The first report of gall induction in the sawfly subfamily Allantinae (Hymenoptera: Tenthredinidae)

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Great Burnet, *Sanguisorba officinalis* L. (Rosaceae), is the previously unknown larval host plant of the sawfly *Empria testaceipes* (Konow, 1896) (Tenthredinidae: Allantinae). We report here that young, endophagous larvae inhabit galls in the leaves, while later instars are external feeders on leaves. This is the first report of a gall-inducing habit in the subfamily Allantinae. The galls of *E. testaceipes* on *S. officinalis* and the larvae are described and illustrated, and the distribution of this rarely recorded sawfly is summarised.

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1. Introduction

Larvae of the sawfly subfamily Allantinae (Hymenoptera: Tenthredinidae) typically feed externally on the leaves of a wide variety of herbaceous and woody plants in ten families of dicotyledonous angiosperms (Smith 1979, Lacourt 1999). The host plant and larva of *Empria testaceipes* (Konow, 1896) were hitherto unknown. During the 9th International Symphyta Workshop held in June 2005 in the Lower Tatras, Slovak Republic, A. Kehl found young larvae of what later proved to be this species inhabiting galls on the leaves of Great Burnet (*Sanguisorba officinalis* L., Rosaceae). Although many tenthredinid sawfly groups induce various galls on plants (Roininen *et al*. 2005), a gall-inducing habit has not previously been reported for any species of the Allantinae. Here we present details of these observations, describe the appearance of the galls and larvae, and summarise the distribution of *Empria testaceipes*.

2. Material

In Slovakia, Lower Tatras, Liptovský Hrádok ESE 9 km, Svarín W 2 km, Svarínske lúky, 47°00.71N 19°49.38E, 690 m a.s.l., about 50 larvae were collected from *Sanguisorba officinalis*, 19.VI.2005. One female and three males emerged April 2006 in heated room, leg. A. D. Liston and

S. M. Blank, coll. Deutsches Entomologisches Institut (DEI), Müncheberg, Germany. Numerous larvae are also preserved in collections of DEI, A. Kehl, and T. Nyman.

The collecting locality is an extensively managed meadow, on the floor of the Demänovská Valley beside the Demänovská River. Vegetation is herb rich grassland, interspersed with bushes and young trees of *Salix* spp. and *Betula* sp. Considerable local differences in the flora of the site seemed to be related mostly to the distribution of slightly raised deposits of freely draining alluvium. The patches of *S. officinalis* contained several hundred plants, but these patches were apparently restricted to a rather small, comparatively wet part of the area. Galls caused by *Empria testaceipes* were abundant, indicating the presence of at least 200 larvae.

3. Results

3.1. Description of gall

Galls occurred on the lower, rosette leaves of *Sanguisorba officinalis*. Flower stems had not yet been produced at the time of collection of the larvae. The closed galls are irregular in shape, strongly domed above the upper side of the leaves, but flush with the lower leaf surface. Whilst the walls of the upper surface are comparatively thick, apparently because of abnormal growth of the mesophyll layer, the underside seems not to be so affected. As the larva develops, the floor of the gall is reduced to little more than the thickness of the epidermis (Fig. 1a). Exterior of the gall may remain green, but upper surfaces of many older ones were coloured red. The gall is positioned on one side of the midrib of a leaflet. Length of the axis of the gall parallel to the midrib varies widely from approximately 5 mm up to c. 20 mm (Figs. 1b, c). The longer galls thus occupy almost the whole length of the leaflet (Fig. 1b). Oviposition scars could not be identified. However, the larger galls appear to consist of a chain of confluent chambers, possibly resulting from multiple insertions of the ovipositor (as in Nematinae species of the *Pontania dolichura* species group, or *Phyllocolpa* spp.).

3.2. Behaviour of larva

One larva inhabits only a single gall. Faeces remain inside the gall. The first instar larva remains entirely within the gall chamber, but the second instar makes a hole in the wall, usually on the underside (Fig. 1d), and probably leaves the gall to skeletonise small areas of the leaf. It was not observed whether this instar re-enters the gall between periods of external feeding, nor was it clear at what exact stage of development of the larva the gall is permanently vacated. From the third instar onwards, feeding is entirely exophagous. These larger larvae are found mostly on the leaf undersides, adopting a coiled posture when not feeding.

