

Discovery of the first European parasitoid of the emerald ash borer *Agrilus planipennis* (Coleoptera: Buprestidae)

MARINA J. ORLOVA-BIENKOWSKAJA¹ and SERGEY A. BELOKOBYSKIJ²

¹A.N. Severtsov Institute of Ecology and Evolution, Russian Academy of Sciences, 33 Leninskiy Prospect, Moscow 119071, Russia; e-mail: marinaorlben@yandex.ru

²Zoological Institute, Russian Academy of Sciences, St Petersburg 199034, Russia; Museum and Institute of Zoology Polish Academy of Sciences, Wilcza 64, Warszawa 00-679, Poland; e-mail: doryctes@gmail.com

Key words. Hymenoptera, Braconidae, *Spathius polonicus*, Coleoptera, Buprestidae, *Agrilus planipennis*, parasitoid, biocontrol, emerald ash borer, European Russia, *Fraxinus pennsylvanica*

Abstract. The emerald ash borer, *Agrilus planipennis*, native to Asia is a devastating pest of ash in North America and European Russia. There are several parasitoids of *A. planipennis* recorded in Asia and North America, but none previously in Europe and European Russia. Eighty two specimens of the ectoparasitoid *Spathius polonicus* Niezabitowski (Hymenoptera: Braconidae: Doryctinae) (23 adults, 56 larvae and three pupae) were found in the remains of *A. planipennis* larvae at five localities in Moscow Province in October 2013 – May 2014. *S. polonicus* is rare but widely distributed and mainly a Western Palearctic species. It seems that the level of parasitism could be relatively high: in nature, more than 50% of the last instar larvae of *A. planipennis* examined were killed by *S. polonicus*. We collected 24 live last instar larvae and prepupae and the remains of 30 last instar larvae of *A. planipennis* previously parasitized by *S. polonicus*. *S. polonicus* may be suitable for the biocontrol of *A. planipennis* both in Europe and North America, because it is a native of the temperate climate zone. The potential of this parasitoid for biological control needs special investigation.

INTRODUCTION

The emerald ash borer (EAB), *Agrilus planipennis* Fairmaire, 1888 (Coleoptera: Buprestidae), is native to East Asia (Wei et al., 2007). About ten years ago it was recorded in North America (Haack et al., 2002) and Russia (Moscow) (Mozolevskaya & Izhevskiy, 2007). Since then it has become a major invasive pest of ash, killing nearly all ash trees in areas it has colonized (Knight et al., 2013; Orlova-Bienkowskaja, 2014). The range of *A. planipennis* is expanding quickly: the pest is currently recorded in 23 states of USA, two provinces of Canada (Emerald ash borer website, 2014) and 11 provinces of European Russia (Orlova-Bienkowskaja, 2013). Almost all ash trees in Moscow and its vicinity have been killed by *A. planipennis* (Straw et al., 2013). There is no doubt that this pest will spread to other European countries (Baranchikov et al., 2008). The possibilities for the biological control of *A. planipennis* are being intensively studied (Bauer et al., 2008; Belokobylskij et al., 2012). So cases of parasitized *A. planipennis* are of special interest. Several parasitoids attacking *A. planipennis* are recorded in Asia and North America, but none in European Russia (Baranchikov et al., 2008; Belokobylskij et al., 2012; Taylor et al., 2012).

RESULTS

Between October 2013 and May 2014 in Moscow Province we collected 54 last instar larvae of *A. planipennis* from under the bark of *Fraxinus pennsylvanica* of which 30 had been killed by the ectoparasitoid *Spathius polonicus* Niezabitowski, 1910 (Hymenoptera: Braconidae: Doryctinae). Eighty two specimens of *S. polonicus* were found in the remains of larvae of *A. planipennis*: 23 adults, 56 larvae and three pupae (Table 1, Figs 1–3). In addition, we examined one female of *S. polonicus* reared from larvae collected from ash at Pushkino (Moscow Province) and five reared from material from *Abies sibirica* in Kemerovo Province

(5 females, Kemerovo Province, Tisul' District, Makarovskoe Forestry, from dry *Abies sibirica*, 30.v.2011, M. Klyukin leg.).

DISCUSSION

S. polonicus is rare, but a widely distributed Western Palearctic species. It occurs in Spain, Netherlands, Switzerland, Italy, Poland, Czech Republic, Slovakia, Serbia, Belarus, Ukraine, Russia (south-east of the European part), Armenia, Azerbaijan, Turkmenistan, Uzbekistan, Tadjikistan, Iran (Belokobylskij, 2003; Yu et al., 2012) and Belgium (Belgian Species List, 2014). It was not recorded in Moscow Province or the center of European Russia and the only previously known locality in European Russia is in its south-eastern part, Volgograd Province (Belokobylskij, 1989). We found *S. polonicus* at six localities north of Moscow. The distance between the two most remote localities is about 50 km. So *S. polonicus* is rather widely distributed in the region of this outbreak of *A. planipennis*. Finding *S. polonicus* in Kemerovo Province is the first record of this species in Siberia.

