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First detection of the southern green stink bug parasitoid *Trichopoda pennipes* (Fabr.) (Diptera: Tachinidae) in Western Switzerland

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Specimens of the feather-legged fly, *Trichopoda pennipes* (Fabricius, 1781), were detected in Gy, Perly and Monniaz (canton of Geneva, Switzerland), parasitizing adults of *Nezara viridula* (L.). This is the first record of this Nearctic species in Switzerland North of the Alps, and one of the first records in temperate Europe. *T. pennipes* could have a potential to control the population of *N. viridula*, a pest that causes increasing damages in various crops and is known to be the principal host of this tachinid fly.

Keywords: Tachinidae, parasitism, *Nezara viridula*, biological control, pest regulation.

INTRODUCTION

The feather-legged tachinid fly *Trichopoda pennipes* (Fabricius, 1781) is an endoparasitoid of adults and late-instar nymphs of the southern green stink bug (SGSB), *Nezara viridula* (L.) (Todd 1989). Native to the Nearctic region, this species has been accidentally introduced in Italy, where it was first recorded in 1988 near Rome (Colazza *et al.* 1996) and is now well established in this country (Colazza *et al.* 1996; Salerno *et al.* 2002; Cargnus *et al.* 2011). In following years, it was found in several other Mediterranean countries: southern France (Tschorsnig *et al.* 2000), Spain (Peris 1998; Tschorsnig *et al.* 2000), Slovenia (De Groot *et al.* 2007), Portugal (Diptera.info 2007a; Diptera.info 2007b), Albania (see Tschorsnig *et al.* 2012), Croatia (Bystrowski 2012), and Israel (Freidberg *et al.* 2011). The species was also detected in Hungary (Sándor 2014), the Netherlands (Zeegers 2010) and northern France (Galerie-insecte 2015). It remains unknown whether it reached Israel and the Netherlands via direct spreading from Italy or by a separate introduction as it happened in Spain (Tschorsnig *et al.* 2000). In Switzerland, *T. pennipes* was detected for the first time in Ticino, in 2006 (Obrecht 2014).

This article presents new records of *T. pennipes* for Switzerland, in the canton of Geneva, and includes notes on its morphology, biology and hosts, as well as some perspectives of its implication in biological control.

RECORDS IN THE CANTON OF GENEVA

Seven parasitized SGSB were found at three different sites in Geneva canton on three different host plants (hollyhock, cucumber, eggplant). Four matures maggots of *T. pennipes* had emerged from some of these bugs.

One adult of *N. viridula* was collected manually on common hollyhock (*Alcea rosea* L.) at Gy (Geneva, 508.627 / 122.967) in a house garden (15.vii.2015). This individual was carrying three eggs fixed on its head and thorax (Fig. 1). The specimen was placed in a small box, fed with fresh bean pods, and sunflower and squash seeds, and maintained at room temperature at the University of Applied Sciences and Arts of Western Switzerland in Geneva (UASWS). On 3 August 2015, a maggot left the bug's body and immediately formed its puparium, soon after the parasitized specimen died. A female of *T. pennipes* (Fig. 2) emerged from the puparium (Fig. 3) 14 days later.

Later, three females and one male of the SGSB parasitized by *T. pennipes* eggs were collected in Perly (Geneva, 496.484 / 113.113), on cucumber cultivated in tunnels. The eggs were located on the abdomen, the pronotum and the corium of the hosts. The first specimen, a male, was collected on 11 September 2015 and kept at a constant room temperature of 25°C in the Agroscope centre of Changins (canton of Vaud). It died two days after its collection (13.ix.2015) and the maggot it contained (Fig. 4) emerged and formed its puparium readily. An adult of *T. pennipes* emerged 13 days later (26.ix.2015). Two other individuals of parasitized *N. viridula* were collected on 25 September 2015 and were still alive during the redaction of this paper. Another specimen of the SGSB was found dead on 30 September 2015 with one empty egg on the pronotum. The mature larva of the parasitoid had probably already emerged.

On the same date, SGSB specimens without eggs were collected and reared in the laboratory. One month later, one puparium was present in the box (29.x.2015),

