

A new gall midge species *Asphondylia coridothymi* sp. nov. (Diptera: Cecidomyiidae) causing galls on *Coridothymus capitatus* (Lamiaceae) in Greece

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Received 7 July 2010; accepted 8 November 2011
Published 15 December 2011

Abstract. *Asphondylia coridothymi* sp. nov. is described based on specimens reared from flower bud galls of *Coridothymus capitatus* (Lamiaceae) found in the island of Samos in Greece. Male, female, larva, pupa and gall are described and morphological characters are illustrated. The poorly known species *Asphondylia serpylli* Kieffer, 1898, occurring in Central Europe and causing similar flower bud galls on *Thymus serpyllum*, is described and a neotype is designated.

Key words. Taxonomy, new species, Diptera, Cecidomyiidae, *Asphondylia*, *Coridothymus*, Greece.

INTRODUCTION

Asphondylia Loew, 1850 is a large cosmopolitan genus including more than 290 species worldwide and several new species are described each year (Gagné 2004, 2010, Skuhrová 2006). About 70 species have been described from the Palaearctic Region, 80 species from the Nearctic Region, 95 species from the Neotropical Region, 20 species from the Afrotropical Region, 13 species from the Oriental Region, and 15 species from the Australian and Oceanian Regions. Many species still remain undescribed. Several species are economically important, in Europe *Asphondylia capparidis* Rübsaamen, 1893, is a pest of caper (*Capparis spinosa*), *A. gennadii* (Marchal, 1904), a pest of carob (*Ceratonia siliqua*), *A. melanopus* Kieffer, 1890, a pest of bird's-foot trefoil (*Lotus corniculatus*) and *A. miki* Wachtl, 1880, a pest of alfalfa (*Medicago sativa*), and in Japan *A. yushimai* Yukawa et Uechi, 2003, is a serious pest of soybean (*Glycine max*) (Darvas et al. 2000, Yukawa et al. 2003).

Of the 50 species of *Asphondylia* described from Europe about half occur in Greece (Skuhravá & Skuhrový 1997, 2006, 2008, 2011). *Asphondylia* is considered to have its origin in the Neotropical Region and then to have spread throughout the world (Möhn 1961, Tokuda & Yukawa 2007). We suppose that at least one centre of diversity of the genus *Asphondylia* is in the Mediterranean area in southern Europe. This area is considered to be one of the centres of origin of plant and animal species in Europe. No species of *Asphondylia* have been found in Norway and Finland and the species numbers in northern parts of Europe are low; in Central Europe about one half of the species occur and in the Mediterranean at least 40 species have been recorded (Skuhravá & Skuhrový, in prep.). Species richness of the genus *Asphondylia* in southern Europe supports our hypothesis that at least one of the centres of diversity of the genus *Asphondylia* is situated in Europe (Skuhravá & Skuhrový 2010).

Of 22 species of *Asphondylia* known to occur in Greece, nine species are associated with Fabaceae and three with Lamiaceae, viz. *Asphondylia massalongoi* on *Ajuga chamaepytis*, *Asphondylia phlomidis* on *Phlomis fruticosa* and the unidentified *Asphondylia* sp. on *Coridothymus capitatus*.

Coridothymus REichb. is treated by some authorities as a plant genus of the family Lamiaceae including only one species, *C. capitatus* (L.) Reichb. This genus is closely related to the genus *Thymus* and some researchers consider *Coridothymus* as a subgenus of the genus *Thymus* (Tutin et al. 1964–1980, Davis 1982). In Flora Europaea it is treated as a synonym of *Thymus*.

The genus *Thymus* L. includes about 200 species occurring in Europe, the Mediterranean, Asia and Ethiopia. Differentiation of species is difficult. *Thymus serpyllum* occurs over a large area from northwestern Europe, across Central to Eastern Europe and Western Siberia, and occurs from lowlands up to the alpine zone of mountains. *Coridothymus capitatus* occurs over a smaller area in the warmer parts of Europe – in southwestern and southeastern Europe, in Northern Africa and Western Asia.

