

***Xenos vesparum* Rossius, 1793 (Strepsiptera: Xenidae) –  
first records in Poland with a review of the species' biology**MAREK L. BOROWIEC <sup>1</sup>, BOGDAN WIŚNIEWSKI <sup>2</sup>, WALDEMAR ŻYŁA <sup>3</sup><sup>1</sup> Corresponding author; Department of Entomology, University of California at Davis, One Shields Avenue,  
Davis, CA95616; e-mail: mlborowiec@ucdavis.edu<sup>2</sup> Ojców National Park, 32-047 Ojców, Poland; e-mail: bogdan@isez.pan.krakow.pl<sup>3</sup> Upper Silesian Museum, Nature Division, pl. Jana III Sobieskiego 2, 41-902 Bytom;  
e-mail: wzyla@muzeum.bytom.pl

BOROWIEC M.L., WIŚNIEWSKI B. & ŻYŁA W. 2012: *Xenos vesparum* Rossius, 1793 (Strepsiptera: Xenidae) – first records in Poland with a review of the species' biology. *Acta Musei Moraviae, Scientiae biologicae* (Brno) **97(2)**: 7–12. – *Xenos vesparum*, a species of the enigmatic insect order Strepsiptera is reported for the first time from the territory of Poland from eight localities in six physiographic regions: Lower Silesia (Dolny Śląsk), Trzebnickie Hills (Wzgórza Trzebnickie), Upper Silesia (Górny Śląsk), Kraków-Wieluńska Upland (Wyżyna Krakowsko-Wieluńska), Bieszczady Mts (Bieszczady), and Pieniny Mts (Pieniny). We also provide a review of the species' biology and its distribution in Europe.

**Key words:** Strepsiptera, *Xenos vesparum*, *Polistes*, Poland

**Introduction**

*Xenos vesparum*, belonging to the family Xenidae (POHL & BEUTEL 2005), is the first strepsipteron described and also one of the best-studied species. Xenidae are parasites of Vespidae (including Eumeninae) and *Xenos* parasitizes (= stylozites) many species of *Polistes* paper wasps. In central Europe, *X. vesparum* is the only strepsipteran parasite of *Polistes* (KINZELBACH 1978). Beani recently reviewed the life cycle of *X. vesparum* and the account below, unless cited otherwise, is based on that publication (BEANI 2006). Probably in July, minute, free-living, first-instar larvae parasitize *Polistes* within their nests. There they enter the immature stages of the wasp through the cuticle and grow together with the host. The cost of the development of *Xenos* is sustainable during the larval stages of *Polistes* (HUGHES & KATHIRITHAMBY 2005). Non-sibling larvae were sometimes found to parasitize the same host individual (VANNINI *et al.* 2008). The parasite moults without shedding exuviae (except first instar) from the previous stages, eventually forming a multilayered male puparium or female cuticle. This apolysis without ecdysis is unique to Strepsiptera (KATHIRITHAMBY *et al.* 1984). The larvae reach final, fourth, instar when the wasps are in their late pupal stage. One to two weeks from the emergence of the adult wasp from its cell, the parasites can be observed partly extruding from the intersegmental membranes, mainly of gastral tergites, of the host. The objects then seen are male puparia (heads of the puparia called cephalothecae), the most conspicuous and easily visible, also in the field, causing significant deformation in the



**Figs 1–2.** 1: two females visible extruding between tergites of *Polistes dominulus* male from Wrocław-Świniary; 2: male puparia on *P. dominulus* female from Strupina.

wasp's gaster (Fig. 2), and fore-ends of female bodies (cephalothoraces), although the latter are more flattened and thus not as striking as cephalothecae (Fig. 1). After emergence (the peak is July to mid-August) the males fly in search of receptive females and live only 5–6 hours after eclosion. Their former hosts carry empty puparia and usually die a few weeks after the emergence of the parasites, although there are observations of wasps overwintering with empty puparia (Hans Pohl, pers. comm.). The females extrude from the intersegmental membranes of wasps and probably attract males actively with sexual pheromones. The females are inseminated through the birth opening, a membranous area between head and prosternum in the cephalothorax, and overwinter. After development of embryos within the hemocoel, the following spring a female is ready to release over 3000 larvae via the same canal through which she was inseminated (HUGHES *et al.* 2004b). The manner in which first-instar larvae (also known as triungulinids) reach host nests in the wild remains to be investigated in more detail, and two hypotheses have been considered: phoretic transport of *Xenos* larvae by wasps having contact with infected substrate, or direct release from infected individuals into host nests. MANFREDINI *et al.* (2010) published a preliminary study on triungulinids in an artificial setting but did not identify any apparent stimuli responsible for host-seeking behaviour.

