N O T E

First Record of *Melanagromyza sojae* (Zehnter) (Diptera: Agromyzidae) in Europe[1]

Ricardo Gil-Ortiz,[2] Michel Martinez[3] and Ricardo Jiménez-Peydró

Laboratorio de Entomología y Control de Plagas, Instituto Cavanilles de Biodiversidad y Biología Evolutiva, Universitat de València, Apartado Oficial 22085, 46071 Valencia, Spain

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A single male of *Melanagromyza sojae* (Zehnter, 1900) (Diptera: Agromyzidae) was identified from insects captured in a Malaise trap operated as part of a 3-yr (2004 - 2007) biodiversity study in the Natural Park of "Tinença de Benifassà" in Spain. The specimen came from material captured in the trap between 18 - 25 September 2006 at GPS coordinates N40°39′22.6" / E00°09′26.8"; 755 m elevation. This represents the first report of this species from Spain and the European continent. Although only a single male was captured, it indicates the occurrence of *M. sojae* in Spain, possibly from the Palaearctic Eastern region.

According to Martinez (2004, http://www.faunaeur.org), *M. sojae* is distributed in Afrotropical, Australian, Palaearctic, and Oriental regions. It is essentially an Oriental species, but its range extends into Egypt and Israel (Spencer 1990, Host specialization in the world Agromyzidae (Diptera), Series Entomologica 45: 1 - 444) and includes Australia, China, Egypt, India, Indonesia, Israel, Japan, Laos, Malaysia, Micronesia, Philippines, Saudi Arabia, Salomon Islands, South Africa, South Korea, Taiwan, Thailand, and Vietnam.

Female *M. sojae* normally oviposit their eggs on the outside of young leaves at the basal part near the petiole. Eggs range in number from 1 - 6 depending on adult population density. Egg eclosion begins on the second day after oviposition, but can occur up to 7 d after oviposition (Wang 1979, J. Agric. Res. China 28: 217 - 223). Larvae tunnel within the mesophyll tissue into the closest vein until they enter the stem. Larvae feed in the pith, where pupation also takes place. The full-grown larva mines through the xylem and phloem tissue to create an exit hole, which is closed with debris to create a place where the adult emerges from pupation (van der Goot 1930, Agromyzid flies of some native legume crops in Java. Shanhua, Taiwan, Asian Veg. Res. Devel. Ctr.). Singh (1982, Mem. School of Entomol., St. John's Coll. Agra. 8: 1 - 126) reported durations of the 3 larval stadia at 32 ± 2°C and 70% RH as: 22 h for the first instar, 43 h

[1]Received 25 March 2009; accepted for publication 24 July 2009.

[2]Address inquiries (email: ricardo.gil@uv.es).
[3]Present address: INRA, UMR CBGP 1062, 2, place Viala 34060 Montpellier cedex 01, France.

for the second instar, and 98 h for the third instar with a total duration of the entire larval stage of 7 d. Natural mortality for larvae is reportedly high with an average of 1.9 adults successfully emerging for every 100 eggs oviposited (Wang 1979).

The pupa is always located near the fly escape hole, which appears as a dark depression. The pupal stage ranges from 6 to 12 d. In Indonesia, the time from egg to adult is 16 - 26 d, with an average of 21 d (van der Goot 1930). Copulation occurs 3 - 5 d after adult emergence only in the morning between 700 - 1000 h. Oviposition begins soon after copulation and continues for 19 d (Wang 1979). Adult activity is influenced by weather, and adults feed on dew drops, plant juices from oviposition and feeding punctures made in the leaves by females, and other similar moist materials.

Melanagromyza sojae is considered an important stem-miner pest of leguminosae crops. According to Spencer (1990), its primary host is *Glycine*, but this species is highly oligophagous and has been recorded from other host plant genera. Known hosts of *M. sojae* represent 13 botanical genera: *Aeschynomene indica* L. (indian joint-vetch), *Astragalus sinicus* L. (chinese milk-vetch), *Cajanus cajan* (L.) Millsp. (pigeon pea), *Crotalaria juncea* L. (sunn hemp), *Flemingia sp.*, *Glycine max* (L.) Merr. (soybean), *Glycine soja* Sieb and Zucc. (wild soybean), *Indigofera suffruticosa* Mill. (anil de pasto), *Indigofera tinctoria* L. (true indigo), *Medicago polymorpha* L. (burclover), *Medicago sativa* L. (alfalfa), *Melilotus* sp., *Phaseolus vulgaris* L. (kidney bean), *Pisum sativum* L. (garden pea), *Stizolobium* sp., *Swainsonia galegifolia* (And.) R.Br. (smooth darling pea), *Vigna aconitifolia* (Jacq.) Marechal (moth bean), *V. angularis* (Willd.) Ohwi & Ohashi (adzuki bean), *V. mungo* (L.) Hepper (black gram), *V. radiata* (L.) R. Wilczek. (mung bean), *V. unguiculata* (L.) Walp. ssp. *sesquipedalis* (L.) Verdc. (yardlong bean), *V. umbellata* (Thunb.) Ohwi & H. Ohashi (rice bean), and *V. unguiculata* (L.) Walp. (blackeyed pea). In the Palaearctic region, *M. sojae* damages *Glycine*, *Medicago*, *Melilotus*, *Phaseolus*, *Pisum* and *Vigna,* including economically important soybean, beans, and pea. *Medicago* and *Melilotus* species are also used as forage for cattle.