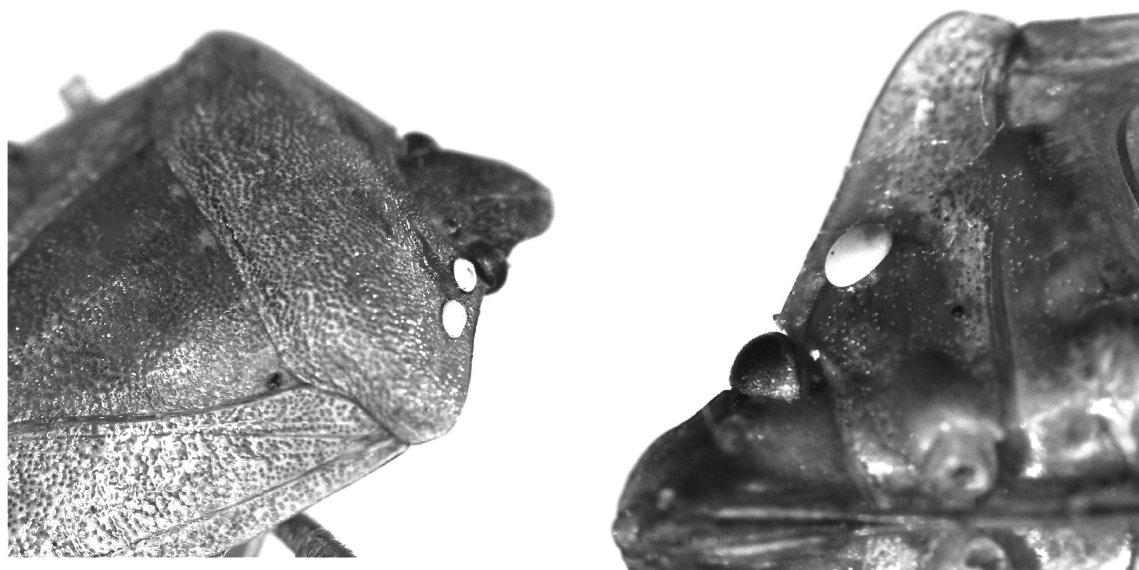


Fig. 1: Specimen of *Nezara viridula* collected at Gy (GE) bearing three eggs of *Trichopoda pennipes*. On the left: two eggs stuck on head and pronotum. On the right: one egg stuck on the propleuron (Photos by Gaël Pétremand, 2015).



Fig. 2: Female of *Trichopoda pennipes* that emerged from the specimen of *N. viridula* in August 2015 (Photo by Gaël Pétremand, 2015).

meaning that eggs probably had been laid on the late-instar nymph of the bug. Finally, several adults of *N. viridula* were collected in eggplant tunnels at Monniaz (Geneva, 512.611 / 121.873, 1.x.2015) and placed in constant room temperature of 23°C at the UASWS. None of them showed eggs on their body. However, a puparium of *T. pennipes* was found in the box on 28 October 2015. The two last puparia did not produce adult flies during the redaction of this paper.

MORPHOLOGY AND BIOLOGY OF *T. PENNIPES*

The adult parasitoid is an easily recognizable Trichopodini, characterized by a row of flattened bristles on the hind tibiae (Fig. 2). Adults are about 10 mm long with a velvety black head. The pronotum is yellowish and shows four longitudinal black stripes. The rest of the thorax and the scutellum are blackish. The abdomen is bright orange, sometimes with a black tip in males, whereas the female's abdomen varies from completely black to orange with a black tip. The wings are mostly black with a hyaline posterior margin, males having a pale ferruginous costal area. Females usually show uniformly black wings, although coastal ferruginous marks sometimes occur (Worthley 1924b).

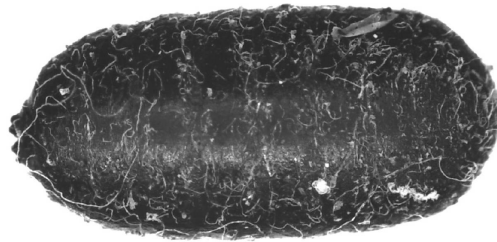


Fig. 3: Puparium of *Trichopoda pennipes* (Photo by Gaël Pétremand, 2015).

In optimal climatic conditions *T. pennipes* shows two to three generations per year. The female lays one to several white-grey oval-shaped eggs on the adults (Fig. 1), or occasionally on late instar-nymphs of large bug species (Salerno *et al.* 2002). Each female produces several hundred eggs during its lifespan. After hatching, neonates perforate the host tegument and enter its body. However, in case of superparasitism, only one larva can survive. The mature maggot (Fig. 4) emerges through the anal extremity of the bug (which dies rapidly), and readily enters the upper soil layer to form a dark brown-red puparium (Fig. 3) (Worthley 1924a). Pupation requires about two (in summer) to four weeks (in spring) (Cargnus *et al.* 2011). *T. pennipes* adults mostly feed on nectar of flowers. Overwintering occurs in the larval stage within the host. Imagos emerge in the following late spring or early summer (Worthley 1924a).

HOSTS OF *T. PENNIPES* IN EUROPE

T. pennipes is known to parasitize several hosts of various Heteroptera families in the New World (Pentatomidae, Coreidae, Alydidae, Pyrrhocoridae) (Arnaud 1978) some of which are of economic importance (Schaefer & Panizzi 2000). However, the most common host is *N. viridula* (Salerno *et al.* 2002). In Europe, since its fortuitous introduction, *T. pennipes* has only been found parasitizing *N. viridula* except for an isolated Italian record on *Graphosoma lineatum* L. (Cerretti & Tschorsnig 2010).