Larvae were reared indoors in a laboratory at the DEI by the first author. Galled *Sanguisorba* leaves were put in narrow-necked flasks filled with water, and the flasks placed in a large, ventilated, glass chamber. Larger larvae were fed with Creeping Cinquefoil (*Potentilla reptans* L., Rosaceae) as a substitute for *Sanguisorba officinalis* under rearing conditions, because *S. officinalis* could not be obtained locally. They fed on *P. reptans* for 1–2 weeks and successfully completed larval development. M. Kraus (pers. comm.) reports that *Sanguisorba officinalis* was not present at the locality where he captured an adult specimen of *E. testaceipes* in Bavaria. The possibility that *E. testaceipes* also uses other Rosaceae species as larval hosts should therefore be considered.

Larvae completed feeding during the first two weeks of July. It was presumed that this species of *Empria*, like all known congeners (Smith 1979), is univoltine. They were therefore given sphagnum moss, cut stems of *Rubus* and *Sambucus*, and some 3–4 cm diameter corks (natural cork, not made of glued fragments) to overwinter in. Examination of these materials showed that the corks had been strongly favoured as the site for diapause. The containers were kept outside, but under cover, during the winter and periodically moistened. Emergence was unnaturally early, after the containers were brought indoors in March to a heated room. No parasitoids were reared.

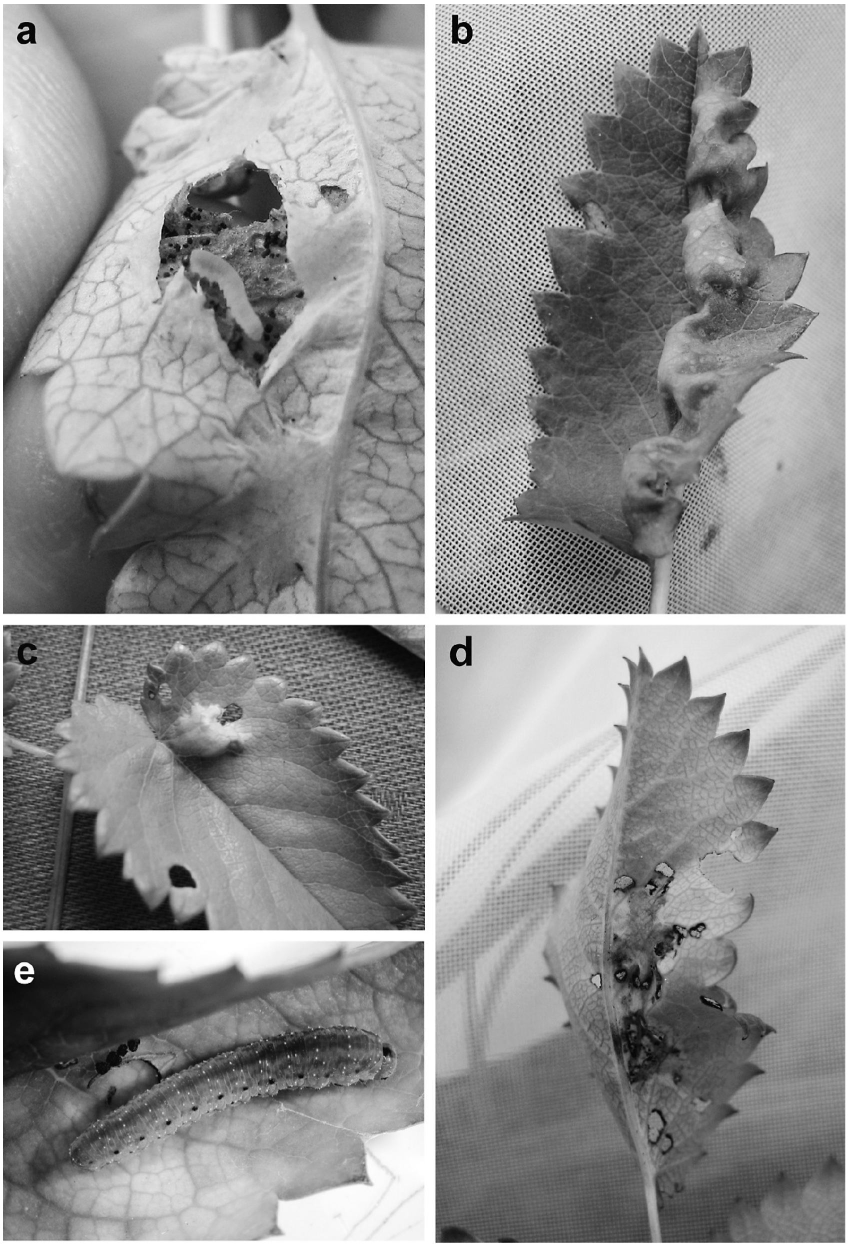

Fig. 1. Galls and larvae of *Empria testaceipes* (Konow) on *Sanguisorba officinalis* L., Slovakia, Lower Tatra. – a. Underside of gall, opened to show a young endophagous larva. – b, c. Upperside of large and small galls. – d. Underside of gall. – e. Mature exophagous larva. Figs. 1a–d by T. Nyman, Fig. 1e by C. Kutzscher.