Three gall midge species are associated with *Thymus serpyllum* and related species but, according to Barnes (1949) no gall midge species has been associated with *Coridothymus capitatus*. Larvae of *Bayeriola thymicola* (Kieffer, 1888) cause rosette leaf galls on *Thymus serpyllum* and *T. praecox*. Leaves of these galls are covered with whitish hairs. Larvae of *Janetiella thymi* (Kieffer, 1888) induce small, smooth galls at the shoot tips of *Thymus serpyllum* and *T. pulegoides* (*T. chamaedrys*). These galls are formed of two pairs of leaves. Larvae of the third species *Asphondylia serpylli* Kieffer, 1898 cause galls on *Thymus serpyllum*. Only very limited information was given on this species by Kieffer (1898) who described the species in only one sentence: “Flowers on *Thymus serpyllum* are deformed. Austria.” No adult, larval or pupal specimens were subsequently described and the type material is considered to be lost (Gagné 2010).

In 2007 Polycarpus Malagaris found galls of an unidentified gall midge species causing serious damage on cultivated thyme plantings of *Coridothymus capitatus* in the Island of Samos and was successful in rearing adults. There he studied the biology and ecology of this species during 2007–2008 and his results have been published in a separate paper (Malagaris 2011).

In the present paper the species *Asphondylia coridothymi* sp. nov. is described as is *Asphondylia serpylli* Kieffer, 1898, which has not been adequately described before.

MATERIAL AND METHODS

Galls on *Coridothymus capitatus* were found for the first time at Galaxidi in Central Greece in May 1995 (Skuhrová & Skuhrový 1997). In 2007 extensive damage to thyme plantings caused by gall midges was observed in the island of Samos and also – to a lesser extent – on Mount Hymettus near Athens on the Greek mainland. Polycarpus Malagaris, an agronomist working in Samos, started to study this species with the aim of reducing populations of this gall midge species developing on thymes. He asked me to identify the causer and sent me larvae, pupae and adults. Examination of morphological characters and comparison of specimens obtained from galls on *Coridothymus capitatus* with specimens of *Asphondylia serpylli* reared from *Thymus serpyllum* showed that it is a new species (Figs 29–30).

Larvae, pupae and adults were mounted on microscope slides using Canada balsam as medium. The holotype and paratypes are deposited in the collection of M. Skuhrová in Prague (Czech Republic) and other material in the collection of Polycarpus Malagaris in Pyrgos, Samos, Greece. The neotype of *Asphondylia serpylli* Kieffer, 1898 is deposited in the collection of M. Skuhrová in Prague (Czech Republic).

Terminology of morphological characters of adults follows the terminology given in Skuhrová (1997) and Gagné (1994), terminology of larvae follows Möhn (1955), and terminology of pupae is after Möhn (1961), with some small exceptions.

Types, paratypes, galls, herbarium items with host plants and galls and all other material have been deposited in the collection of Marcela Skuhrová, Prague, Czech Republic.

TAXONOMY

Asphondylia Loew, 1850

Asphondylia Loew 1850: 21, 37, as a subgenus of *Cecidomyia* Meigen, 1803.

TYPE SPECIES. *Cecidomyia (Asphondylia) sarothamni* Loew 1850: 38 (by subsequent designation of Karsch 1877: 15).

The genus is defined by the following combination of characters:

Palpi 1–3 segmented, segments usually short. Antennae 2+12 segmented in both sexes; flagellomeres of both sexes cylindrical; three distal flagellomeres of female distinctly shortened; male flagellomeres subequal in length or slightly shortened distally, with short distal stems and tortuous circumfila; female flagellomeres with two ring-shaped circumfila connected with a commisura; wing with R_5 joining costa near, at or beyond the wing apex; Cu forked; tarsal claws simple on all legs, bent nearly at right angles, empodium as long as claws. Male genitalia consisting of thick and large gonocoxites, fused mediobasally, with apical lobe; gonostyli rounded, inserted dorsally or dorso-caudally on the gonocoxites, and with bidentate and strongly sclerotized tooth or teeth apically; cerci small, divided into two lobes; hypoproct small and emarginated. Ovipositor with two dorsal lobes, terminal part of ovipositor is aciculate.

Larvae cause galls on leaf and flower buds and on fruits of host plants belonging to various plant families. Larval chambers are covered with fungal mycelium inside. Full-grown larvae usually have large, strongly sclerotized, quadridentate sternal spatulae. Pupae are usually brownish pigmented and have various head- and abdominal structure that make it easier to leave the gall where larva developed. Pupation takes place in the gall. The pupa is not covered by a cocoon.

Identification to the species level is difficult because adults are very similar in their morphological characters. Identification in the past was based above all on the host plant species and the structure of the gall. But it is now known that the situation is complicated by the fact that not all species are host specific: some use two or more different host plant species in the course of their development exhibiting alternation of host plants.

