

The Twisted-Wing Insects (Strepsiptera) of South-Eastern Belarus [†]

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Abstract: An overview of the twisted-wing insects for the South-Eastern Belarus is provided. Our own researches (2016–2021) of species compositions of the twisted-wing insects in South-Eastern Belarus were executed in different biotopes on the territory of Gomel area. Five species from two families – *Hylecthrus rubi* Saunders, 1850, *Stylops hammella* Perkins, 1918, *S. melittae* Kirby, 1802, *S. thwaitesi* Perkins, 1918 and *Paraxenos spheccidarum* (Dufour, 1837) – have been recorded. Collection data for each species are presented and their known distribution and biology briefly discussed.

Keywords: faunistics; hosts; twisted-wing insects; Strepsiptera; South-Eastern Belarus

1. Introduction

Members of the order Strepsiptera display highly peculiar morphology and lifestyles. They are small to medium sized insects (1.0–7.5 mm long) exhibiting extreme sexual dimorphism [1,2]. Free living and flying males have twisted hind wings, while their fore wings are reduced to clublike appendages. Usually endoparasitic and wingless females are known to colonize members of seven insect orders [2,3]. Approximately 600 Strepsiptera species are known to exist globally [4,5], while 30 species from 7 families are known in Europe [6,7].

The order Strepsiptera in Belarus hasn't been studied, data on the record of one species *Stenocranophilus anomalocerus* Pierce, 1918 from the family Halictophagidae, parasitoid of *Liburnia* Stel, 1866 (Hemiptera: Delphacidae), has been published previously [8]. Continuing the research, 3 more species of twisted-wing insects have been found in Belarus [9–11]. The present study aims to summarize and contribute new data to the already published results.

2. Materials and Methods

The materials were obtained by the author using standard collection methods on the territory of Gomel (the main research), Bragin and Loev districts of Gomel area during the field seasons of 2016–2021. An analysis of these collections made it possible to provide new faunistic information about 5 species of twisted-wing insects. The asterisk marks the species first discovered on the territory of Belarus.

3. Results

Order Strepsiptera Kirby, 1813
Family Stylopidae Kirby, 1813
Subfamily Stylopinae Kirby, 1813
Genus *Hylecthrus* Saunders, 1850
Hylecthrus rubi Saunders, 1850

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Material examined: Belarus, Gomel area, Gomel district, floodplain meadow in the valley of the Iput River east of the Gomel city, 52°25'07"N, 31°03'37"E, 120 a.s.l., 21.07.2019 — 1♀ of *Hylaeus (Hylaeus) communis* Nylander, 1852 stylized by 1♀ of *H. rubi* (between V and VI tergites in the middle).

Hosts. *H. (H.) communis* Nylander, 1852 [11,12], *H. (H.) angustatus* (Schenck, 1861), *H. (H.) leptcephalus* (Morawitz, 1871), *H. (Dentigera) brevicornis* Nylander, 1852, *H. (Koptogaster) punctulatissimus* Smith, 1842, *H. (Spatulariella) hyalinatus* Smith, 1842, *H. (S.) punctatus* (Brülle, 1832), *H. (Paraprosopis) albonotatus* (Walker, 1871), *H. (P.) clypearis* (Schenck, 1853), *H. (P.) pictipes* Nylander, 1852, *H. (P.) sinuatus* (Schenck, 1853), *H. (Prosopis) gibbus* Saunders, 1850, *H. (Pr.) signatus* (Panzer, 1798), *H. (Pr.) variegatus* (Fabricius, 1798) [12].

Genus *Stylops* Kirby, 1802

Stylops hammella Perkins, 1918 *

Material examined: Belarus, Gomel area, Gomel district, Chenki forestry, the clearing in the mixed forest between the horticultural partnership "Motor" and Chenki village, 52°19'59"N, 30°57'55"E, 127 a.s.l., 06.05.2018 — 1♂ of *Andrena (Notandrena) chrysoseles* (Kirby, 1802) stylized by 1♀ of *S. hammella* (between IV and V tergites on the left).

Hosts. *A. (N.) chrysoseles* (Kirby, 1802) [13], *A. (N.) nitidiuscula* Schenck, 1853 [14,15].

