981 genera and 155 families (Benabid 2000, Fennane & Tattou

2012). Morocco is divided into seven bioclimatic zones according to the different climatic conditions: Rif Mountains (RIF), Morocco oriental (MO), Atlantic plains (PA), Moyen Atlas (MA), Haut Atlas (HA) (= Grand Atlas), Anti-Atlas (AA) and Maroc Sahara Desert (MS) (Fig. 1).

MATERIAL AND METHODS

We gathered data on the occurrence of gall midges occurring in Morocco from articles of various researchers, published over a period of more than a hundred t years, from the beginning of the 20th century until the present. Most of the species of gall midges recorded in Morocco were found by collecting galls from different host plants. Some species of gall midges are known only on the basis of the description of galls, others on the basis of larvae and a few on the basis of adults. It will be needful to find galls of such species which are based on galls or larvae and try to rear adults. It is the best way to verify the identity of the causers and inhabitants of the galls. Identification of galls is based on keys of Houard (1909, 1913a, 1922–1923). The nomenclature of gall midge species is based on Gagné & Jaschhof (2017), the nomenclature of host plant species on Tutin et al. (1964–1980) and The Plant List (TPL 2013). The economic importance of gall midge species was assessed based on information in Barnes (1946a, b, 1948a, b, 1949, 1951, 1956), Nijveldt (1969), Darvas et al. (2000) and Skuhravá & Roques (2000), zoogeography on Skuhravá & Skuhravý (2010).

Distribution is based on data of occurrence of gall midges in the Palaearctic region (Skuhravá 1986), in the world (Gagné & Jaschhof 2017), on analysis of areas of distribution (Skuhravá 1980, 1984, 1987) and on results of investigations of M. Skuhravá and V. Skuhravý carried out in the years 1955–2013 at 1898 localities situated in twenty three countries of Europe and twelve islands in the Mediterranean Sea which were published in series of articles cited in Skuhravá & Skuhravý (2010); further on data given in Jaschhof (1998), Fedotova (2000), Mirumian (2011), Skuhravá & Skuhravý (2016a, b) and Skuhravá et al. (2013, 2014a, b).

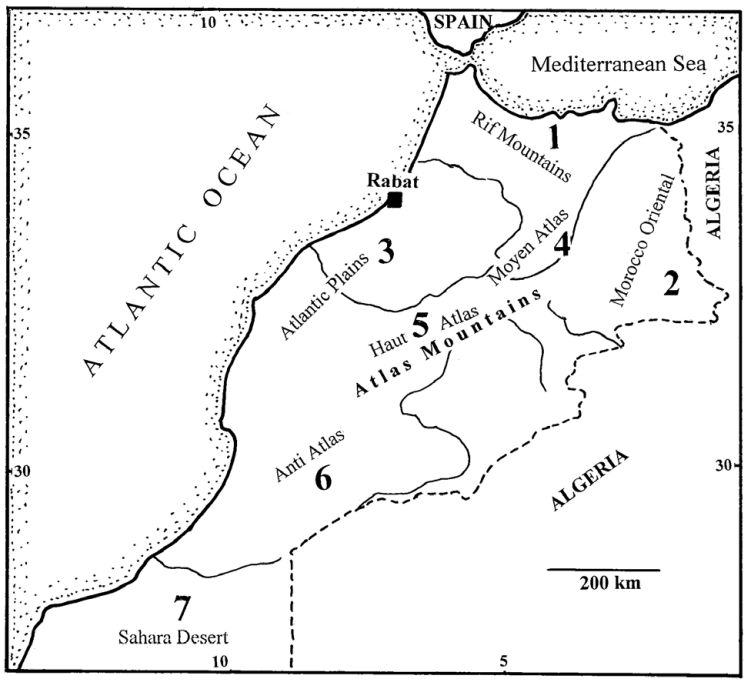


Fig. 1. Morocco, with adjacent countries, divided into seven bioclimatic zones according to the different climatic conditions: 1 – Rif Mountains (RIF), 2 – Morocco Oriental (MO), 3 – Atlantic Plains (PA), 4 – Moyen Atlas (MA), 5 – Haut Atlas (HA), 6 – Anti- Atlas (AA), 7 – Maroc Sahara Desert (MS).

RESULTS

The fauna of gall midges of Morocco includes 57 valid species belonging to 31 genera and four undescribed species which were found in seven areas of Morocco (Fig. 1). In the following part we present an annotated list of all gall midge species recorded in Morocco and a list of host plant species with associated gall midge species. At the end we evaluate all data obtained in Morocco from the zoogeographical point of view.

Annotated list

The following data are given for each species: species name, author and date of description, short description of the biology (if known), desciption of the gall, host plant species and family, occurrence in Morocco with names of localities where galls were found in the past, type of distribution and references to publications of researches in Morocco.

Subfamily Lestremiinae

Lestremia parvostylia Jaschhof, 1994

Occurrence. Jaschhof (1994: 123): Abeino.
Distribution. Estonia, Latvia, Hungary, Morocco.

Subfamily Micromyinae

Campylomyza flavipes Meigen, 1818

Occurrence. Jaschhof (1998: 160): Hoher Atlas, Telouet, 4 April 1993, leg. Jeske.
Distribution. Holarctic, New Zealand.

Campylomyza fusca Winnertz, 1853

Occurrence. Jaschhof (1998: 164): Hoher Atlas, Telouet, 4 April 1993, leg. Jeske.
Distribution. Holarctic.

Campylomyza mohrigi Jaschhof, 2009

Occurrence. Jaschhof (2009: 109): Morocco, no accurate locality.
Distribution. Palaearctic.

Monardia toxicodendri (Felt, 1907)

Occurrence. Jaschhof (1998: 309): Morocco, no accurate locality.
Distribution. Holarctic, Mexico.

Subfamily Cecidomyiinae

Asphondylia capparis Rübsaamen, 1893

Larvae develop in swollen flower buds of *Capparis spinosa* L. (Capparidaceae) (Fig. 2). Rübsaamen (1893) described this species based on material collected in Sicily (Italy). Attacked flower buds are swollen, malformed and remaining shut. Several larvae develop in one gall where they pupate. Several overlapping generations develop per year.

Occurrence. Houard (1921: 120): Fez, 1913, leg. J. Pitard.
Distribution. Mediterranean.

Asphondylia ?*cytisi* Frauenfeld, 1873

Larvae produce galls on buds of *Lembotropis nigricans* (L.) Griseb. (Syn. *Cytisus nigricans* L.) and related species of the genus *Cytisus* (Fabaceae). It is necessary to collect new material of galls on *Cytisus purgans* from Morocco, rear adults and identify the causer to be sure that it is actually this species.
Occurrence. Mimeur (1949: 181): galls on *Cytisus purgans* (L.) Benth (as Cecidomyiidae sp.): Tanzat, 1800 m a. s. l., Amalou Nou Mansour, Djebel Sargho, 2000 m a. s. l.
Distribution. European.

Asphondylia punica Marchal, 1897

Larvae cause large galls, up to several centimeters long, on the stems of *Atriplex halimus* L. (Chenopodiaceae) including the whole shoot on which all flower buds are changed into small galls, each with one larva (Fig. 3). Dorchin et al. (2014) redescribed *Asphondylia punica* and made *A. conglomerata a* junior synonym of *A. punica.*
Occurrence. Houard (1922: 89): Maroc meridional: Djebel Tagla, Zousfana, 1913, galls on *Atriplex parvifolia* Lowe, leg. C. J. Pitard. Mimeur (1949: 168): Agdz, galls on *Atriplex halimus* L.
Distribution. Mediterranean.