No comprehensive key for identification of adults has been constructed. Species of the genus *Asphondylia* may be differentiated in the larval stage mainly on the shape of the sternal spatula and in the pupal stage by the shape and arrangement of the antennal and cephalic armature, prothoracic spiracles and the number and arrangement of spines on the abdominal segments. Recently molecular analyses have been used to assist differentiation of morphologically similar species (Yukawa et al. 2003, Kolesik et al. 2010).

Asphondylia coridothymi sp. nov.

(Figs 1–17, 29–30)

TYPE MATERIAL. **Holotype:** male, *Coridothymus capitatus*, flower bud gall. Greece: Samos: Pyrgos, 450 m, em. 30.3.2008, leg. Malagaris Polycarpos. Microscope slide Nr. 8317, deposited in the collection of M. Skuhřavá, Prague, Czech Republic. **Paratypes:** 3 males, 2 females, same data as for holotype. **Additional material:** 3 males, 11 females, same data; 5 larvae: Samos: Balos, Koumeika, 50 m, 1–10.10.2007; 22 exuviae of pupae: Samos: Pyrgos, 450 – 500 m, November 2007; all specimens leg. Malagaris Polycarpos.

DESCRIPTION. **Adults.** Colour of recently emerged males and females: head black, antennae brown, upper part of thorax dark brown, lateral parts red, wings smoke-grey, legs brown, upper and lower parts of abdomen dark-brown, lateral parts red, terminalia of male dark-brown. Natural colours of adults mounted on microscope slides in Canada balsam medium change into honey-coloured brown of various shade. Wing and legs are covered with thin, long setae.

Male. Body size: 2.7–2.9 mm (n=9); wing length 3.1 mm, wing width 1.1 mm. Head with large holoptic eyes. Eye bridge 8–10 ommatidia wide. Ommatidia large, circular. Mouthparts reduced. Frontoclypeus with a group of thin setae. Palpus three-segmented; the first segment globular, the second twice as long as first and the third segment three times longer than the second. All segments are densely covered with long setae.

Antennae: 2+12 segmented. Scape obconical, about twice as long as broad, pedicel smaller, ovoid to subglobular, first and second flagellomeres separated. All flagellomeres are cylindrical with very short stems, almost all of the same size. Each flagellomere is covered with tortuous adpressed circumfila forming a net and with many thin setae.

Wings are relatively large and broad with prominent alar lobe. Costa is interrupted at the point of junction with R_5 , subcosta visible only in the basal part. R_1 reaches to the first third of the anterior wing margin R_5 is slightly bent before the end and joining costa at the wing apex. Median fold present, Cu is forked. Wing surface and veins densely covered with long setae. Legs are long and covered with long hairs. Claws simple on all legs, strongly sclerotized, black, bent near midlength, empodia as long as claws.