Stylops melittae Kirby, 1802

Material examined: Belarus, Gomel area, Gomel district, field near Znamya Truda village, on the side of a country road, 52°22'46"N, 31°08'27"E, 130 a.s.l., 12.04.2020 — 1♀ of *Andrena (Melandrena) nitida* (Müller, 1776) stylized by 1♀ of *S. melittae*; in the same place, on the inflorescences of *Salix acutifolia* Wild. on the edge of a swamp, 52°22'34"N, 31°09'05"E, 127 a.s.l., 12.04.2020 — 1♀ of *A. (M.) nitida* stylized by 1♀ of *S. melittae*; in the same place, on the support of the power line, 52°23'00"N, 31°09'20"E, 129 a.s.l., 11.04.2021 — 11♀ of *A. (M.) nitida* stylized by 15♀ of *S. melittae*; in the same place, 52°22'57"N, 31°09'01"E, 130 a.s.l., 18.04.2021 — 2♀ of *A. (M.) nitida* stylized by 4♀ of *S. melittae*.

Information about the nature of their stylization is presented in Table 1.

Table 1. The character of stylization of the studied specimens of *A. nitida* by the strepsipteron *S. melittae* from the population of the Znamya Truda village in the Gomel district of the Gomel area.

| Sex of the Host Bee | Number of Parasites | Their Localization between the Abdominal Segments of the Host Bee |
|---------------------|---------------------|--|
| ♀ | 1 | ♀ between IV and V tergites on the left |
| ♀ | 1 | ♀ between IV and V tergites on the right |
| ♀ | 2 | 2♀ between IV and V tergites on the sides |
| ♀ | 1 | ♀ between IV and V tergites on the left |
| ♀ | 1 | ♀ between IV and V tergites on the right |
| ♀ | 1 | ♀ between IV and V tergites on the left |
| ♀ | 1 | ♀ between IV and V tergites on the left |
| ♀ | 1 | ♀ between IV and V tergites on the left |
| ♀ | 3 | ♀ between IV and V tergites in the middle, 2♀ between IV and V tergites on the sides |
| ♀ | 2 | ♀ between III and IV tergites in the middle, ♀ between IV and V tergites on the left |
| ♀ | 1 | ♀ between IV and V tergites in the middle |
| ♀ | 1 | ♀ between IV and V tergites on the left |
| ♀ | 1 | ♀ between IV and V tergites on the left |
| ♀ | 2 | 2♀ between IV and V tergites on the sides |
| ♀ | 2 | 2♀ between IV and V tergites on the sides |

Hosts. *A. (M.) nigroaenea* (Kirby, 1802) [16], *A. (M.) nitida* (Müller, 1776) [17], *A. (Zonandrena) flavipes* Panzer, 1799 [18], *A. (M.) thoracica* (Fabricius, 1775), *A. (Z.) soror*

Dours, 1872 [14], *A. (Z.) gravida* (Imhoff, 1832) [19], *A. (Hoplandrena) carantonica* Pérez, 1902, *A. (H.) ferox* Smith, 1847 [20].

***Stylops thwaitesi* Perkins, 1918 ***

Material examined: Belarus, Gomel area, Gomel district, floodplain meadow in the valley of the Uza River near Uza village, 52°22'53"N, 30°52'35"E, 118 a.s.l., 14.05.2016 — 1♂ of *Andrena (Taeniandrena) ovatula* (Kirby, 1802) stylopized by 1♀ of *S. thwaitesi* (between IV and V tergites in the middle).

Hosts. *A. (T.) ovatula* (Kirby, 1802) [13,21], *A. (T.) similis* Smith, 1849 [22], *A. (T.) albofasciata* Thomson, 1870 [17,23], *A. (T.) ezoensis* Hirashima, 1965 [24,25], *A. (T.) wilkella* (Kirby, 1802) [14,17,23], *A. (T.) intermedia* Thomson, 1870, *A. (T.) lathyri* Alfken, 1899 [19].

Family Xenidae Saunders, 1872

Subfamily Paraxeninae Kinzelbach, 1971

Genus *Paraxenos* Saunders, 1872

***Paraxenos spheccidarum* (Dufour, 1837)**

Material examined:

1. Belarus, Gomel area, Gomel district, Novobelitsa forestry, the clearing in the mixed forest south of the Gomel city, 52°19'48"N, 31°00'15"E, 123 a.s.l., 6.06.2016 — 1♂ of *Amomphila sabulosa* (Linnaeus, 1758) stylopized by 1♂ of *P. spheccidarum* (the remains of ♂ puparium between IV and V tergites on the left).