Asphondylia scrophulariae Schiner, 1856

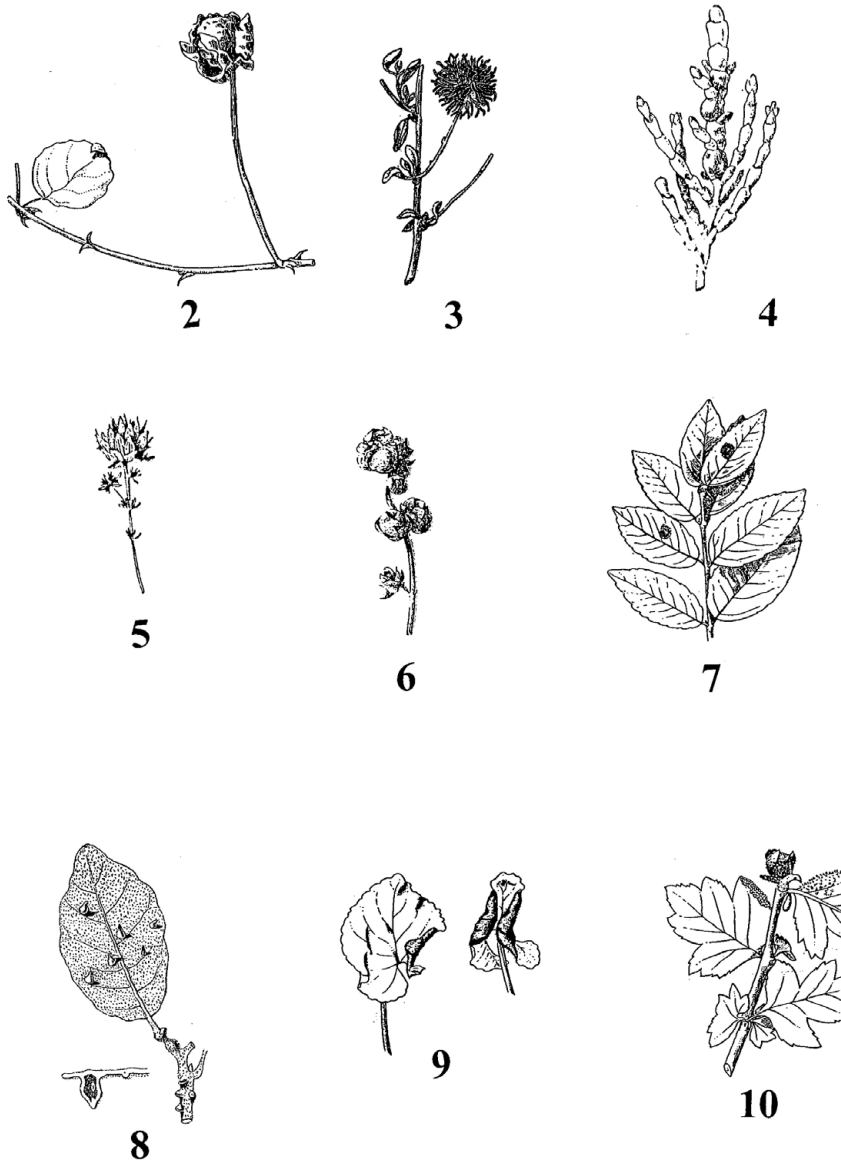
A solitary larva develops inside swollen flower bud of *Scrophularia canina* L. (Scrophulariaceae) where it also pupates.
Occurrence. Mimeur (1949: 169): galls on *Scrophularia canina* L.: Rabat, Arcila.
Distribution. Mediterranean.

Asphondylia verbasci (Vallot, 1827)

Larvae cause flower bud galls on various species of *Verbascum* spp. (Scrophulariaceae). Two or more generations develop per year.
Occurrence. Mimeur (1949: 168): galls on *Verbascum sinuatum* L.: Mamora, Rabat, Zaër.
Distribution. Mediterranean.

Baldratia salicorniae Kieffer, 1897

Larvae cause swellings on stems of *Sarcocornia fruticosa* (L.) A. J. Scott (syn. *Arthrocnemum fruticosum* (L.) Moq., *Salicornia fruticosa* L.) (Chenopodiaceae) (Fig. 4). Each gall occupies only a single internode of the stem and one larva develops in a chamber inside the gall. Probably more than one generation develops in a year. Pupation takes place in the gall, adults emerge from April until the summer.
Occurrence. Möhn (1969: 167): Melilla, Bocana, galls on *Arthrocnemum fruticosum*, 24 September 1932, collector not given; Rabat, 2 April 1936, galls on *Arthrocnemum perenne*, collector not given. Mimeur (1949: 160): Rabat, Salé, Bou-Regreg: galls on *Salicornia arabica* L. (as *Baldratia hyalina*).
Distribution. Mediterranean.



Figs. 2–9. Galls of gall midges found in Morocco. 2 – Gall of *Asphondylia capparis* on flower bud of *Capparis spinosa.* 3 – Gall of *Asphondylia punica* on stem of *Atriplex halimus.* 4 – Galls of *Baldratia salicorniae* on segments on the stem of *Sarcocornia fruticosa*. 5 – Gall of *Bayeriola thymicola* on vegetative tip of *Thymus hirtus.* 6 – Galls of *Blastomyia origani* on leaf buds of *Origanum glandulosum.* 7 – Galls of *Braueriella phillyreae* on leaves of *Phillyrea latifolia.* 8 – Galls of *Contarinia ilicis* on leaves and galls of *Contarinia luteola* on leaf stalks and branches of *Quercus ilex.* 9 – Galls of *Dasineura affinis* on leaf margins of *Viola reichenbachiana.* 10 – Gall of *Dasineura crataegi* on vegetative tip of *Crataegus oxyacantha*. All figures are original drawings taken from publications by Houard (1909; Fig. 8), Houard (1912; Figs. 4, 5), Houard (1921; Fig. 2), Houard (1922; Fig. 3), Houard (1923; Fig. 6), Mimeur (1949; Figs. 7, 9, 10).

Bayeriola thymicola (Kieffer, 1888)

Larvae produce terminal or axillary rosette galls on *Thymus serpyllum* L. (Lamiaceae) (Fig. 5). Two or more generations develop per year.
Occurrece. Houard (1923: 149): Grand Atlas, Reraya, 2800 m a. s. l., 23 July 1922, galls on *Thymus serpyllum* L. var. *atlanticus* Ball., leg. R. Maire. Mimeur (1949: 171): galls on *Thymus hirtus* Willd.: Ifrane, Azrou, bordj-Doumergue, Timhadite, Aguuelmaen, Sidi-Ali. Galls on *Thymus ciliatus* (Desf.) Benth: Oujda, Djebel-Hamra, Itzer.
Distribution. European, Mediterranean.

Blastomyia origani (Tavares, 1901)

Larvae cause large galls on *Origanum vulgare virens* Hoffm. & Link (Lamiaceae) (Fig. 6).
Occurrence. Houard (1922: 99): Maroc Central: Col de Bouchtata, Zalagh (Mouret), galls on *Origanum compactum* Benth., leg. C. J. Pitard, 1913.
Distribution. Mediterranean.

Braueriella phillyreae (F. Löw, 1877)

Larvae cause pustule galls on leaves of *Phillyrea latifolia* L. (Oleaceae) where they also pupate (Fig. 7). Only one generation develops per year.
Occurrence. Houard (1922: 97): Maroc septentrional: Djebel Kébir, galls on *Phillyrea media* L., leg. C. J. Pitard, 1912; Houard (1923: 147): Cap Ghiz, 31 March 1922, leg. R. Maire. Mimeur (1949: 172, Figs. 240–247): galls on *Phillyrea angustifolia* L. and *P. latifolia* Maire: Beni-Snassen, Djebel Said, Larache, Zoumi, Ouezzane, Tahala, Taza, Zaer, Mehdia, Sehoul, Tadla.
Distribution. Mediterranean.

Contarinia ilicis Kieffer, 1898

Larvae cause small galls on leaves of *Quercus ilex* L. (Fagaceae) with an opening on small pipe on the lower part of leaves (Fig. 8). Only one generation develops per year.
Occurrence. Houard (1919: 81): Morocco, without locality, leg. J. Pitard, 1913. Mimeur (1949: 175): galls on *Quercus ilex* L.: Beni-Snassen, Ras Foughal, Ifrane, El-Harcha, Bou-Mzil, Monts Zaian, Agoumi n'Ait Mguild.
Distribution. Mediterranean.

Contarinia luteola Tavares, 1902

Larvae cause small cylindrical galls on bark of young shoots and leaf petioles of *Quercus ilex* L. and *Q. coccifera* L. (Fagaceae) (Fig. 8). Only one generation develops per year.
Occurrence. Mimeur (1949: 175): galls on *Quercus ilex* L.: Ifrane, El Harcha, Djaba, Imouzzer--du-Kandar, Tafechna.
Distribution. Mediterranean.

Contarinia nasturtii (Kieffer, 1888)

This is a polyphagous species developing on various species and genera of the family Brassicaceae, mainly on *Raphanus raphanistrum* L. Several generations develop a year. Pupation takes place in the soil. It is a pest, mainly in Europe (Darvas et al. 2000).

Occurrence. Mouna (1998): Morocco, no accurate locality.
Distribution. European.