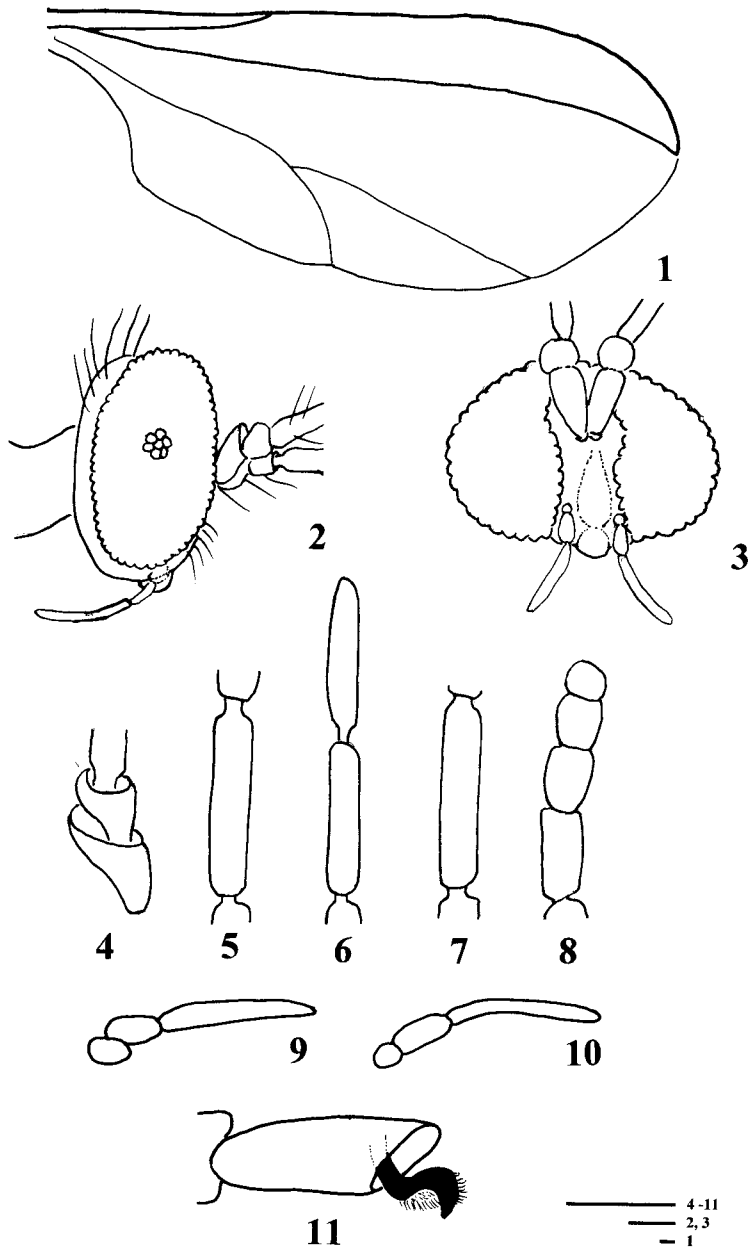
Male terminalia are relatively small. Gonocoxites are thick and ovoid, fused mediobasally; gonostyli small and ovoid, with bidentate and strongly sclerotized claw apically, densely covered with long hairs, cerci large, hemispherical and setose, hypoproct small and bilobed, with several setae in distal half, aedeagus long and thin, pointed at the end, as long as gonostyli.

Female. Similar to male unless mentioned otherwise. Body size: 2.7 mm long, wing length 2.7 mm, wing width 1.1 mm. Antennae 2+12 segmented, flagellomeres cylindrical, almost without stems, distal three flagellomeres distinctly shortened, the terminal flagellomere subglobular. Flagellomeres densely covered with microtrichia, with many sensorial hollows and hairs and with sensorial thread forming usually two rings which are connected by a commissure. Eighth abdominal segment dorsally with two densely haired lobes. Terminal part of ovipositor is aciculate.

Larva. The first instar larva has a vermicular form and is bright yellow, 0.8 mm long and 0.4 mm broad. The second instar larva is egg-shaped, bright yellow, 0.8–1.2 mm long and 0.6–0.7 mm broad. The third instar larva is fusiform with broader anterior body part and tapered posterior part, bright yellow, 2.1 mm long and 0.9 mm broad. The larva of this instar has a sternal spatula, a sclerotized organ of characteristic shape, on the ventral part of the prothorax. The head capsule is very small and bears very small antennae. The sternal spatula is 175–190 μm long, strongly sclerotized, with broad anterior part, narrow stem and broad foot. The anterior part is formed of four teeth of which the inner two are smaller than the outer. Larval skin is smooth. Abdominal segments have ventral areas with very small spines.

Pupa. Pupal exuviae are 2.5–3 mm long, slightly brown coloured. Bases of antennal sheaths are provided with narrow, strongly sclerotized marginal part. Each of a pair of very short cephalic setae is only 20 μm long. Facial part with slightly expressed upper and lower frontal horns situated medially. Upper frontal horn is formed of a small sclerotized plate resembling the human upper lip, similar to the lower frontal horn which is smaller and narrower and is accompanied by three pairs of small papillae. Each abdominal segment, except first and terminal ones, is dorsally covered with spines. The spines of the anterior part of the segments are smaller and irregularly situated, successively they are larger and in the posterior part of the segments there is a transverse row of 17–20 large spines, each 10–12 μm long. Ventral part of abdominal segments is quite without spines. The skin is formed of small, round, close-fitting plates.