S. polonicus is an ectoparasitoid of mainly buprestid larvae: *Agrilus suvorovi* Obenberger, 1935 (Kenis & Hilszczanski, 2007), *A. viridis* Linnaeus, 1758 (on *Populus nigra*), *A. constantini* Obenberger, 1927, *Anthaxia* sp., *Coraebus florentinus* (Herbst, 1801), *Melanophila picta* (Pallas, 1773), *Melanophila picta decastigma* (Fabricius, 1787), *Ovalisia mirifica* (Mulsant, 1855), *Cratomerus* sp., *Sphenoptera kaznakovi* Jakovlev, 1899 and *S. davatchii* Descarpentries, 1960, and exceptionally also *Scolytus* sp. (Curculionidae: Scolytinae) (Belokobylskij, 2003; Yu et al., 2012).

Several species of parasitoids are recorded attacking *A. planipennis* in Asia and North America (Belokobylskij et al., 2012). There are five species of the genus *Spathius* among them: *S. simillimus* Ashmead, 1893, *S. floridanus* Ashmead, 1893 and *S. laflammei* Provancher, 1880 are native to America (Taylor et al., 2012), and *S. agrili* Yang, 2005 and *S. galinae* Belokobylskij



Figs 1–3. *Spathius polonicus* (Niezabitowski). 1 – dorsal view; 2 – lateral view; 3 – wings.

et Strazanac, 2012 are native to Asia (Yang et al., 2005; Belokobylskij et al., 2012).

Three species of parasitoids were introduced from China into the United States for classical biocontrol of emerald ash borer: *Spathius agrili* Yang, 2005, *Tetrastichus planipennis* Yang, 2006 and *Oobius agrili* Zhang et Huang, 2005 (Bauer et al., 2008). Although these parasitoids have established stable populations at several U.S. locations, parasitism rates of emerald ash borer by these parasitoids from China are considerably lower in newly introduced regions than those reported in China (Duan et al., 2012). Recently a new species attacking *A. planipennis*, *Spathius galinae* Belokobylskij et Strazanac, was described (Belokobylskij et al., 2012). It is also proposed that it could be used as biological control agent.

CONCLUSIONS

S. polonicus is the first parasitoid of *A. planipennis* to be recorded in Europe. It is possible that the level of parasitism could be rather high because more than 50% of the last instar larvae of *A. planipennis* examined were parasitized. *S. polonicus* may be suitable for biocontrol of *A. planipennis* both in Europe and

North America, because it is a native of the temperate climate zone. The potential of this parasitoid for biological control needs to be investigated.

ACKNOWLEDGEMENTS. The authors are grateful to K.V. Markarov (Moscow State Pedagogical University) for preparing the photographs. This study was supported by a grant to the second author from the Russian Foundation for Basic Research (grant No. 13-04-00026).

REFERENCES

- BARANCHIKOV Y.N., MOZOLEVSKAYA E.G., YURCHENKO G.I. & KENIS M. 2008: Occurrence of the emerald ash borer (*Agrilus planipennis*) in Russia and its potential impact on European forestry. — *EPPO Bull.* **38**: 233–238.
- BAUER L.S., LIU H., MILLER D. & GOULD J. 2008: Developing a classical biological control program for *Agrilus planipennis* (Coleoptera: Buprestidae), an invasive ash pest in North America. — *Newsl. Mich. Entomol. Soc.* **53**(3–4): 38–39.
- BELGIAN SPECIES LIST 2014: *Spathius polonicus* Niezabitowski, 1910. <http://www.species.be/en/8753>. Accessed 29 March 2014.

TABLE 1. Specimens of *S. polonicus* from EAB larvae collected from under the bark of *F. pennsylvanica* in Moscow Province.

Locality	Date of collection	Number of specimens of <i>S. polonicus</i> collected	Number of EAB last instar larvae killed by <i>S. polonicus</i>	Number of live EAB last instar larvae and prepupae
Zelenograd, 11th district, 56.00N, 37.18E	1.–2.x.2013	12 larvae, 1 pupa	2	8
	29.x.2013	4 larvae, 1 pupa	1	1
Zelenograd, 16th district, 55.97N, 37.16E	30.x.2013	20 larvae	3	4
	11.iii.2014	9 adults	1	2
Zelenograd, Georgievsky prospect, 55.98N, 37.21E	4.v.2014	2 larvae, 1 pupa	2	1
	9.i.2014	5 larvae	1	4
Planernaya, 55.92N, 37.38E	10.iii.2014	1 adult, 7 larvae	2	3
	28.iv.2014	10 adults	12	0
Povarovka, 56.07N, 37.07E	2.v.2014	3 adults, 6 larvae	6	1
Total number	—	23 adults, 3 pupae, 56 larvae	30	24