Contarinia pyrivora (Riley, 1886)

Larvae develop in young fruits of pears *Pyrus communis* L. (Rosaceae). They live inside the misshapen and enlarged fruitlets which dry up and crack and fall to the ground. Attacked fruits are unshapely and enlarged. One generation develops per year. It is a major pest of pear in Europe (Darvas et al. 2000).
Occurrence. Mouna (1998): Morocco, no accurate locality.
Distribution. Eurosiberian (Holarctic).

Dasineura affinis (Kieffer, 1886)

Larvae cause galls on leaves of *Viola reichenbachiana* Jord. ex Boreau (= *V. sylvestris* Lam.) (Violaceae) (Fig. 9). Leaf margins are rolled up and thickened. Several larvae develop in one roll where they pupate in white cocoon. Two or more generations develop per year.
Occurrence. Mimeur (1949: 161): galls occur very frequently on cultivated *Viola odorata* L. in the Mediterrannean, central and Atlantic parts of the country (Figs. 225–228): Oujda, Tahala, Fés, Tanger, Rharb, Port-Lyautey, Rabat, Fédala, Marchand, Casablanca, Mazagan, Settat, Oued-Zem, Mogador.
Distribution. European, known to occur in many countries, North Africa (Algeria, Egypt), Asia (Kazakhstan, Turkey).

Dasineura asparagi (Tavares, 1902)

Larvae cause galls at tips of young branches of *Asparagus aphyllus* L. (Liliaceae). Two generations develop per year.
Occurrence. Mimeur (1949: 161): Rabat, Zaër, Chaouia: galls on *Asparagus aphyllus* L.
Distribution. Mediterranean.

Dasineura crataegi (Winnertz, 1853)

Larvae cause terminal rosette leaf galls on *Crataegus laevigata* (Poiret) DC. (= *C. oxyacantha* L.) and *C. monogyna* Jacq. (Rosaceae) (Fig. 10). Some larvae pupate in galls, some larvae leave galls and pupate in the soil. Two generations develop per year.
Occurrence. Mimeur (1949: 163, Fig. 229): galls on *Crataegus oxyacantha* L.: Berkane, Massif des Beni-Snassen, Tahala, Ifrane, Aguelmane de Sidi-Ali, Fes, Agoumi n'Ait Mguild, Tarhzirt, Argana, Imi-n-Tanoute.
Distribution. European, as far as Turkey.

Dasineura ericaescopariae (Dufour, 1837)

Larvae cause galls on vegetative tips of *Erica scoparia* L., *Erica arborea* L. and other species (Ericaceae) (Fig. 11). Each gall contains many larvae. Pupation takes place in the gall. Only one generation develops per year.
Occurrence. Houard (1912: 147): galls on *Erica scoparia*, Cap Spartel, leg. F. Sohde; Rübsaamen (1899: 272, n. 92).
Distribution. Mediterranean.

Dasineura helianthemi (Hardy, 1850)

Larvae cause galls on leaf buds of *Helianthemum nummularium* (L.) Mill. Cistaceae). Harris (2009) designated a neotype after analysing morphological characters of reared adults and larvae coming to the conclusion that this species belongs to the genus *Dasineura*.
Occurrence. Mimeur (1949: 174): as *Contarinia helianthemi*, galls on *Helianthemum guttatum* (L.) Mill.: Rharb, Momora, Zaer.
Distribution. European.

Dasineura napi (Loew, 1850)

Larvae live gregariously in swollen and prematurely ripening and yellowing siliquas of *Brassica napus* L. ssp. *napus*, *B. oleracea* L. and other host plant species of the family Brassicaceae. In Europe it is a serious pest of oilseed rape in rape-growing areas (Darvas et al. 2000). Two to four generations develop per year. Larvae pupate in the soil.
Occurrence. Mouna (1998): Morocco, no accurate locality.
Distribution. European.

Dasineura ?periclymeni (Rübsaamen, 1889)

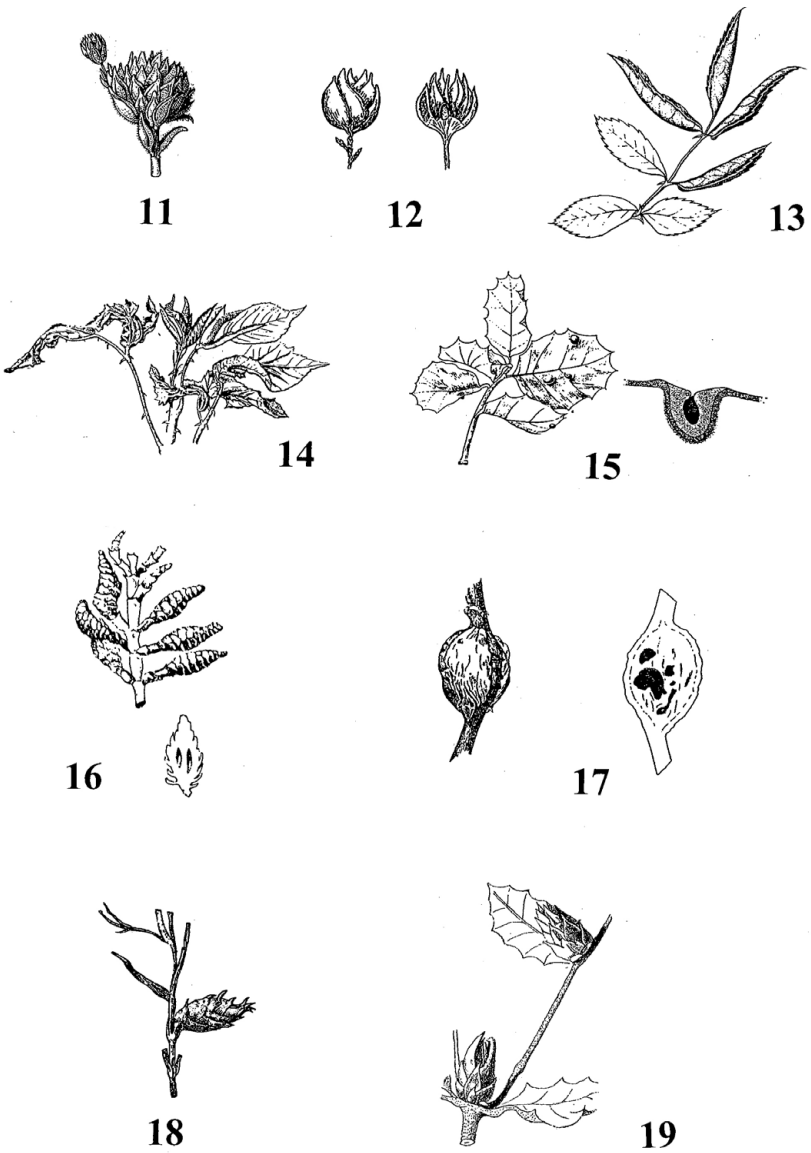
Larvae live in fleshy, thickened leaf rolled margins on *Lonicera periclymenum* L. (Caprifoliaceae or Loniceraceae). It is necessary to collect new material of galls, rear adults and identify the causer.
Occurrence. Mimeur (1949: 166): as *Perrisia* sp. on *Lonicera implexa* Aiton: Rabat, Yquem, Grou and Korifla. Galls on *Lonicera biflora* Desf.: Berkane, Chellah.
Distribution. European.

Dasineura plicatrix (Loew, 1850)

Larvae cause galls formed by contorted and twisted young leaves of *Rubus caesius* L. and other species (Rosaceae) (Fig. 14). Two generations develop per year. Larvae pupate in the soil. In Europe it is a pest on blackberry, loganberry and raspberry (Darvas et al. 2000).
Occurrence. Mimeur (1949: 164, Figs. 230–231): galls on *Rubus ulmifolius* Shott: Massif des Beni-Snassen, Azrou, Ifrane, Monts Zaian, El-Harcha, Oulmés, Khénifra, 1800 m a. s. l., Lareche, Dar-Xauen, Korifla, Grou, Yquem, Malah, Rabat, Bigoudine, Tizi Machou, 2000 m a. s. l.
Distribution. European, with large area spread as far as North Africa, also up to Turkey. Galls of this species have been confirmed from North America – in southwestern British Columbia (Sinclair et al. 2009).

Dasineura rosae (Loew, 1850)

Larvae cause galls on leaflets of *Rosa canina* L. and some other species of *Rosa* (Rosaceae) (Fig. 13). Two or more generations develop per year. Larvae pupate in the soil.
Occurrence. Mimeur (1949: 165, Figs. 232, 233): galls on *Rosa* sp.: Ifrane, Aguelmane de Sidi--Ali, Aguelmane-Azigza, Zaad, borj-Doumergue, Bekrite, Tizi Machou.
Distribution. Widespread in Europe; Asia: Kazakhstan, Russian Far East.