DIFFERENTIAL DIAGNOSIS. Adults of *A. coridothymi* sp. nov. are morphologically similar to adults of *A. sarothamni* Loew, 1850, the type species of the genus *Asphondylia* Loew, 1850. The pupa of *A. coridothymi* sp. nov. differs from the pupa of *A. sarothamni* in the shape of the upper and lower frontal horns and by the number, size and placement of spines on the dorsal part of the



Figs 1–11. *Asphondylia coridothymi* sp. nov. 1 – wing, 2 – head of male, 3 – head of female, 4–6 male antenna, 4 – scape and pedicell, 5 – 5th flagellomere, 6 – last two flagellomeres, 7 – 5th flagellomere of female, 8 – last four flagellomeres of female, 9 – palpus of male, 10 – palpus of female, 11 – last tarsomere of female with claw and empodium. Scale bars = 0.1 mm.

last abdominal segments, as illustrated in Skuhrová & Cam (1998, Figs 17 and 18), and from the larva of *A. sarothamni* in the shape of sternal spatula as given in Möhn (1955, Table 16, Fig. 9). For differences in morphological characters between *A. coridothymi* sp. nov. and *A. serpylli* see under *A. serpylli*.

HOST PLANT. *Coridothymus capitatus* (L.) Reichenb. (Lamiaceae).

GALL. The small flower bud gall is hidden among leaves clustered on the tips of the stem, forming a gall 8–10 mm long. Inside each gall is one chamber with walls lined with fungal mycelium.

LIFE HISTORY. Only one generation develops per year. Adults emerge from the middle of March to middle of June. females usually lay one egg in the flower bud where subsequently the larva develops. Adults live briefly, at most five days. Only one larva develops inside each gall. Larval development lasts from June to October and then larvae t. Pupae hibernate in galls until the spring of the following year when adults emerge from galls (Malagaris 2011).

DISTRIBUTION. Greece: Athens, Galaxidi; Samos and Lefkada.

ETYMOLOGY. The specific name of the new species, *coridothymi*, is derived from the generic name of the host plant.

***Asphondylia serpylli* Kieffer, 1898**
(Figs. 18–28)

Asphondylia serpylli Kieffer, 1898: 20; Skuhrová 1986: 212; Skuhrová 1989: 209.

Asphondylia thymi Kieffer, 1898: 59; Skuhrová 1986: 213; Skuhrová 1989: 209.

Asphondylia proxima Kieffer, 1909: 30; Skuhrová 1986: 213; Skuhrová 1989: 209.

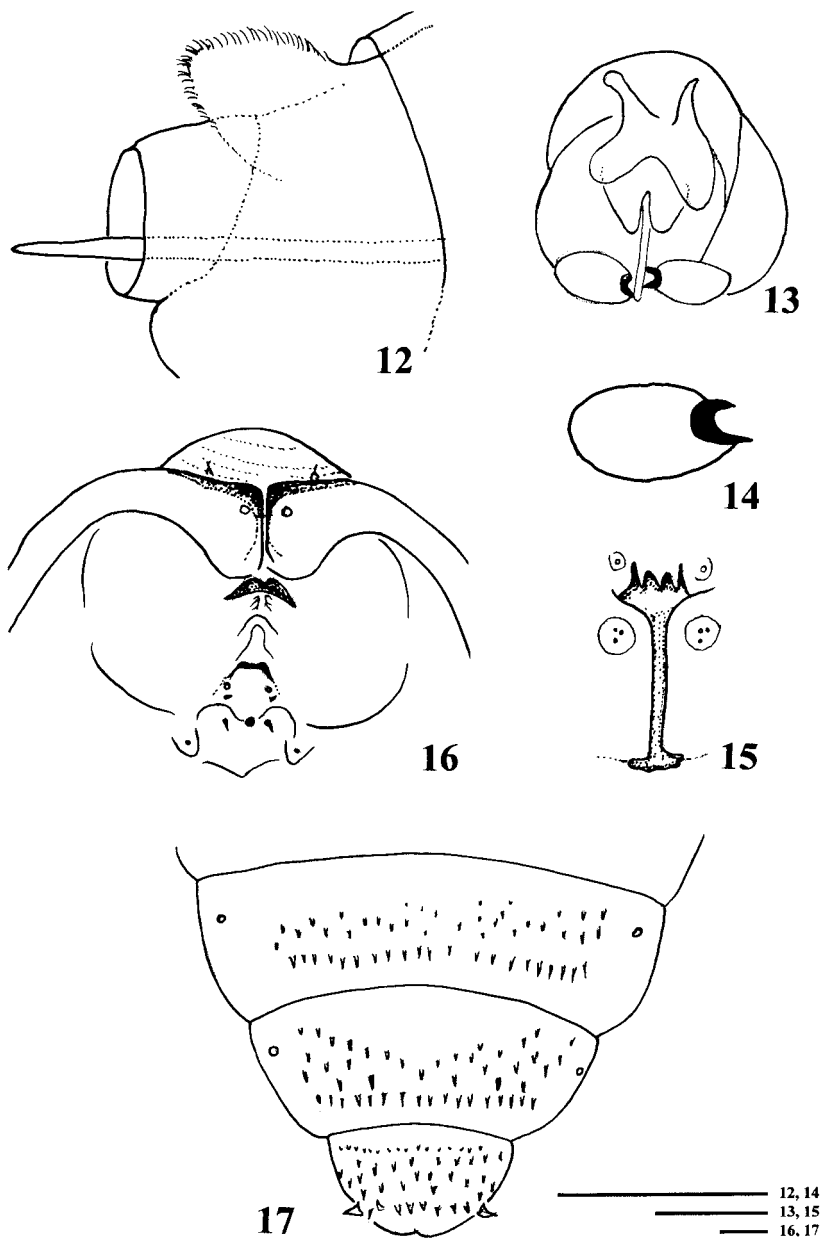
COMMENTS. Kieffer (1898: 20) gave under the name “*Asphondylia serpylli* Kieffer” the following brief diagnosis: “Flowers of *Thymus serpyllum* are deformed. Austria”, and on page 59 in “Ad-denda”, under the name “*Asphondylia thymi* nov. sp.”, a short description of the female ending with a note on the biology: “In deformed flowers of *Thymus serpyllum*.” It is obvious that Kieffer incorrectly used two different names for the same species. Later Kieffer (1913: 94) in *Genera Insectorum* used the name “*Asphondylia serpylli* Kieffer, 1892” (incorrectly attributing his reference to the year 1892). In his article published in 1892 on page 77 is written: “*Asphondylia* sp.? On deformed flowers of *Thymus serpyllum* L.” (only the genus name with a question mark and no specific name). Later Kieffer (1909) introduced even a further name as “*Asphondylia? proxima* nov. sp.” on *Thymus serpyllum* with a short diagnosis “Flower swollen and closed; red larva.”