The SGSB is native to Mediterranean and/or Ethiopian regions (Todd 1989). In Europe it has recently become established in non-Mediterranean countries: Hungary, the United Kingdom, Germany and Switzerland (see Rabitsch 2008). It has also been found in Austria, Belgium and Finland, where it is, however, considered as not yet established (Rabitsch 2008). In Switzerland this invasive bug is present, at least occasionally, in most of low altitude areas. In the canton of Geneva, it is



Fig. 4: Maggot of *Trichopoda pennipes* after its emergence from the bug (Photo by Gaëtan Jaccard, 2015).

nowadays a common pest of greenhouse cucumber and eggplant crops and of house gardens and green roofs of the town of Geneva. In the canton of Vaud, it has been repeatedly reported from soybean crops around Nyon and from protected solanaceous crops near Yverdon and elsewhere.

The brown marmorated stink bug, *Halyomorpha halys* (Stål, 1855) (Pentatomidae), is also cited as a host of *T. pennipes* in North America (Rice *et al.* 2014; CABI 2015), and thus the fly could participate in the control of this invasive pest detected in Zürich, for the first time in Europe, in 2007 (Wermelinger *et al.* 2008). Since its establishment in Switzerland, this bug has spread in neighbouring countries: France, Germany, Liechtenstein and Italy, but also in Hungary and Greece (see Haye *et al.* 2015). Today, the species is observed throughout Switzerland from St. Gallen to Geneva in the low altitude areas, though its presence is for now restricted mostly to urban areas, inducing very few damages to crops.

Another potential host in Europe is the western conifer seed bug *Leptoglossus occidentalis* Heidemann, 1910 (Coreidae) that is parasitized by *T. pennipes* in Connecticut (USA) (Ridge-O'Connor 2001). This bug was first found in northern Switzerland in 2006 (Wyniger 2007) and is rather well established today at least in some regions (Elsa Obrecht pers. com.).

Other known hosts do not occur in Europe but *T. pennipes* could possibly develop on a larger range of Heteroptera species, given the diversity of host families recorded in the New World.

DISCUSSION

The survey of the SGSB in the canton of Geneva revealed the presence of *T. pennipes* for the first time in the North of the Alps area in Switzerland. However, it is impossible to assess how *T. pennipes* reached this region yet. Did it spread naturally from France to Switzerland given that it was found inter alia in the Department of Isère (about 100 km away from Geneva canton)? Did it reach this Swiss area passively through parasitized *N. viridula* via the freight of goods by trucks or planes from Ticino, Italy or from other European or extra-European countries? To answer these questions, some additional records are required, as well as genetic studies. In order to get more data on the dispersion of *T. pennipes* in Switzerland or elsewhere, and to initiate research on its biology and behaviour, the authors would greatly appreciate information on any further records and observations of this beneficial fly.

The feather-legged fly clearly deserves investigations about its potential as a biocontrol agent, as some attempts of introduction to control *N. viridula* or *Anasa tristis* (De Geer 1773) were successful in Hawaii and California (Davis 1964; Pickett *et al.* 1996). However, other experiments led to equivocal results in Australia, South Africa, Argentina and the Fiji Islands (see Salerno *et al.* 2002). Salerno *et al.* (2002) observed a maximum rate of parasitism of nearly 25 % of *N. viridula* populations by *T. pennipes* in various crops distributed in two areas of central Italy. In Hawaii, a 100 % rate of parasitism of *N. viridula* has been reported (Davis 1964).

In the current context of climate warming, damages due to the SGSB and brown marmorated stink bug will probably increase during the next decades. Given the potentiality of *T. pennipes* in the control of *N. viridula* populations, an effort of investigations should be done to assess: 1) the possibility of the parasitoid to

establish permanently in the North of the Alps area in Switzerland, 2) its capacity to survive brief periods of adverse climatic conditions and 3) its potential for the control of *N. viridula* and/or other Pentatomidae species.

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RÉSUMÉ

Des individus de *Trichopoda pennipes* (Fabricius, 1781) parasitant des adultes de *Nezara viridula* (L.) ont été récoltés à Gy, Perly et Monniaz (canton de Genève, Suisse). C'est la première mention de cette espèce néarctique au nord des Alpes en Suisse, et une des premières mentions en Europe tempérée. *T. pennipes* pourrait avoir un potentiel de régulation des populations de *N. viridula*, un ravageur qui inflige des dégâts de plus en plus importants dans différentes cultures et connu comme étant l'hôte principal de cette mouche tachinide.

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