A particularly remarkable aspect of stylopization by *Xenos vesparum* is that it apparently modifies host behaviour. Host manipulation and its evolutionary implications have been studied by BEANI *et al.* (2004), HUGHES *et al.* (2004b), and DAPPORTO *et al.* (2007). Among the alterations described to date, the most conspicuous is the case of

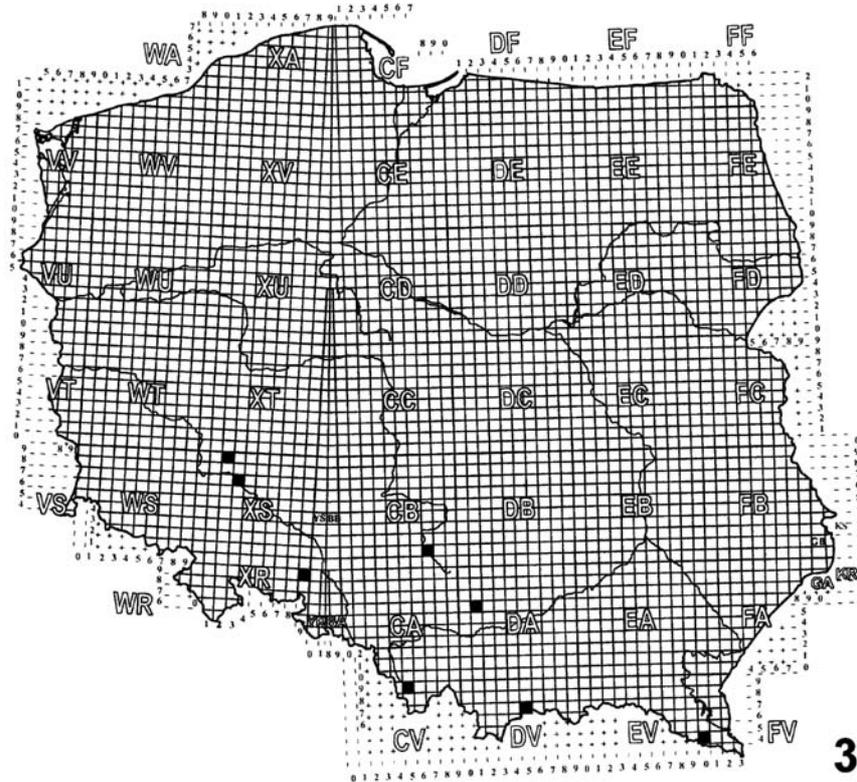


Fig. 3. Known distribution of *Xenos vesparum* Rossius, 1793 in Poland.

summer aggregations observed in Italian populations of *Polistes dominulus*. Parasitized wasps cease to work for the colony and aggregate in a manner similar to sexuals preparing for hibernation in leks. It has been hypothesized that this is an adaptive behavioural change induced by the parasite that enables mate encounter of *Xenos* and thus facilitates parasite reproduction. The summer aggregations interested the famous evolutionary biologist, W.D. Hamilton, who played a crucial role in encouraging later studies of the phenomenon. Other observed alterations include prolongation of winter hibernation of stylopized wasps. BEANI & MASSOLO (2007) studied spatial behaviour of overwintered stylopized wasps and found that they flew from nest to nest before the emergence of parasites. The nests contain wasp larvae, the target of infection, and so this can be viewed as a further adaptive manipulation of host behaviour, supporting the direct-release hypothesis for the spread of first-instar larvae, alongside phoresy. All parasitized individuals of *Polistes*, whether worker or queen, male or female, are castrated and unable to reproduce.