There are therefore three names but almost nothing is known about the morphology of adults, larvae, pupae and biology. Barnes (1949: 120) summarized this situation. Kieffer’s original material has been lost and the synonymization of these three species given in Skuhrová (1986, 1989) was accepted by Gagné (2004: 84; 2010: 129).

NEOTYPE. Male, Prep. Nr. 2845, from flower bud of *Thymus serpyllum*, Bohemia: Kadov, 8 August 1965 (rearing Nr.44), leg. M. Skuhrová. Other material: one female, 2 exuviae of pupae (Prep. 2846), same data.

DESCRIPTION. **Male.** Body size: 2.6 mm; wing length 2.7 mm, wing width 0.9 mm. Head with large holoptic eyes. Ommatidia large, circular. Mouthparts reduced. Frontoclypeus with a group of thin setae. Palpus three-segmented; the first segment subglobular, the second a little longer than the first and the third segment a little longer than the second. All segments are densely covered with long setae.

Antennae: 2+12 segmented. Scape obconical, pedicel smaller and ovoid, first and second flagellomeres separated. All flagellomeres are cylindrical with very short stems, almost all flagellomeres of the same size. Each flagellomere is covered with tortuous adpressed circumfila forming a network and with many thin setae.



Figs 12–17. *Asphondylia coridothymi* sp. nov. 12 – postabdomen of female with ovipositor, 13 – male terminalia, 14 – detail of gonostyle with claw, 15 – sternal spatula of larva, 16 – head part of pupa in ventral view, 17 – last abdominal segments of pupa in dorsal view. Scale bars = 0.1 mm.

Wings are relatively large and broad. Wing surface and veins densely covered with long setae. Legs are long and covered with long hairs. Claws simple on all legs, strongly sclerotized, black, bent near midlength, empodia as long as claws.

Male terminalia are relatively small. Gonocoxites are thick and ovoid, fused mediobasally; gonostyli small and ovoid, with bidentate and strongly sclerotized claw apically, densely covered with long hairs, cerci large, broad, hemispherical and setose, hypoproct small and bilobed, aedeagus long and thin, pointed at the end, a little longer than hypoproct.