- BELOKOBYSKIY S.A. 1989: The Palaearctic species of braconide wasps of the genus *Spathius* Nees: *S. labdacus*, *S. urios* and *S. leucippus* species group (Hymenoptera, Braconidae, Doryctinae). — *Proc. Zool. Inst. USSR Acad. Sci.* **188**: 39–57 [in Russian].
- BELOKOBYSKIY S.A. 2003: The species of the genus *Spathius* Nees, 1818 (Hymenoptera: Braconidae: Doryctinae) not included in the monograph by Nixon (1943). — *Ann. Zool.* **53**: 347–488.
- BELOKOBYSKIY S.A., YURCHENKO G.I., STRAZANAC J.S., ZALDIVAR-RIVERON A. & MASTRO V. 2012: A new emerald ash borer (Coleoptera: Buprestidae) parasitoid species of *Spathius* Nees (Hymenoptera: Braconidae: Doryctinae) from the Russian Far East and South Korea. — *Ann. Entomol. Soc. Am.* **105**: 165–178.
- DUAN J.J., YURCHENKO G.I. & FUESTER R. 2012: Occurrence of emerald ash borer (Coleoptera: Buprestidae) and biotic factors affecting its immature stages in the Russian Far East. — *Environ. Entomol.* **41**: 245–254.
- EMERALD ASH BORER WEBSITE 2014: <http://www.emeraldashborer.info>. Accessed 29 March 2014.
- HAACK R.A., JENDAK E., LIU H., MARCHANT K.R., PETRICE T.R., POLAND T.M. & YE H. 2002: The emerald ash borer: a new exotic pest in North America. — *Newsl. Mich. Entomol. Soc.* **47**: 1–5.
- KENIS M. & HILSZCZANSKI J. 2007: Natural enemies of Cerambycidae and Buprestidae infesting living trees. In Lieutier F., Day K.R., Battisti A., Grégoire J.-C. & Evans H.F. (eds): *Bark and Wood Boring Insects in Living Trees in Europe, a Synthesis*. Springer, Dordrecht, pp. 475–498.
- KNIGHT K.S., BROWN J.P. & LONG R.P. 2013: Factors affecting the survival of ash (*Fraxinus* spp.) trees infested by emerald ash borer (*Agrilus planipennis*). — *Biol. Invasions* **15**: 371–383.
- MOZOLEVSKAYA E.G. & IZHEVSKIY S.S. 2007: The foci of the ash buprestid in Moscow region. — *Zashch. Karant. Rast.* **5**: 28–29 [in Russian].
- ORLOVA-BIENKOWSKAJA M.J. 2013: Dramatic expansion of the range of the invasive ash pest, buprestid beetle *Agrilus planipennis* Fairmaire, 1888 (Coleoptera, Buprestidae) in European Russia. — *Entomol. Rev.* **93**: 1121–1128.
- ORLOVA-BIENKOWSKAJA M.J. 2014: Ashes in Europe are in danger: the invasive range of *Agrilus planipennis* in European Russia is expanding. — *Biol. Invasions* **16**: 1345–1349.
- STRAW N.A., WILLIAMS D.T., KULINICH O. & GNINENKO Y.I. 2013: Distribution, impact and rate of spread of emerald ash borer *Agrilus planipennis* (Coleoptera: Buprestidae) in the Moscow region of Russia. — *Forestry* **86**: 515–522.
- TAYLOR P.B., DUAN J.J., FUESTER R.W., HODDLE M. & VAN DRIESCHE R. 2012: Parasitoid guilds of *Agrilus* woodborers (Coleoptera: Buprestidae): their diversity and potential for use in biological control. — *Psyche* doi: 10.1155/2012/813929
- WEI X., WU Y., REARDON R., SUN T.H., LU M. & SUN J.H. 2007: Biology and damage traits of emerald ash borer (*Agrilus planipennis* Fairmaire) in China. — *Insect Sci.* **14**: 367–373.
- YANG Z.Q., ACHTERBERG C.V., CHOI W.Y., STRAZANAC J.S. & MARSH P.M. 2005: First recorded parasitoid from China of *Agrilus planipennis*: a new species of *Spathius* (Hymenoptera: Braconidae: Doryctinae). — *Ann. Entomol. Soc. Am.* **98**: 636–642.
- YU D.S., VAN ACHTERBERG C. & HORSTMAN K. 2012: *Taxapad 2012, Ichneumonoidea 2011*. Database on flash-drive. Ottawa, Ontario, Canada.

Received April 28, 2014; revised and accepted June 2, 2014
Prepublished online August 13, 2014