Damage caused by *M. sojae* varies depending on the crop, the plant variety, environment conditions, cultural methods, and plant growth stage when infestation occurs. Yield reduction only occurs when the plant is initially infested during the seedling stage. If infestation occurs later in the plant phenology, damage and yield losses are reduced. Spencer (1973, Series Entomologica 9: 1 - 418) reported that when infestation of soybean occurs in the unifoliate or early trifoliate leaf stage, the seedlings are well-established and infestation rarely causes plant death. Yield losses in soybean have been reported as higher than 80% (Berg et al. 1998, J. Appl. Ecol. 35: 514 - 522), as 33% (Pan and Pan 1996, Plt. Prot. 22: 22 - 24) and, depending upon plant variety, from 18 - 40% (Kundu and Sekhar 1995, Ann. Agric. Res. 16: 499 - 501). Talekar (1989, J. Econ. Entomol. 82: 584 - 588) found that *M. sojae* damage to soybean significantly reduces plant height, leaf area, dry matter accumulation, leaf moisture content, number of branches per plant, *Rhyzobium* nodules and nodule weight, number of pods per plant, number of seeds per pod, and seed yield.

Numerous studies have been directed to developing efficacious management methods for this pest. Insecticides are commonly applied as foliar sprays and seed treatments (Elbadry et al. 2006, Egyptian J. Agric. Res. 84: 101 - 110; Dey et al. 2006, Res. Pest Manag. Newsl. 15: 20 - 22; Salunke et al. 2004, J. Soils and Crops 14: 156 - 162; Purwar and Yadav 2004, Soybean Res. 2: 54 - 60; Keshbhat et al. 2004, J. Oilseeds Res. 21: 202 - 203), and there has been some success with varietal resistance (Jadhav et al. 2006, Ann. Plt. Prot. Sci. 14: 237 - 238; Taware et al. 2005, J. Maharashtra Agric. Univ. 30: 125 - 126; Manoj et al. 2005, Soybean Gen. Newsl. 32: 1 - 8; Gupta et al.

2004, Ann. Plt. Prot. Sci. 12: 63 - 66). Parasitoids from the families Pteromalidae, Eucoilinae, and Braconidae (Hymenoptera) provide some mortality, but appear to be most effective in an integrated pest management approach (Jayappa et al. 2002, Ins. Environ. 8: 192; Abe and Konishi 1995, Appl. Entomol. Zool. 30: 309 - 312; Berg et al. 1995, Intern. J. Pest Manag. 41: 127 - 133). Cultural tactics (e.g., intercropping, weed management, plant density, mulches) (Hirano et al. 1993, Appl. Entomol. Zool. 28: 260 - 262), microbial agents (Dubey et al. 1998, Crop Res. (Hisar) 15: 256 - 259; Chawla et al. 1990, Current Nematol. 1: 43 - 46), irradiation (Sharma et al. 1996, Indian J. Agric. Sci. 66: 497 - 501), and neem products (Kundu and Trimohan 1992, Pestic. Res. J. 4: 65 - 68) also have been evaluated, but have not proven to provide economic control.

In the Palaearctic region, only the stem-miner *Ophiomyia phaseoli* (Tryon) attacks the soybean at the same time as *M. sojae*, and *O. phaseoli* has been recorded only from European Turkey. These 2 insects can be easily distinguished in the larval and pupal stages by locating their feeding and pupation sites within the host plant. *Ophiomyia* larvae feed close to the leaf surface (cortex feeders), pupating in the cortex just beneath the stem epidermis; whereas *M. sojae* larvae feed internally in the pith (pith feeders), boring down to the root and then again feeding upwards until it is fully-grown. It pupates in the pith.

The species also can be distinguished by the morphology of their posterior spiracles in the larval and pupal stages (Talekar 1990, Agromyzid flies of food legumes in the tropics. Wiley Eastern, New Delhi). In *O. phaseoli*, the posterior spiracles are close to each other on conical projections with ~10 small bulbs, whereas the spiracles of *M. sojae* are separated and normally consist of 6 raised pores around a central truncated horn. Other agromyzids that can damage the same hosts as *M. sojae* include *Liriomyza congesta* (Becker), *L. trifolii* (Burgess *in* Comstock), *Phytomyza horticola* Goureau, *Agromyza frontella* (Rondani), *Agromyza nana* Meigen, *L. huidobrensis* Blanchard, *L. strigata* (Meigen), and *L. xanthocera* (Czerny *in* Czerny and Strobl), but these species only mine the leaves.

Melanagromyza sojae is further characterized by whitish eggs, translucent, oval, with sizes estimated averaging 0.34 ± 0.02 mm in length and 0.15 ± 0.01 mm in width (Lee 1976; Formosan Sci. 30: 54 - 62; Wang 1979). Young larvae are nearly colorless and cause tiny holes at the base of the leaf lamina. Infested stems contain dark red to brownish feeding damage in the pith and larvae or pupae in the feeding tunnels. The peculiar shape, size and nature of sclerotization of posterior spiracular bulbs can be used in identification. The anterior spiracles are short and knoblike, with 8 min pores. Posterior spiracles are well separated and normally consist of 6 raised pores around a central truncated horn. The pupa is cylindrical, yellowish-brown, and measures 2.75 mm long and is 1.00 mm wide (Singh 1982). Spencer (1973) provides details of other morphological characters. Taxonomic identification of the species is not necessary because the plant damage symptoms can be used as a diagnostic tool in that no other stem-miners exhibiting the same behavior occur in the Palaearctic region.

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