Female. Similar to male unless mentioned otherwise. Body size: 2.4 mm long, wing length 2.7 mm, wing width 0.9 mm. Antennae 2+12 segmented, flagellomeres cylindrical, nearly without stems, distal three flagellomeres distinctly shortened, the terminal flagellomere subglobular. Flagellomeres densely covered with microtrichia, with many sensorial hollows and hairs and with sensorial threads forming usually two rings which are connected by a commissure. Eighth abdominal segment dorsally with two densely haired lobes. Terminal part of ovipositor is aciculate.

Larva. Unknown.

Pupa. Pupal exuviae (after emergence of a male and a female) are 2.7–2.8 mm long, slightly brown coloured. Bases of antennal sheaths are provided with short antennal horns. A pair of very short cephalic setae 18 µm long is present. Facial part with slightly expressed upper and lower frontal horns situated medially. Upper frontal horn is formed of a small sclerotized plate resembling the human upper lip, on each side with a small papilla with a very short seta. The lower frontal horn is very small and resembles in shape a letter „x“ with black central part. Dorsal side of abdominal segments, with the exception of the first and terminal, are provided with a row of 15 – 18 spines posteriorly. Anterior part of these segments bears several very small spines arranged irregularly situated. The ventral part of the abdominal segments is quite without spinulae. The skin is formed of small, round, close-fitting plates.

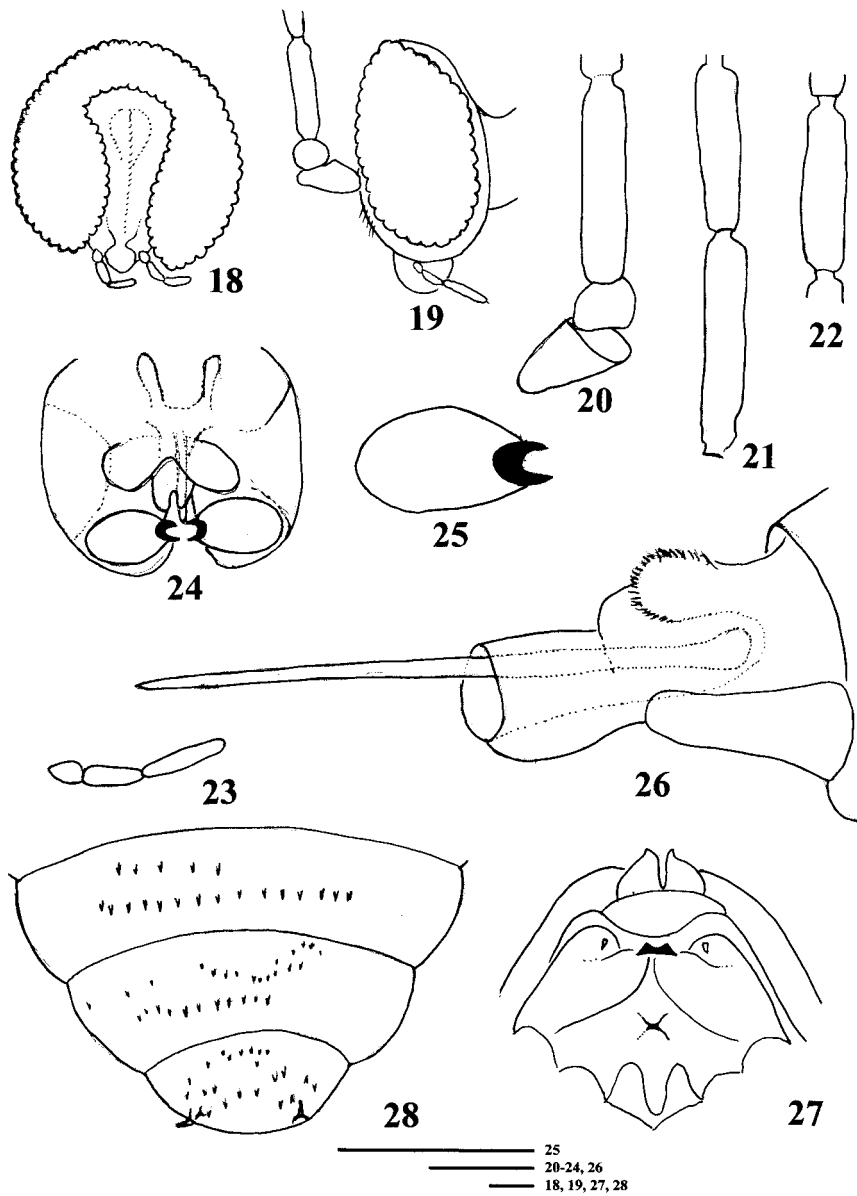
DIFFERENTIAL DIAGNOSIS. Adults of *Asphondylia serpylli* are morphologically very similar to adults of *A. coridothymi* sp. nov., but adults of *A. serpylli* are a little smaller. The third palpal segment of *A. serpylli* is shorter, only 1.3 times longer than the second segment, whereas the third palpal segment of *A. coridothymi* sp. nov. is 2.5 times longer than the second segment. The cerci of male terminalia in *A. serpylli* are rounded with broad and deep emargination, in contrast to cerci of *A. coridothymi* sp. nov. which are triangular with very narrow incision. The pupa of *A. serpylli* differs from the pupa of *A. coridothymi* sp. nov. in the shape of the upper and lower frontal horns (Fig. 16, Fig. 27) and by the number, size and placement of spines on the dorsal part of the last abdominal segments (Fig. 17, Fig. 28). Antennal horns at the bases of antennal sheaths of *A. serpylli* consist of a pair of two small pointed lobes (Fig. 27), whereas the bases of the antennal sheaths of *A. coridothymi* sp. nov. are without such lobes, with only a sclerotized field present on the margin (Fig. 16).