Figs. 11–19. Galls of gall midges found in Morocco. 11 – Galls of *Dasineura ericaescopariae* on vegetative tip of *Erica scoparia.* 12 – Gall of *Etsuhoa thuriferae* on vegetative tip of *Juniperus thurifera.* 13 – Galls of *Dasineura rosae* on leaflets of *Rosa* sp. 14 – Galls of *Dasineura plicatrix* on young leaves of *Rubus ulmifolius*. 15 – Galls of *Dryomyia lichtensteinii* on leaves of *Quercus ilex*, with cross-section of one gall on the right. 16 – Lateral branches of *Sarcocornia fruticosa* changed into galls by *Houardiella salicorniae*, with cross-section of one gall on the right. 17 – Gall on the stem of *Rubus* sp. caused by *Lasioptera rubi*, with cross-section of the gall on the right. 18 – Several malformed leaves of *Cynodon dactylon* massed together to form the gall of *Orseolia cynodontis*. 19 – Swollen leaf buds of *Quercus coccifera* induced by *Phyllodiplosis cocciferae*. All figures are original drawings taken from publications by Houard (1909; Figs. 11, 19), Trotter (1904; Fig. 16), Houard (1922; Fig. 18), Mimeur (1949; Figs. 13, 14, 15, 17) and Skuhravá (1996; Fig. 12).

Dicrodiplosis pseudococci (Felt, 1914)

Larvae are predators of *Planococcus citri* (Risso) (= *Pseudococcus citri* Risso (Hemiptera: Pseudococcidae).
Occurrence. Harris (1968: 439): Asni, 20 October 1932; Rabat, 5 October 1949; Rubus-Sale, 11 August 1950.
Distribution. Mediterranean, Middle East, Nigeria.

Dryomyia lichtensteinii (F. Löw, 1878)

Larvae cause galls on leaves of *Quercus ilex* L. and *Q. suber* L. (Fagaceae) (Fig. 15). The gall is ovoid, situated on the lower side, thick-walled, with one chamber inside and with a slit opening on the upper side of the leaf. Larvae pupate in the gall. Only one generation develops per year.
Occurrence. Mimeur (1949: 166): galls on *Quercus ilex* L.: Debdou, Ras Foughal, Taza, El-Harcha, Oulmes, Azrou, Aguelmane, Azigza, Ifrane, Imouzzer-du-Kandar, Tizi n'Tretten, l'Ayachi, 1600 m a. s. l., Ida-ou Tanane, Azilal.
Distribution. Mediterranean.

Etsuhoa thuriferae Skuhravá, 1996

Larvae cause rounded or ovoid galls at the tips of shoots on *Juniperus thurifera* L. (Cupressaceae) (Fig. 12). The gall includes a shortened shoot and consists of several shortened leaves. Only one larva develops inside the gall where it also pupates. One generation develops per year.
Occurrence. Mimeur (1949: 179): galls on *Juniperus thurifera* L. (as Cecidomyiidae sp.): Sidi--Chamarouch, Bou-Jafar.
Distribution. Mediterranean.

Feltiella acarisuga (Vallot, 1827)

Larvae are predators of mites, almost exclusively on red spider mites (Acarina: Tetranychidae). Larvae occur in colonies of spider mites where they feed on eggs, nymphs and adult spider mites. They are used in biological control. Several generations develop a year. Full-grown larvae spin a white cocoon either on the leaf, or drop to the soil where they pupate (Osborne et al. 2002).
Occurrence. Gagné (1995: 24): Morocco: Rabat, examined material (male and female) originated from Rabat, associated with *Tetranychus turkestani* Ugarov et Nikolski.
Distribution. Cosmopolitan.

Gephyraulus diplotaxis (Solinas, 1982)

Larvae cause flower bud galls on *Diplotaxis muralis* D.C. (Brassicaceae).
Occurrence. Houard (1922: 92): Maroc Meridional: Oasis de Fignig and Djebel Onazzani, galls on *Diplotaxis* sp., as „Cecidomyide", leg. C. J. Pitard, 1913. Mimeur (1949: 181): galls on *Diplotaxis catholica* (L.) DC: (as Cecidomyiidae sp.): Vallée de l'oued Korifla, Sidi-Bouknadel.
Distribution. Mediterranean.

Gephyraulus raphanistri (Kieffer, 1886)

White larvae develop gregariously in unopened, swollen flower buds of *Raphanus raphanistrum* L. and other genera of Brassicaceae. Two generations develop per year. Larvae hibernate and pupate in the soil (Vitou et al. 2008).

Occurrence. Houard (1923: 132): Dunes de Mogador, 28 March 1922, galls on *Raphanus raphanistrum* L., leg. R. Maire. Mimeur (1949: 160): galls on *Erucastrum varium* Durieu: Rharb, Ito; galls on *Raphanus raphanistrum* L.: Skhirat, Bouznika; also on *Brassica napus* L., *Brassica oleracea* L. and *B. nigra* Koch.
Distribution. European.

Houardiella salicorniae Kieffer, 1912

Larvae cause swellings on lateral branches of *Sarcocornia fruticosa* (L.) A. J. Scott (Syn. *Arthrocnemum fruticosum* (L.) Moq.) (Chenopodiaceae), up to 10 to 15 mm long, 5 – 6 mm in diameter, including several internodes , with one or two chambersi nside where larvae develop and also pupate (Fig. 16). One or two generations develop per year.
Occurrence. Trotter (1904: 14): Tingis near Tanger (as Cecidomyid, a gall on *Arthrocnemum glaucum* Ung., with a figure of the gall showing swollen lateral branches). Mimeur (1949: 176): galls on *Salicornia arabica* L.: Rabat, Salé, Bou-Regreg. Galls on *Arthrocnemum glaucum* (Del) Ung. Stern.: Tanger, Moulouya, Loukos, Larache, Bou-Regreg, Rabat, Salé, Ksob, Ameur, Mogador, Agadir.
Distribution. Mediterranean.

Iteomyia major (Kieffer, 1889)

Larvae cause galls in the form of irregular swellings, plurilocular, whitish and hard, which are situated on leaf veins of *Salix aurita* L. and *S. cinerea* L. (Salicaceae). Only one generation develops per year.
Occurrence. Mimeur (1949: 169): galls on *Salix pedicellata* L.: Legzel, Korifla, Grou. It is necessary to collect new material of galls, rear adults and identify the causer.
Distribution. Europaean.

Jaapiella bryoniae (Bouché, 1847)

Larvae cause large leaf bud galls galls on *Bryonia cretica* subsp. *dioica* (Jacq.) Tutin (Cucurbitaceae). Larvae pupate in white cocoons in the gall. Two or more generations develop per year.
Occurrence. Mimeur (1949: 163): galls on *Bryonia cretica* subsp. *dioica* Jacq.: Tahala, Fés, Khemisset, Monod, Larache, Ouezzane, Sidi-Bouknadel, Mehdia, Temara, Sjkhira, Pont-Blondin, Boulhaut, Marchand, Safi, Agadir.
Distribution. European.

Lasioptera berlesiana Paoli, 1907

Larvae live as inquilines in the fruits of *Olea europaea* L. (Oleaceae) damaged by the fly *Bactrocera* (*Dacus*) *oleae* Gmelin (Diptera: Tephritidae).
Occurrence. Sacantanis (1953): Morocco, no accurate locality.
Distribution. Mediterranean.

Lasioptera rubi (Schrank, 1803)

Larvae develop gregariously in hard woody swellings on stems of *Rubus idaeus* L. and other *Rubus* species (Rosaceae) (Fig. 17). Larvae pupate in the gall. Only one generation develops per year. It is a minor, but widespread pest on *Rubus* species (Darvas et al. 2000).

Occurrence. Mimeur (1949: 158): galls on *Rubus ulmifolius* Schoot.: Ifrane, Taza, Tinkert, N'Fis, Oumer-Rbia, Tarhzirt, Djebel Tardema.
Distribution. Eurosiberian.

Lasioptera thapsiae Kieffer, 1898

Kieffer (1898) described this species and stated that larvae produce large multilocular swellings at the base of umbels on *Thapsia* sp. (Apiaceae). Material for description originated from Algeria.
Occurrence. Houard (1921: 124): as *Lasioptera carophila*, gall 12 mm in diameter, on *Elaoselinum meioides* Koch: Tanger; Houard (1923: 147): as *Lasioptera carophila*, gall 13 mm in diameter: d'Ito, 1400 m a. s. l., 25 July 1921, leg. R. Maire; Mimeur (1949: 159): galls on *Elaeoselinum thapsoides* (Desf.) Maire (Figs. 221–224): Beni-Snassen; Mimeur (1949: 160): galls on *Thapsia garganica* L. (as *Lasioptera thapsiae* Kieffer): Tedders, Guercif, Settat.
Distribution. Mediterranean.