2. Belarus, Gomel area, Gomel district, grassy slope on the edge of the sand quarry near Uza village, on the inflorescences of *Solidago canadensis* L., 52°22'57"N, 30°52'45"E, 122 a.s.l., 12.08.2017 — 1♂ of *A. sabulosa* stylopized by 2♀ of *P. spheccidarum* (1♀ between IV and V tergites on the left and 1♀ between V and VI tergites in the middle).

3. Belarus, Gomel area, Bragin district, on a mixed-grass meadow bordering a pine forest near Kirovo village, 51°24'20"N, 30°34'32"E, 107 a.s.l., 14.08.2019 — 12♂ and 8♀ of *A. sabulosa* stylopized by 17♂ and 14♀ of *P. spheccidarum*.

Information about the nature of their stylization is presented in Table 2.

Table 2. The character of stylopization of the studied specimens of *A. sabulosa* by the strepsipteron *P. spheccidarum* from the population of the Kirovo village in the Bragin district of the Gomel area.

| Sex of the Host Wasp | Number of Parasites | Their Localization between the Abdominal Segments of the Host Wasp |
|----------------------|---------------------|--|
| ♂ | 1 | The remains of ♂ puparium between V and VI tergites on the right |
| ♂ | 2 | The remains of ♂ puparium between IV and V tergites on the right, ♀ between VI and VII tergites on the left |
| ♂ | 1 | ♂ puparium between IV and V sternites in the middle |
| ♀ | 1 | ♂ puparium between IV and V tergites on the left |
| ♀ | 2 | ♀ between V and VI tergites on the right, ♀ between III and IV sternites in the middle |
| ♀ | 1 | The remains of ♂ puparium between IV and V tergites on the right |
| ♀ | 1 | ♀ between IV and V tergites on the left |
| ♂ | 1 | ♂ puparium between V and VI sternites on the left |
| ♂ | 1 | The remains of ♂ puparium between IV and V tergites on the left |
| ♂ | 1 | The remains of ♂ puparium between IV and V tergites on the left |
| ♂ | 1 | ♀ between IV and V tergites on the right |
| ♀ | 4 | ♀ between III and IV tergites on the right, ♀ between IV and V sternites on the left, 2♀ between V and VI tergites on the sides |
| ♂ | 2 | The remains of ♂ puparium between V and VI tergites on the right, ♀ between IV and V tergites on the left |
| ♀ | 3 | The remains of ♂ puparium between III and IV tergites on the left, ♀ between IV and V tergites on the left, ♀ between V and VI tergites on the right |
| ♂ | 1 | The remains of ♂ puparium between IV and V tergites on the right |

| | | |
|---|---|--|
| ♂ | 2 | The remains of 2♂ pupariums between IV and V tergites on the sides |
| ♂ | 1 | The remains of ♂ puparium between IV and V tergites on the right |
| ♀ | 3 | The remains of ♂ puparium between IV and V tergites on the left, ♀ between V and VI tergites on the right, ♂ puparium between VI tergite and VI sternite above the sting |
| ♀ | 1 | The remains of ♂ puparium between V and VI tergites on the left |
| ♂ | 1 | ♀ between V and VI tergites in the middle |

4. Belarus, Gomel area, Bragin district, pine forest on the dunes with adjacent farmland and a dense network of reclamation channels between Asarevichi and Grushnoe villages, on dry meadow-steppe areas of a sandy slope with low grass vegetation, 51°37'22"N, 30°25'52"E, 106 a.s.l., 18.08.2019 — 1♀ of *A. sabulosa* stylotized by 1♂ of *P. spheccidarum* (♂ puparium between IV and V tergites on the right) and 1♀ of *A. sabulosa* stylotized by 1♂ and 1♀ of *P. spheccidarum* (the remains of ♂ puparium between IV and V sternites on the right and ♀ between IV and V tergites on the right).