3.3. Description of larva

Larval material has been sent to M. Prous and M. Heidemaa (Tartu University, Estonia), who are preparing a key to the larvae of European *Empria* species. Because a detailed morphological characterisation will appear therein, only a brief description is given here.

Young larva (Fig. 1a) (length 3–5 mm): head pale brown apart from black stemmatum. Body uniformly pale green. The first markings to develop are a row of black spots just above each spiracle.

Mature larva (Fig. 1e) (length 11–14 mm): head pale brown with triangular marking running along coronal suture, its anterior point ending exactly where coronal suture meets the frontal suture. Thoracic legs brown. Body pale green with a rather complex pattern of darker green markings, comprising a medial dorsal stripe and on each body side a supraspiracular stripe (in which the blackish supraspiracular flecks are situated) and a slightly narrower stripe between these. A narrow interrupted stripe also runs along the ventral edges of the surpedal lobe.

The precise extent of these green pigmented areas is visible in alcohol material, but in the living larva is obscured by the underlying colour of haemolymph and gut. The living larva appears to the naked eye mottled dark green dorsally, pale green ventrally, with conspicuous white (wax covered) glandubae on dorsum of thorax and annulets 2 and 4 of abdominal segments. Supraspiracular fleck occupies approximately full length of annulet 2.

Colouration of mature larva is very similar to *E. pumila* (Konow, 1896) (Heidemaa & Prous 2006), which is attached to *Filipendula ulmaria* (L.) Maxim. Mature larvae of *E. testaceipes* are smaller than those of *E. pumila*, which are 13–17 mm long according to Heidemaa and Prous (2006). This difference is to be expected, because the length of *E. testaceipes* imagines (4–5 mm based on our reared specimens and two males, caught as adults, in the DEI collection) is less than that of any other *Empria* species, except perhaps for the smallest individuals of *E. alpina* Benson, 1938 and *E. gussakovskii* Dovnar-Zapolskij, 1929. Imagines of *E. testaceipes* are also more slender than other species.

4. Discussion

A search of literature on plant galls failed to reveal previous records of gall induction within the subfamily Allantinae, or similar galls made by Tenthredinidae on *Sanguisorba*, apart from inconclusive comments by Buhr (1965) for *Claremontia puncticeps* (Konow, 1886) (as *Monophadnoides puncticeps*) (Blennocampinae). This work tentatively attributes to *C. puncticeps*, thickening of leaves and leaf-petioles and deformation of young leaflets. Such a plant is illustrated by Dittrich (1924: plate 45, Fig. 61), who however stated that the gall inducer is a *Nematus* species. A second type of damage is described by Buhr (translated from German): "Sometimes on some such deformed plants 4–6 irregular, pale green "procecidia" are simultaneously found scattered over the compound leaf, projecting mainly from the leaf underside. It could not be established whether these are caused by the same wasp". The size of these structures is not indicated. It seems unlikely that *E. testaceipes* is responsible for either of these types of deformation, because the appearance of the compound leaves and their ribs was not otherwise noticeably affected by the presence of *E. testaceipes* galls, and the swellings described by Buhr protruded more from the undersides of the leaflets (in *E. testaceipes* only from the upper sides).

There are no other galls known on *Sanguisorba*, or related genera, in Europe which resemble those of *E. testaceipes*. For this plant genus, Buhr (1965) keys the galls of six arthropod species, comprising the mite *Aceria sanguisorbae* (Canestrini, 1891) (Acarina), the gall midge *Dasineura sanguisorbae* (Rübsaamen, 1890) (Diptera: Cecidomyiidae), and four apparently polyphagous aphids and coccids (Homoptera). No gall wasps (Hymenoptera: Cynipidae) are known from *Sanguisorba*, although a few species are stem gallers on the related genus *Potentilla* (Ronquist & Liljeblad 2001). *E. testaceipes* is therefore, according to present knowledge, one of at most two hymenopterans which cause galls on *Sanguisorba*.