From central Europe, KINZELBACH (1978) reported 16 species of Strepsiptera and, more recently, POHL & MELBER (1996) gave 21. The fauna of Germany currently holds 15 species (POHL 2010). In Europe, *Xenos vesparum* is widely distributed although more common in southern parts (KINZELBACH 1978), apparently absent from Fennoscandia and the British Isles, and has been reported to date (after Pohl 2010 except where cited otherwise) from Austria, Belgium, Bosnia and Herzegovina, Croatia, Cyprus, the Czech Republic (BATELKA & STRAKA 2005, HÁVA 2012), Turkey, France, Germany, Greece, Hungary, Italy, Luxembourg, the Netherlands (SMIT & SMIT 2005), Portugal, Romania, Slovakia, Spain, and Switzerland. There is also an uncertain, literature-based record for Sweden (POHL 2010). Extrapolating from the distribution data, the presence of *X. vesparum* in Poland is not surprising. Until recently, there was no comprehensive account specifically dedicated to the strepsipteran fauna of Poland within its present borders, although a few contributions from before World War II mention specimens from territories now outside the country (e. g., NOSKIEWICZ & POLUSZYŃSKI 1925, OGLOBLIN 1925; see HUFLEJT & LIANA 2004). In 2004 a review by HUFLEJT & LIANA listed seven species (*Halictophagus agalliae* Abdul-Nour, 1971, *Elenchus tenuicornis* (Kirby, 1815), *Halictoxenos spencei* Nasonov, 1893, *Halictoxenos tumulorum* Perkins, 1918, *Paraxenos spheccidarum* (Dufour, 1837), *Pseudoxenos heydenii* (Saunders, 1852), *Stylops melittae* Kirby, 1802, and remarked that more remain to be found within the territory of the country.

## Results

In this report we provide the first data on the occurrence of *Xenos vesparum* in Poland.

- Trzebnickie Hills (Wzgórze Trzebnickie): Strupina UTM: XS29 (51°23'N 16°48'E) 4–6 VII 2008, two and six, respectively, male puparia on two *Polistes dominulus* females, leg. M.L. Borowiec
- Lower Silesia (Dolny Śląsk): Wrocław – Świniary XS37 (51°12' N 16°59'E) 11 VIII 2010, two females on *Polistes dominulus* male, leg. M.L. Borowiec; Moszna XR99, 06 VIII 2004, male puparium on *Polistes dominulus* female, leg. W. Żyła
- Upper Silesia (Górny Śląsk-Beskid Zachodni): Wisła-Czarne CV59, 16 VIII 2007, two male puparia on *Polistes dominulus* female, leg. W. Żyła
- Kraków-Wieluń Upland (Wyżyna Krakowsko-Wieluńska): Ojców National Park, Peperówka DA16, 2 VIII 2001, two females on *Polistes nimphus* female, leg. B. Wiśniowski; Biskupice, Kolonia Chorońska CB71, 4 VIII 2011, two females and one male puparium on male *Polistes dominulus*, leg. B. Wiśniowski
- Pieniny Mts (Pieniny): Pieniński National Park, Wąwóz Sobczański DV57, 25 VIII 2011, one female on female *Polistes dominulus*, leg. B. Wiśniowski
- Bieszczady Mts (Bieszczady): Bieszczady National Park, Moczarne FV04, 25 VII 2000, male puparium on *Polistes nimphus* male, leg. B. Wiśniowski

### Discussion

All strepsipteran individuals reported in this paper come from southern Poland (Fig. 3). They were observed on *Polistes dominulus* (Christ, 1791) and *P. nimphus* (Christ, 1791). The material collected by the senior author was obtained through examination and selective collection of infected individuals in the field. Others come from the extensive aculeate collections of Waldemar Żyła (Upper Silesian Museum, Nature Division in Bytom) and Bogdan Wiśniowski (Ojców National Park, Ojców). HUFLEJT & LIANA (2004) based their records mostly on the large hymenopteran collection of the Museum and Institute of Zoology PAS, Warsaw, and found no *Xenos* specimens. The absence of specimens in MIZ PAS and only four infected wasps in Bytom and Ojców collections would suggest relative rarity of *Xenos vesparum* in Poland. We did not, however, perform any dissections of *Polistes* nests or individuals, nor did we search for hibernating aggregations, a much more efficient method of studying the occurrence of the species, as exemplified by HUGHES *et al.* (2003, 2004a), who found it relatively common and locally abundant in Italy. Neither of the authors observed the parasite-induced, early aggregations of *Polistes*, reported from Italy (HUGHES 2002, HUGHES *et al.* 2004b). Another explanation of the rarity of *X. vesparum* in museum collections might be a recent range expansion of the parasite towards the north, as documented for Germany (SAURE 1994).

### Acknowledgements

We would like to thank Laura Beani, Hans Pohl, and Philip Ward for reprints and valuable comments on the manuscript. Our thanks to Jiří Kolibáč and the two anonymous reviewers for additional insight.