5. Belarus, Gomel area, Gomel district, sandy road along the mixed forest between the horticultural partnership "Glushets" and Mikhal'ki village, on the side of a country road, 52°16'05"N, 30°49'04"E, 118 a.s.l., 08.09.2019 — 1♀ of *Podalonia affinis* (W. Kirby, 1798) stylotized by 1♀ of *P. spheccidarum* (between IV and V tergites on the right).

6. Belarus, Gomel area, Loev district, Karpovka village, on the side of a country road, 52°01'15"N, 30°54'07"E, 115 a.s.l., 12.06.2021 — 1♀ of *P. affinis* stylotized by 1♂ and 1♀ of *P. spheccidarum* (♂ puparium between IV and V tergites on the left and ♀ between V and VI tergites on the right).

Hosts. *A. sabulosa* (Linnaeus, 1758) [10,20], *A. pubescens* Curtis, 1836 [26], *P. affinis* (W. Kirby, 1798) [27].

4. Discussion

It is quite obvious that the taxonomy of Strepsiptera is far from resolved. In genus *Stylops* additional name-changes are expected. In order to resolve the exact species delimitations molecular analyses are needed. Apart from the taxonomical uncertainties there are also a species of twisted-wing insects that are still expected to turn up in the Belarus because their hosts do occur here and are sometimes even quite common.

5. Conclusions

Thus, as a result of the studies carried out on the territory of the southeast of Belarus, five species of twisted-wing insects were identified, among which *Stylops hammella* Perkins, 1918 and *S. thwaitesi* Perkins, 1918 are new to the strepsipterofauna of the Republic.

Since the material identified is small, and there is no published data on the fauna of twisted-wing insects in Belarus and neighboring countries, this study can be considered to be only a preliminary overview. Further study is planned for the future, and an expansion of the species list of twisted-wing insects in Belarus is to be expected.