While *E. testaceipes* is the only *Empria* species so far known to be attached to *Sanguisorba*, this host-plant association is not unexpected. Of the 49 *Empria* species worldwide currently regarded as valid (Taeger & Blank 2006), hosts are recorded for 20 species. Their combined host-plant spectrum includes plants from the Betulaceae, Salicaceae, and multiple woody and herbaceous genera in the Rosaceae (e.g., *Filipendula*, *Rubus*, *Fragaria*, *Potentilla* and *Geum*) (Smith 1979, Lacourt 1999). Rosaceous plants also support numerous species in other allantine genera, but the presently known collective host range of the subfamily comprises ten plant families (Smith 1979, Lacourt 1999). Of the approximately 210 species of Allantinae whose larvae are known, only a single species has previously been found to feed internally: larvae of the taxonomically isolated *Eopsis beaumonti* Benson, 1959 mine inside leaf stalks of Common Bistort, *Polygonum bistorta* L. (Polygonaceae) (K. Beneš, pers. comm.).

Because no other gall inducers are known from the Allantinae, it is very likely that the galling habit has been derived independently in *E. testaceipes*. Gall-inducing sawflies are so far known from multiple, phylogenetically widely separated taxa of the Xyelidae and Tenthredinidae (Lorenz & Kraus 1957, Roininen *et al*. 2005). Within Tenthredinidae, galling species have been found only in the subfamilies Nematinae and Blennocampinae (Roininen *et al*. 2005, Nyman *et al*. 2006). Swelling of the plant tissue around the oviposition site has, however, also been recorded in tribes Blennocampini and Phymatocerini of Blennocampinae and genera of Nematinae whose larvae feed exophytically (Lorenz & Kraus 1957, Scheibelreiter 1973, Zinovjev & Vikberg 1998). In these groups it is not always clear whether the pustule which develops around the egg is caused by a secretion applied by the female during oviposition, or whether the plant tissue is simply distended by an increase in egg size caused by absorption of fluid from the host. Similar small swellings at the oviposition site also occur in some Empriini (Allantinae) species (genera *Empria*, *Monsoma*, *Monostegia*), but these are vacated immediately after the larva hatches (Miles 1936, Kontuniemi 1951, 1955, Pieronek 1980, Altenhofer & Pschorn-Walcher 2003). The structure inhabited by the young larva of *Empria testaceipes* is so much larger than the larva which it encloses, and the upper walls so strongly distended and thickened (thus indicating a stimulation of growth by the causative organism not resulting from simple mechanical influence on the host-plant's tissues) that it must be regarded as a true gall in the sense of Meyer (1987) and Redfern and Askew (1992). Amongst previously described sawfly life histories, the larval development of the *Amauronematus longiserra* species group (Nematinae) on *Salix* species (Salicaceae) seems to most closely parallel that of *E. testaceipes*. The galls formed by these nematine species are similar to *E. testaceipes* galls in that growth of the upper leaf tissues is accelerated, and the underside of the leaf is reduced to the thickness of the epidermis (Zinovjev & Vikberg 1998). However, unlike *E. testaceipes*, the larvae of the *A. longiserra*-group leave the gall and start to feed externally only one or two days after hatching from the egg.

E. testaceipes, described by Konow (1896) from the holotype male collected in Moravia, Czech Republic, is a very rarely recorded species, at least in Europe. Three other previously published European records, all based on single specimens, are from Germany and Slovakia (Kraus 1998; Roller & Lukáš 1999). Further occurrences are reported from the European parts of Russia (Zhelochovtsev & Zinovjev 1996), Mongolia, and the Irkutsk Region of Siberia (Muche 1968). As already pointed out by Conde (1940), the repeatedly mentioned presence of *E. testaceipes* in the Middle East (Enslin 1914), Asia Minor (Zhelochovtsev & Zinovjev 1988), or Iraq (Lacourt 1999) is a result of misidentifications of *E. archangelskii* Dovnar-Zapolskij, 1929. Imagines of these species can be identified using the key by Zhelochovtsev and Zinovjev (1988). The description of *Emphytus immersus* (Klug, 1818) in Stephens (1835), said to have been collected in the area of London, matches *Empria testaceipes* but not *E. immersa* (Klug 1818). This is possibly an indication that *E. testaceipes* is, or was, more widespread in Europe than is at present thought. The ability to recognise the galls should in future enable the easier detection of this rare sawfly. The importance already attached to the conservation of *Sanguisorba officinalis* as a host plant for endangered butterfly species (e.g., Bergmann *et al*. 2005) may increase the likelihood that some potential and actual habitats of *Empria testaceipes* receive adequate protection. Finally, we would like to recommend study of the behaviour of the second instar larvae, which could not be satisfactorily clarified in the present study, as a subject worthy of future examination.

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