Lestodiplosis aonidiellae Harris, 1968

This species was described based on adults larvae of which were predators on the scale *Aonidiella aurantii* (Hemiptera: Diaspididae). Larvae may be predators of other scale insects.
Occurrence. Harris (1968: 452): Rabat, 20 March 1945, adults reared from *Lepidosaphes beckii* (Newman) and *Parlatoria ziziphus* (Lucas): Rabat, 12 March, 1949; Oujda, 17 May 1950; Fes, 26 May 1950.
Distribution. South Africa; Italy.

Mayetiola avenae (Marchal, 1895)

Larvae develop in onion-shaped galls on stem of *Avena sativa* L. (Poaceae).
Occurrence. Lhaloui et al. (1992, 2005): Settat, Safi, El Jadida, Beni Mellal, Khouribga, Marrakech, El Kelad.
Distribution. European; Algeria .

Mayetiola destructor (Say, 1817)

Larvae cause swellings on the lower part of the stem on *Triticum aestivum* L. (*T. vulgare* Vill.), *Secale cereale* L. and occasionally also on various species of weed grasses (Poaceae). Usually two generations develop per year. Larvae hibernate in puparia on plants and pupate there in the next spring. It is a minor pest in Europe but the main pest of cereals in North America (Gagné et al. 1991, Skuhravá et al. 1984a, Darvas et al. 2000).
Occurrence. Mimeur (1949: 171): it is very abundant in the areas of cereal production. Material from Morocco (adults, larvae and galls) is deposited in the Natural History Museum in Rabat and originates from Rabat and Moyen Atlas.
Distribution. Cosmopolitan. This species originates from the Palaearctic, it is widespread in Europe, western Asia, in northern Africa from Morocco to Tunis; immigrant in Nearctic wherever wheat is grown; it occurs also in New Zealand (Barnes 1956).
References. Amri et al. (1992), Azzam et al. (1997), El Bouhssini et al. (1992a, b, 1996a, b, 1997, 1998, 1999), Gagné & Jaschhof (2017), Khalifi et al. (1996), Naber et al (2000, 2003), Lhaloui et al. (1992, 2001, 2005), Skuhravá (1986: 185).

Mayetiola hordei Kieffer, 1909

Kieffer (1909) described this species very briefly as a saddle-shaped gall under the leaf sheaths of *Hordeum vulgare* L. (Poaceae), without giving a locality. Barnes (1956) involved this species under possible synonym of *M. destructor* which was followed by Skuhravá (1986). Gagné et al. (1991) demonstrated that it is a distinct species.
Occurrence. Lhaloui et al. (2005): this species is very abundant in areas of cereal production: Settat, Safi, Jadida, Marrakech, Beni Mellal, Khouribga, El Kelaa.
Distribution. European; Morocco, Algeria.
References. Gagné et al. (1991), Gagné & Jaschhof (2017).

Oligotrophus panteli Kieffer, 1898

Kieffer (1898) described this species on the basis of larva and adults obtained from galls on *Juniperus communis* L. (Cupressaceae). The gall has a bulbous base and pointed apex. One generation develops per year. Larvae pupate in the gall.
Occurrence. Mimeur (1949: 170): galls on *Juniperus oxycedrus* L.: Beni-Snassen, Moyen-Atlas, l'Aguelmane, l'Ayachi, Bou-Jafar, d'Azrou.
Distribution. European.

Oligotrophus valerii (Tavares 1904)

A single larva causes an ovoid, pointed bud gall on *Juniperus oxycedrus* L. The gall is 10–12 mm high, 6 mm broad. Larvae hibernate in galls where they pupate in the spring. Only one generation develops per year.
Occurrence. Mimeur (1949: 170): galls on *Juniperus oxycedrus* L.: Ayachi, Bou-Jafar.
Distribution. Mediterranean.

Orseolia cynodontis Kieffer et Massalongo, 1902

Larvae cause galls on *Cynodon dactylon* Pers. (Poaceae) (Fig. 18). The gall is oval and consisting of several malformed leaves massed together at the extremity of the shoot, forming a tube. Inside the gall is a solitary larva which pupates in the gall (Barnes 1946b).
Occurrence. Houard (1922: 87): Maroc Sempertrional: Tanger, Aine Dalia, galls on *Cynodon dactylon*, leg. C. J. Pitard, 1911.
Distribution. Mediterranean.

Phyllodiplosis cocciferae (Tavares, 1901)

Larvae live in swollen leaf buds of *Quercus coccifera* L. (Fagaceae) and were found also on *Q. ilex* L. and *Q. suber* L. (Fig. 19). One generation develops per year. Hibernation takes place in the soil.
Occurrence. Trotter (1904: 15): galls on *Quercus coccifera* L.: Cabo Spartel; Mimeur (1949: 173): galls on *Quercus coccifera* L.: Cap Spartel, Beni-Snassen. Galls on *Quercus ilex* L.: Taza, ouezzane, El-Harcha, Djaba, Ifrane, Imouzzer-du-Kandar, Dayet-Achlaf, Dayet Ifrah, Michlifen, bordj-Doumergue, Zaad, Bekrite, Aguelmane-Azigza, Bou-Mzil, Bou-Jafar, Agoumi n'Ait Mguild, Dj. Tardema. Galls on *Quercus suber* L.: Larache, Mamora, Zaer, Boulhaut.
Distribution. Mediterranean.

Psectrosema tamaricum (Kieffer, 1912)

Larvae cause small ovoid or fusiform swellings on young leaf branches and on flowering shoots of *Tamarix africana* Poiret, *T. gallica* L. and some other species of *Tamarix* (Tamaricaceae) (Fig. 20). Inside the gall is a large cavity in which the solitary larva lives and pupates.
Occurrence. Houard (1922: 96): Maroc Mérirional: Zousfana, near Sidi Youssef, galls on *Tamarix gallica*, leg. C. J. Pitard, 1913. Mimeur (1949: 177): galls on *Tamarix gallica* L.: Zousfana, Sidi Youssef, Tafilalet, Agad, Moulouya. Galls on *Tamarix speciosa* Ball.: Sous. Galls on *T. brachystylis* J. Gay: Moulouya, Haouz, Tadla. Galls on *T. africana* Poiret: "Maroc atlantique, méditerranéen, continental et subdésertique". Galls on *T. boveana* Bunge: Berkane.
Distribution. Mediterranean.

Resseliella oleisuga (Targioni-Tozzetti, 1886)

Larvae develop under the bark of twigs of *Olea europaea* L. (Oleaceae). Two generations develop per year.
Occurrence. Hafraoui (1966: 139): first record in Morocco, no accurate locality given.
Distribution. Mediterranean, recently this species was found in Australia (Kolesik 2014).