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References

1. Kinzelbach, R.K. Morphologische Befunde an Fächerflüglern und ihre phylogenetische Bedeutung (Insecta: Strepsiptera). *Zoologica* **1971**, *119*, 1–256.
2. Kathirithamby, J. Review of the Order Strepsiptera. *Systematic Entomology* **1989**, *14*, 41–92.
3. Kathirithamby, J. Host-Parasitoid Associations in Strepsiptera. *Annual Review of Entomology* **2009**, *54*, 227–249.
4. Kathirithamby, J. Strepsiptera. Twisted-wing parasites. Version 24 September 2002 (under construction). The Tree of Life Web Project. Available online: <http://tolweb.org/Strepsiptera/8222/2002.09.24> (accessed on 15 June 2021).
5. Kinzelbach, R.K.; Pohl, H. *Ordnung Strepsiptera, Fächerflüger*. Wirbellose Tiere. 5. Teil: Insecta; Spektrum Akademischer Verlag: Heidelberg-Berlin, Germany, 2003; ss. 526–539.
6. Pohl, H. Fauna Europaea: Strepsiptera. Fauna Europaea, ver. 2.4. Available online: <http://www.faunaeur.org> (accessed on 15 June 2021).
7. Soon, V.; Kesküla, T.; Kurina, O. Strepsiptera species in Estonia. *Entomol. Fenn.* **2011**, *25*, 213–218.
8. Medvedev, L.N. [The order Strepsiptera]. In *Keys to the insects of the European part of the USSR. Coleoptera and Strepsiptera*; Bey-Bienko, G.Ya., Eds.; Nauka Publ.: Moscow-Leningrad, USSR, 1965; Volume 2, Issue 89, pp. 641–645 (In Russian).
9. Ostrovsky, A.M. A first record of *Stylops melittae* Kirby, 1802 (Insecta: Strepsiptera: Stylopidae) in Belarus. *Euroasian Entomol. J.* **2018**, *17*(3), 189–190. DOI: 10.15298/euroasentj.17.3.08.
10. Ostrovsky, A.M. A new record of strepsipteron *Paraxenos sphaecidarum* (Dufour, 1837), (Insecta, Strepsiptera: Xenidae) from Belarus. *Euroasian Entomol. J.* **2019**, *18*(3), 186–187. DOI: 10.15298/euroasentj.18.3.07.
11. Ostrovsky, A.M. *Hylecthrus rubi* Saunders, 1850 — a new species of strepsipteron (Insecta: Strepsiptera: Stylopidae) in the fauna of Belarus. *Euroasian Entomol. J.* **2019**, *18*(6), 412–413. DOI: 10.15298/euroasentj.18.6.9.
12. Kinzelbach, R.K. Redeskription und revision der Strepsipteren-Gattung *Hylecthrus* Saunders, 1850. *Angew. Parasitol.* **1971**, *12*(4), 204–219.
13. Perkins, R.C.L. Synopsis of British Strepsiptera of the genera *Stylops* and *Halictoxenus*. *Entomologist's Monthly Magazine* **1918**, *54*, 67–76, plate 1.
14. Luna de Carvalho, E. Contribuição para o estudo dos *Stylops* da Península Ibérica (Streps. Stylopidae). *Eos: Revista Española de Entomologia* **1974**, *48*, 301–365.
15. Poluszyński, G. *Stylops nitidiusculae* n. sp. *Polskie Pismo Entomologiczne* **1927**, *6*, 92–99.
16. Kirby, W. Monographia Apum Angliae; or, an attempt to divide into their natural genera and families, such species of the Linnean genus *Apis* as have been discovered in England: with descriptions and observations. In *To which are prefixed some introductory remarks upon the class Hymenoptera, and a synoptical table of the nomenclature of the external parts of these Insects*; Raw, J., Eds.; Ipswich: London, England, 1802; pp. 258.
17. Pasteels, J. Enquêtes sur les Strepsiptères (4e série). – Strepsiptères du Musée zoologique de Lausanne. *Bulletin et Annales de la Société Entomologique de Belgique* **1954**, *90*, 349–355.
18. Hofeneder, K. *Stylops* in copula. *Verhandlungen der Zoologisch-Botanischen Gesellschaft in Wien* **1924**, *73*, 128–134.
19. Smit, J.T.; Smit, J.; Raemakers, I.P.; Hoorn, B. The Strepsiptera of the Netherlands revisited (Insecta). *Entomologische Berichten* **2020**, *80*(1), 8–30.
20. Klaus, M. Über Fächerflügler (Strepsiptera) bei Hautflüglern (Hymenoptera) in Franken und darüber hinaus. *Galathea* **2016**, *32*, 83–99.
21. Kifune, T.; Tadauchi, O.; Lee, C.E. Records of the Strepsiptera parasitic on the Korean Apoidea (Notulae Strepsipterologicae-XXIII). *Esakia* **1994**, *34*, 209–214.
22. Hofeneder, K. Über zwei neue Strepsipteren aus *Andrena similis* F. Smith und *Halictus malachurus* Kirby. *Veröffentlichungen aus dem Deutschen Kolonial- und Übersee-Museum in Bremen* **1939**, *2*, 181–200.
23. Günther, V.; Šedivý, J. Řád Řasnokřídli – Strepsiptera. In *Klíč zvířeny ČSR [Key to the fauna of Czechoslovakia]*; Kratochvíl, J., Eds.; Čsáv: Praha, Czechoslovakia, 1957; Díl II, pp. 407–417.
24. Kifune, T.; Hirashima, Y. Nine new species of the genus *Stylops* (Strepsiptera: Stylopidae) parasitic on the genus *Andrena* (Hymenoptera: Andrenidae) of Japan (Studies on the Japanese Strepsiptera X). *Esakia* **1985**, *23*, 45–57.
25. Kifune, T.; Maeta, Y. Ten new species of the genus *Stylops* (Strepsiptera, Stylopidae) parasitic on the genus *Andrena* (Hymenoptera, Andrenidae) of Japan (Studies on the Japanese Strepsiptera XIII). *Esakia* **1990**, *29*, 97–110.
26. Pekkarinen, A.; Raatikainen, M. The Strepsiptera of Eastern Fennoscandia. *Notulae Entomologicae* **1973**, *53*, 1–10.
27. Ostrovsky, A.M. *Podalonia affinis* (W. Kirby, 1798) (Hymenoptera: Apoidea: Sphaecidae), a new host species of the strepsipteron *Paraxenos sphaecidarum* (Dufour, 1837) in Belarus. *Euroasian entomological journal* **2021**, *20*(1), 55–56. DOI: 10.15298/euroasentj.20.1.9.