### References

- BATELKA J. & STRAKA J. 2005: Výskyt *Xenos vesparum* a *Pseudoxenos heydeni* (Strepsiptera: Xenidae) v České republice. *Klapálekiana* **41**: 1–9.
- BEANI L. 2006: Crazy wasps: when a parasite manipulates *Polistes* phenotype. *Annales Zoologici Fennici Special Issue* **43**: 564–574.
- BEANI L. & MASSOLO A. 2007: *Polistes dominulus* wasps (Hymenoptera Vespidae), if parasitized by *Xenos vesparum* (Strepsiptera, Stylopidae), wander among nests during the pre-emergence phase. *Redia* **90**: 161–164.
- BEANI L., HUGHES D. P., TURILLAZZI S. & KATHIRITHAMBY J. 2004: Parasitic castration does not promote social behaviour in paper wasps. *Insect Social Life* **5**: 17–21.
- DAPPORTO L., CINI A., PALAGI E., MORELLI M., SIMONTI A. & TURILLAZZI S. 2007: Behaviour and chemical signature of pre-hibernating females of *Polistes dominulus* infected by the strepsipteran *Xenos vesparum*. *Parasitology* **134**: 545–552.
- HÁVA J. 2012: Poznámky k výskytu *Xenos vesparum* (Strepsiptera: Xenidae) v Čechách. *Elateridarium* **6**: 58–60.
- HUFLEJT T. & LIANA A. 2004: Materiały do poznania wachlarzoskrzydłych (Strepsiptera) w Polsce. *Nowy Pamiętnik Fizjograficzny* **3(1–2)**: 61–80.
- HUGHES D. P. 2002: The value of a broad mind: some natural history meanderings of Bill Hamilton. *Ethology Ecology & Evolution* **14**: 83–89.

- HUGHES D. P. & KATHIRITHAMBY J. 2005: Cost of strepsipteran macroparasitism for immature wasps: Does sociality modulate virulence? *Oikos* **110**: 428–434.
- HUGHES D. P., KATHIRITHAMBY J. & BEANI L. 2004a: Prevalence of the parasite Strepsiptera in adult Polistes wasps: field collections and literature overviews. *Ethology Ecology & Evolution* **16**: 363–375.
- HUGHES D. P., BEANI L., TURILLAZZI S. & KATHIRITHAMBY J. 2003: Prevalence of the parasite Strepsiptera in Polistes as detected by dissection of immatures. *Insectes Sociaux* **50**: 62–68.
- HUGHES D. P., KATHIRITHAMBY J., TURILLAZZI S. & BEANI L. 2004b: Social wasps desert the colony and aggregate outside if parasitized: parasite manipulation? *Behavioral Ecology* **15**(6): 1037–1043.
- KATHIRITHAMBY J., SMITH D. S., LOMAS M. & LUKE B. M. 1984: Apolysis without ecdysis in larval development of a strepsipteran, *Elenchus tenuicornis* (Kirby). *Zoological Journal of the Linnean Society* **82**: 335–343.
- KINZELBACH R. K. 1978: *Fächerflügler (Strepsiptera)*. Jena, Ger.: Gustav Fischer. 166 pp.
- MANFREDINI F., MASSOLO A. & BEANI L. 2010: A difficult choice for tiny pests: host-seeking behaviour in *Xenos vesparum* triungulin. *Ethology Ecology & Evolution* **22**: 247–256.
- NOSKIEWICZ J. & POLUSZYŃSKI G. 1925: Neue Arten der Strepsipterengattung Halictoxenos Pierce. *Polskie Pismo Entomologiczne* **3**(4): 182–188.
- OGLOBLIN A. 1925: New and little known Strepsiptera from Poland. *Polskie Pismo Entomologiczne* **3**(4): 113–122.
- POHL H. 2010: *Strepsiptera*. Fauna Europaea version 2.2, <<http://www.faunaeur.org>, accessed at: 2010.09.01.>
- POHL H. & BEUTEL R. G. 2005: The phylogeny of Strepsiptera (Hexapoda). *Cladistics* **21**: 328–374.
- POHL H. & MELBER A. 1996: Verzeichnis der mitteleuropäischen Fächerflügler und die Beschreibung einer neuen Art. Der Gattung Malayaxenos Kifune 1981 (Insecta: Strepsiptera). *Senckenbergiana Biologica* **75**(1–2): 171–180.
- SAURE C. 1994: Mitteilung über neue Nachweise von Fächerflüglern als Bienen- und Wespenparasiten in Berlin und Umland (Insecta: Strepsiptera: Stylopidae). *Brandenburgische Entomologische Nachrichten* **2**: 47–53.
- SMIT J. T. & SMIT J. 2005: De waaiervleugeligen (Strepsiptera) van Nederland. *Entomologische Berichten* (Amsterdam) **65**(2): 43–51.
- VANNINI L., CARAPPELLI A., FRATI F. & BEANI L. 2008: Non-sibling parasites (Strepsiptera) develop together in the same paper wasp. *Parasitology* **135**(6): 705–713.