Rhopalomyia navasi Tavares, 1904

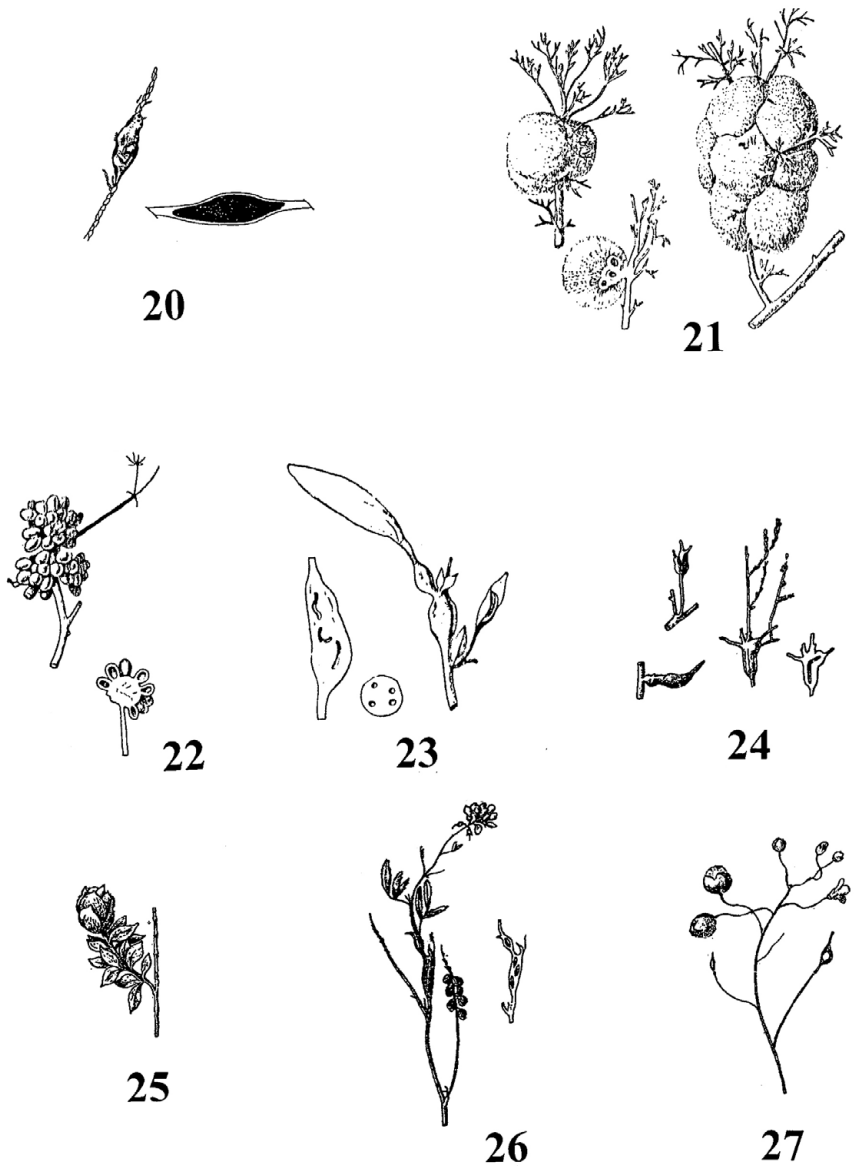
Larvae cause large, densely white pubescent, galls on *Artemisia herba-alba* Asso and *A. incana* (Asteraceae) (Fig. 21). Galls are situated on stem sides. Several chambers occur inside one gall. Only one larva develops in one chamber where it also pupates.
Occurrence. Houard (1922: 103): Maroc Merirional: Djebel Mais, Djahifa, galls on *Artemisia herba-alba* Asso, leg. C. J. Pitard, 1913. Houard (1923): Grand Atlas, Ait-Ameli, 1800 m a. s. l., April 1919, galls on *Artemisia herba-alba*, leg. R. Maire. Mimeur (1949: 178): Galls on *Artemisia herba-alba* Asso: Djebel Mais, Djahifa, Figuig, Djebel Nokra, Ifkern, Haute Moulouya, Tadla.
Distribution. Mediterranean.

Schizomyia buboniae (Frauenfeld, 1859)

Larvae cause strange, berry-like galls 1–2.5 cm large on the thin stems of *Deverra tortuosa* DC (*Pituranthus tortuosa* Benth. et Hooker) (Apiaceae) (Fig. 22). Such galls are composed of 30–60 small, unilocular galls. A single larva develops in each small gall where it also pupates. Only one generation develops per year. It is necessary to collect new material of galls, rear adults and then identify the causer.
Occurrence. Houard (1917: 125): Djorf de Taouriet, galls on *Deverra scoparia* Coss et Dur., marked as Cécidomyide. Galls on *Deverra scoparia* differ from galls caused on *D. tortuosa*, figured by Frauenfeld (1859). Houard (1922: 96): Maroc Méridional: Djebel Tagla, and Aine Yalon, as Cécidomyide, galls on *Deverra scoparia*, leg. C. J. Pitard, 1913.
Distribution. Mediterranean.

Stefaniella trinacriae De Stefani, 1900

Larvae cause fusiform plurilocular swellings of stems of *Atriplex halimus* L. (Chenopodiaceae) of the size of a nut (Fig. 23). The gall is composed of many chambers, in each chamber one yellow-whitish larva develops. Larvae pupate in the galls. Two generations develop per year.



Figs. 20–27. Galls of gall midges found in Morocco. 20 – Fusiform swelling on stem of *Tamarix africana* caused by *Psectrosema tamaricum*, with cross-section of gall. 21 – Large gall of *Rhopalomyia navasi* on stems of *Artemisia herba-alba* and a section of a gall. 22 – Group of galls of *Schizomyia buboniae* on stem of *Deverra tortuosa*, with cross-section of galls. 23 – Stem galls of *Stefaniella trinacriae* on *Atriplex halimus* and cross-section of a gall. 24 – Elongate swellings on stem of *Salsola vermiculata* caused by *Stefaniola bilobata.* Galls of undescribed species of gall midges: 25 – Gall at vegetative tip of *Calamintha baetica.* 26 – Stem swelling on *Melilotus sulcata.* 27 – Swollen flower bud on *Savignya longistylia.* All figures are original drawings taken from publications by Houard (1912; Figs. 21, 23), Houard (1922–1923; Figs. 22, 24–27) and Mimeur (1949; Fig. 20).

Occurrence. Mimeur (1949: 179): galls on *Atriplex colerei* Maire (as *Stefaniella* sp.): El-Oualidia, Zima, Casablanca. It is necessary to collect new material of galls and identify the causer.
Distribution. Mediterranean.

Stefaniola africana Möhn, 1971

Larvae cause oval or egg-shaped galls on *Suaeda fruticosa* Forsk. and *S. baccata* Forsk (Chenopodiaceae). Möhn (1971) described only the larva. He obtained several larvae from dry galls. His material originated from Eritrea.
Occurrence. Mimeur (1949: 182): galls on *Suaeda maritima* (L.) Dumort and *Suaeda fruticosa* (L.) Forsk.: Rabat, Salé, Bou-Regreg (as Cecidomyiidae sp.). It is necessary to collect new material of galls, rear adults and identify the causer.
Distribution. Mediterranean.

Stefaniola bilobata (Kieffer, 1913)

Larvae cause small elongate swellings on stem of *Salsola vermiculata* L. (Chenopodiaceae) (Fig. 24).
Occurrence. Houard (1922: 90): Maroc Meridional: El Ardja, galls on *Salsola vermiculata* L., leg. C. J. Pitard, 1913. Möhn (1971: 206) redescribed the larva of *S. bilobata* on the basis of material collected in Morocco: Haute Moulouya, 25 June 1924 (collector not given). Mimeur (1949: 180): galls on *Salsola vermiculata* L. (as Cecidomyiidae sp.): Haouz, Tadla, Ksar-es-Souk.
Distribution. Mediterranean.

Stefaniola opulenta Möhn, 1971

Larvae cause galls on *Anabasis aphylla* L. and *A. hausknechtii* Bunge (Chenopodiaceae). Möhn (1971: 240) described the larva of this species on the basis of the material originated from Mahetta (Palestine).
Occurrence. Möhn (1971: 240) examined larvae belonging to this species that were collected on *A. aphylla* in Morocco: Dar-Drins, 7 November 1930, without giving the name of the collector.
Distribution. Mediterranean.

Stefaniola ventriosa Möhn, 1971

Larvae cause galls on *Traganum nudatum* Delile (Chenopodiaceae). Möhn (1971: 245) described this species on the basis of larvae which were in galls collected in Gabes (Tunisia).
Occurrence. Möhn (1971: 245) examined larvae collected in Morocco at Oued Gheris, 11 April 1933, without giving the name of the collector.
Distribution. Mediterranean.

Thecodiplosis brachyntera (Schwägrichen, 1835)

One to five orange red larvae cause galls at the base of the pair of needles of *Pinus sylvestris* L. and other species of the genus *Pinus* (Pinaceae). Attacked pine needles are abnormally short and discoloured. One generation develops per year. Pupation takes place either in galls or in the soil. It is a major pest of pine in Central Europe. Several outbreaks were observed during the 19th and 20th centuries (Skuhravá & Roques, 2000, Skuhravý 1991).

Occurrence. Mouna (1998): Morocco: no accurate locality.
Distribution. Eurosiberian.

Undescribed species

Cecidomyiidae sp. on *Calamintha baetica* (Brassicaceae) (valid name: *Clinopodium nepeta* subsp. *glandulosum* (Req.) Gov.; Fig. 25). The gall consists of a rosette of leaves on vegetative tips of the host plant, 10–12 mm in diameter, similar to the galls caused by *Bayeriola thymicola* (Kieffer, 1888) on *Thymus serpyllum* L. (Lamiaceae).
Occurrence. Houard (1922: 99): Tanger, 15 March 1911.