HOST PLANT. *Thymus serpyllum* L. (Lamiaceae).

GALL. Small flower bud gall in inflorescence, of size only 2.5 – 3 mm, internal chamber with walls covered with fungal mycelium.

LIFE HISTORY. Two generations develop per year. Galls of the first generation are found at the beginning of summer, usually in June. Inside each gall only one larva develops where it also pupates. Adults emerge in August. females lay eggs on flower buds in inflorescences of thyme and larvae (or pupae) hibernate in galls up to the following spring.

DISTRIBUTION. *Asphondylia serpylli* is distributed throughout Europe but it is very rare, usually known only from a single locality in each country where it has been recorded. The galls of *A. serpylli* have been found in the most southern parts of Sweden and Finland, in UK, France, Spain, Andorra, Germany, Czech Republic, Austria, Hungary, Italy, Croatia, Serbia, Montenegro and in Macedonia.



Figs 18–28. *Asphondylia serpylli* Kieffer, 1898. 18 – head of female in frontal view, 19 – head of male in lateral view, 20 – scape, pedicel and the first flagellomere of male, 21 – first and second flagellomeres of female, 22 – fifth flagellomere of male, 23 – palpus of male, 24 – male terminalia, 25 – detail of gonostylus with claw, 26 – female postabdomen with ovipositor, 27 – head part of pupa in ventral view, 28 – last abdominal segments of pupa in dorsal view. Scale bars = 0.1 mm.



Figs 29–30. *Asphondylia coridothymi* sp. nov. 29 – adults reared from flower bud galls on *Coridothymus capitatus*, female above, male below, 30 – small green gall caused by the larva *Asphondylia coridothymi* sp. nov. in the inflorescence of *Coridothymus capitatus* (both images by Polykarpos Malagaris).

COMMENTS. Both gall midge species, *Asphondylia serpylli* and *A. coridothymi* sp. nov., causing similar flower bud galls on related host plant species, differ from each other not only in morphological characters but also in their biology. Each of them is associated with its own host plant species and occupies its own distribution area: *Asphondylia serpylli* occupies a large distribution area spread over the whole Europe and *A. coridothymi* sp. nov. only a small distribution area in the most south-eastern part of Europe – in south-eastern Greece. The life cycle of *A. coridothymi* sp. nov. includes only one generation in contrast to *A. serpylli* which has two generations per year. Both gall midge species are well adapted in their life cycles to the flowering period of their host plants. It is relatively long in *Thymus serpyllum* in Central Europe lasting several months from spring up to autumn, in contrast to a very short flowering period of *Coridothymus capitatus* in south-eastern Greece where it includes only two months, May and June. Subsequently the inflorescences of this host plant dry out owing to high temperatures and dry weather.

Acknowledgements

I would like to express my thanks to Dr K. M. Harris (Ripley, Woking, Surrey, England) for valuable comments on the manuscript and for improvements of the English text. I thank Polykarpos Malagaris for permission to use his two images of *Asphondylia coridothymi* sp. nov. in my article.

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