Cecidomyiidae sp. on *Enarthrocarpus clavatus* Delile (*Enarthrocarpus chevallieri* Beginot) (Brassicaceae). The gall is formed of swollen flower buds, 6–8 mm in diameter.
Occurrence. Houard (1922: 92): South Morocco: Djebel Grouz, April 1912.

Cecidomyiidae sp. on *Melilotus sulcatus* Desf. (Fabaceae). The gall is formed of swollen parts of the stem (Fig. 26).
Occurrence. Houard (1922: 93): Central Morocco: Fez, 1913, leg. C. J. Pitard.

Cecidomyiidae sp. on *Savignya parviflora* subsp. *longistyla* (Boiss. & Reut.) Marie (Brassicaceae). The gall is formed of swollen flower buds (Fig. 27).
Occurrence. Houard (1922: 91): Southern Morocco, El Ardja, March 1913; leg. C. J. Pitard.

DISCUSSION

Species richness

The fauna of gall midges in Morocco including 57 known species belonging to 31 genera is relatively rich. It occupies the second position from the point of view of species richness of gall midge faunas in North Africa (Tables 1 and 2). Algeria, spread along the eastern boundary of Morocco, with 94 gall midge species, is the species richest country of North Africa. It is followed by the gall midge fauna of Morocco with 57 species, fauna of Egypt including 48 species and fauna of Tunisia including 35 species. Libya with 15 species of gall midges is at the last position (Skuhravá 1986, 1987, Skuhravá et al. 1984, Skuhravá & Skuhravý 2010, Skuhravá et al. 2014).

The two most species rich genera are *Dasineura* with nine species and *Asphondylia* with five species. These are followed by *Stefaniola* and *Contarinia*, each with four species, and *Lasioptera* and *Mayetiola*, each with three species. These findings differ substantially from results that were obtained in the evaluation of species numbers of the main genera of gall midges in Europe (Skuhravá & Skuhravý 2010).

Most of the known gall midge species occurring in Morocco are phytophagous (86.2%) and their larvae cause galls on various host plants, five species (8.6%) are mycophagous feeding mainly on fungal hyphae (*Campylomyza flavipes*, *C. fusca*, *C. mohrigi*, *Lestremia parvostylia*, *Monardia toxicodendri*) and three species (5.2%) are zoophagous and attack various small arthropods (*Dicrodiplosis pseudocci*, *Feltiella acarisuga*, *Lestodiplosis aonidiellae*).

Phytophagous species are associated with 52 plant species which belong to twenty two plant families. Of them the family Chenopodiaceae hosts the highest species number of gall midges – eight gall midge species, followed by Fagaceae hosting six gall midge species and Rosaceae five gall midge species. About two third of host plant species are herbaceous plants (35 species, 67%) and one third (17 species, 33%) trees or shrubs including *Erica*, *Juniperus*, *Phillyrea*, *Quercus* and *Tamarix*.

Usually each species of gall midge in Morocco is associated with one host plant species, two species of gall midges are associated with four host plant species: *Juniperus oxycedrus* with *Oligotrophus panteli* and *O. valerii*, *Olea europaea* with *Lasioptera berlesiana* and *Resseliella oleisuga*, *Quercus coccifera* with *Contarinia luteola* and *Phyllodiplosis cocciferae* and *Rubus ulmifolius* with *Dasineura plicatrix* and *Lasioptera rubi. Quercus ilex* is the host plant hosting the highest number of gall midges – three species: *Contarinia ilicis*, *C. luteola* and *Dryomyia lichtensteinii.*

Distribution in Morocco

Gall midges and their galls in Morocco are not distributed regularly over the whole territory. Gall midges follow their host plants which they need for their development and occur in various bioclimatic zones and diverse biotopes. Galls of gall midges may be found on various host plants growing along the sea coast, they go up gradually to higher altitudes, they may occur in all vegetative zones and may reach up to high mountains. Galls of gall midges and their occurrence in Morocco were intensively studied by several researchers mainly in the first half of the twentieth century. Later attention has been devoted mainly to gall midges damaging agricultural plants, especially to species damaging cereal crops – to the complex of *Mayetiola* species.

The distribution of 57 species of gall midges **in seven bioclimatic zones** of Morocco will be given in the paper by Kettani (in prep.). In the following part we use these data. Ten gall midge species were discovered in the Rif Mountains (RIF) situated in the north of the country, seventeen species were found in eastern Morocco (Morocco Oriental, MO) and twenty seven species were recorded in the Atlantic Plains (PA), which are situated in the western part of the country along the Atlantic Ocean. Thirty six species were found in the Atlas Mountains located in the center and the south of the country; of them twenty three species in the Moyen Atlas (MA), twenty six in the Haut Atlas (HA) and seven species in the Anti-Atlas (AA). Only one species of gall midges, *Asphondylia punica* causing galls on *Atriplex halimus*, was recorded in the Maroc Sahara Desert (MS).

From the point of view of **vertical distribution**, gall midges are able to live at localities situated in a relatively large altitudinal span. Many species prefer biotopes along the seaside, in lowlands and hilly countries, but some species may occur up to high mountains. The following five species of gall midges were found in the Atlas Mountains at altitudes between 1600 m and 2800 m a. s. l.: *Dryomyia lichtensteinii* inducing galls on leaves of *Quercus ilex* at altitude of 1600 m a. s. l., *Rhopalomyia navasi* causing galls on *Artemisia herba-alba* at 1800 m a. s l., *Dasineura plicatrix* inducing leaf galls on *Rubus ulmifolia* and *Asphondylia cytisi* on *Cytisus purgans* at 2000 m a. s. l. The galls of *Bayeriola thymicola* on *Thymus serpyllum* were found at the highest altitude 2800 m a. s. l.

Distribution in North African countries

We compared the fauna of gall midges of Morocco not only with four North African countries but also with the gall midge fauna of the Cadiz Province (Table 2). Cadiz Province is spread in the southernmost part of mainland Spain, that is the southernmost part of continental Europe. Africa is separated in that area by the Strait of Gibraltar, narrow straits that connect the Atlantic Ocean to the Mediterranean Sea and separates Gibraltar and Peninsular Spain in Europe from Morocco in Africa. Europe and Africa are separated by 14.3 km of ocean at the Strait narrowest point.

The fauna of gall midges of Cadiz Province was intensively studied by Inigo Sanchez who carried out investigatations at many localities of this province and found altogether 133 species of gall midges in the course of about twelve years, results of which he published in two papers (Sanchez et al. 2012, Sanchez 2016).

Table 1. List of host plants and gall midges

host plant species	gall midge species
Anabasis aphylla	*Stefaniola opulenta*
Artemisia herba-alba	*Rhopalomyia navasi*
Arthrocnemum macrostachyum	*Houardiella salicorniae*
Asparagus aphyllus	*Dasineura asparagi*
Atriplex halimus	*Asphondylia punica*
Atriplex colerei	*Stefaniella trinacriae*
Avena sativa	*Mayetiola avenae*
Brassica napus	*Dasineura napi*
Bryonia cretica subsp. *dioica*	*Jaapiella bryoniae*
Capparis spinosa	*Asphondylia capparis*
Crataegus laevigata	*Dasineura crataegi*
Cynodon dactylon	*Orseliola cynodontis*
Cytisus purgans	*Asphondylia cytisi*
Deverra tortuosa, *D. scoparia*	*Schizomyia buboniae*
Diplotaxis muralis	*Gephyraulus diplotaxis*
Erica arborea, *E. scoparia*	*Dasineura ericaescopariae*
Helianthemum nummularium	*Dasineura helianthemi*
Hordeum vulgare	*Mayetiola hordei*
Juniperus oxycedrus	*Oligotrophus valerii*
	Oligotrophus panteli
Juniperus thurifera	*Etsuhoa thuriferae*
Lonicera implexa, *L. biflora*	*Dasineura periclymeni*
Olea europaea	*Lasioptera berlesiana*
	Resseliella oleisuga
Origanum vulgare subsp. *virens*	*Blastomyia origani*
Phillyrea latifolia	*Braueriella phillyreae*
Pinus sylvestris	*Thecodiplosis brachyntera*
Pyrus communis	*Contarinia pyrivora*
Quercus coccifera	*Contarinia luteola*
	Phyllodiplosis cocciferae
Quercus ilex	*Contarinia ilicis*
	Contarinia luteola
	Dryomyia lichtensteinii
Quercus suber	*Dryomyia lichtensteinii*
	Phyllodiplosis cocciferae
Raphanus raphanistrum	*Contarinia nasturtii*
	Gephyraulus raphanistri
Rosa sp.	*Dasineura rosae*
Rubus ulmifolius	*Dasineura plicatrix*
	Lasioptera rubi
Salix pedicellata	*Iteomyia major*
Salsola vermiculata	*Stefaniola bilobata*
Sarcocornia fruticosa	*Baldratia salicorniae*
Scrophularia canina	*Asphondylia scrophulariae*
Secale cereale	*Mayetiola destructor*
Suaeda fruticosa, *S. maritima*	*Stefaniola africana*
Tamarix gallica, *T. africana*, *T. boveana*, *T. brachystylis*	*Psectrosema tamaricum*
Thapsia garganica	*Lasioptera thapsia*
Thymus spp.	*Bayeriola thymicola*
Traganum nudatum	*Stefaniola ventriosa*
Triticum aestivum	*Mayetiola destructo*
Verbascum sinuatum	*Asphondylia verbasci*
Viola reichenbachiana	*Dasineura affinis*

The similarity or relationships between the fauna of gall midges of Morocco and faunas of four countries situated in North Africa – Algeria, Tunisia, Libya and Egypt, and the fauna of the Cadiz Province, may be shown by **number of common (or shared) species**, that are such species occurring in Morocco and one or more of these countries.

The number of common species indicates a similarity in faunal composition: the higher the number of common species means a higher degree of similarity of the faunas. The similarity in composition of the known gall midge fauna in Morocco and faunas of four North African countries is shown in Table 2. It is necessary to emphasize that the number of common species is influenced mainly by the geographical position of the country, country area size, species number of gall midge fauna, the level of knowledge of the country, number of explored localities and the intensity of investigations (Skuhravá & Skuhravý 2010).

The highest number of common species – thirty three species – occurs between Morocco and Algeria, which is the nearest country with a long shared boundary. It is followed by sixteen species occurring in Morocco and Tunisia, nine species occurring in Morocco and Egypt, and seven species occurring in Morocco and Libya. A relatively high number of species – twenty six species – occur in Morocco and Cadiz Province spread in the southernmost part of continental Europe. Probably in this part where the African continent is separated from the Europen continent by a narrow strait, European gall midge species penetrate into Africa and, on the other hand, the African gall midge species penetrate into Europe.

The following five species of gall midges, occurring in Morocco, are recorded from all five North African countries: *Asphondylia punica* causing galls on *Atriplex halimus*, *Baldratia salicorniae*, inducing swellings on *Sarcocornia fruticosa*, *Psectrosema tamaricum*, producing swellings on young leaf branches and on flowering shoots of *Tamarix africana*, *Rhopalomyia navasi* inducing large galls on stems of *Artemisia herba-alba* and *Schizomyia buboniae* on *Deverra tortuosa*. These five species of gall midges are the most frequent species of gall midges in North African countries.

Geographical distribution

The gall midge species occurring in Morocco may be divided, according to their overall distribution in the world, into four zoogeographic units: Mediterranean, European, Eurosiberian and cosmopolitan. Of 57 species of gall midges occurring in Morocco, the majority – 34 (58%) are Mediterranean species, 18 species (32%) are European or Eurosiberian and the remaining species belong to other zoogeographical units: four are Holarctic and two cosmopolitan.

Mediterranean species have centres of origin in the Mediterranean area. They occur along the shores of the Mediterranean and are associated with Mediterranean host plants. Some of them occur over greater areas and a few species reach the northern limits of their distribution areas even in Central Europe. In such cases they are designated as submediterranean species.

In Morocco thirty four species, forming more than a half of all species found there, belong in this group, as for example five species of the genus *Asphondylia* and four species of the genus *Stefaniola*.

European species are associated with European host plant species that have centres of origin in Europe. They may reach marginal parts of Asia. In Morocco fifteen species (17%) belong in this group, as for example *Contarinia nasturtii*, *Dasineura crataegi* and *D. plicatrix*. *Dasineura plicatrix* is a typical representative of European species. It occupies a large distribution area from Britain and Portugal in Western Europe to Greece in Eastern Europe, to Algeria and Morocco in northern Africa and recently it was recorded in Turkey in western Asia.

Euro-Siberian species inhabit the Euro-Siberian subregion of the Palaearctic region. They have centres of origin in Europe where they occur, usually abundantly, and extend at least to

Table 2. Species richness and number of common species of the family Cecidomyiidae in Morocco in comparison with four countries of North Africa and with Cadiz Province of Spain, the southernmost part of continental Europe. The presence of a species is expressed by the symbol +

country	Morocco	Algeria	Tunisia	Libya	Egypt	Cadiz
Cecidomyiinae						
Asphondylia capparis	+	+				
Asphondylia cytisi	+					+
Asphondylia punica	+	+	+	+	+	
Asphondylia scrophulariae	+	+				+
Asphondylia verbasci	+	+				+
Baldratia salicorniae	+	+	+	+	+	+
Bayeriola thymicola	+	+	+			+
Blastomyia origani	+	+				+
Braueriella phillyreae	+	+				+
Contarinia ilicis	+	+				+
Contarinia luteola	+					+
Contarinia nasturtii	+	+				
Contarinia pyrivora	+					
Dasineura affinis	+	+			+	+
Dasineura asparagi	+	+				+
Dasineura crataegi	+					+
Dasineura ericaescopariae	+	+	+			+
Dasineura helianthemi	+		+			
Dasineura napi	+					
Dasineura periclymeni	+					
Dasineura plicatrix	+	+				+
Dasineura rosae	+					+
Dicrodiplosis pseudococci	+					+
Dryomyia lichtensteinii	+	+	+			+
Etsuhoa thuriferae	+	+	+			
Feltiella acarisuga	+				+	
Gephyraulus diplotaxis	+		+			+
Gephyraulus raphanistri	+					+
Houardiella salicorniae	+		+	+		+
Iteomyia major	+					
Jaapiella bryoniae	+	+				+
Lasioptera berlesiana	+					
Lasioptera rubi	+					
Lasioptera thapsiae	+	+				+
Lestodiplosis aonidiellae	+					
Mayetiola avenae	+	+				
Mayetiola destructor	+	+	+			+
Mayetiola hordei	+	+	+			
Oligotrophus panteli	+	+				
Oligotrophus valerii	+	+		+		+
Orseolia cynodontis	+	+				
Phyllodiplosis cocciferae	+	+				+
Psectrosema tamaricum	+	+	+	+	+	
Rhopalomya navasi	+	+	+	+	+	
Resseliella oleisuga	+	+				
Schizomyia buboniae	+	+	+	+	+	
Stefaniella trinacriae	+	+	+		+	+
Stefaniola bilobata	+	+				
Stefaniola opulanta	+					
Stefaniola ventriosa	+		+		+	
Thecodiplosis brachyntera	+					

Table 2. (continued)

country	Morocco	Algeria	Tunisia	Libya	Egypt	Cadiz
Lestremiinae						
Lestremia parvostylia	+					
Micromyinae						
Campylomyza flavipes	+					
Campylomyza fusca	+					
Campylomyza mohrigi	+					
Monardia toxicodendri	+					
number of species	57	94	35	15	48	133
number of common species	–	33	16	7	9	26

Western Siberia, with some of them reaching to Central Siberia and only a few reaching to Eastern Siberia and to the most eastern part of the Palaearctic Region, to the Far East. They may also reach marginal parts of Asia and northern Africa. In Morocco belong three species in this group: *Dasineura rosae*, *Lasioptera rubi* and *Thecodiplosis brachyntera*.

Holarctic species occur simultaneously in the Palaearctic and in the Nearctic regions. Three such species occur in Morocco: *Campylomyza flavipes*, *C. fusca* and *Monardia toxicodendri*.

Cosmopolitan species are species that occur on all continents of the Earth (except Antarctica), having a world-wide distribution. In Morocco three species belonging in this group occur: a zoophagous species *Feltiella acarisuga*, a phytophagous species *Contarinia pyrivora*, a pest of pear which is an originally European species that has been secondarily introduced into all continents; similarly *Mayetiola destructor*, developing on cereals, is considered to be a primarily European species that has been imported into other continents, probably with straw.

Economic importance

In Morocco three gall midge species cause serious damage to cereals*: Mayetiola destructor*, *M. hordei* and *M. avenae*. Of them *M. destructor* is the most important pest and many researchers from various institutes are studying possibilities to reduce its harmfulness. Several other species of gall midge may be counted as potential pests of agricultural plants: *Contarinia nasturtii* and *Dasineura napi* (= *D. brassicae*) on various brassica plants, *Contarinia pyrivora* on pear, *Dasineura plicatrix* and *Lasioptera rubi* on raspberry and blackberry.

A c k n o w l e d g e m e n t s

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