

Original Scientific Article

SECONDARY HOST PLANTS OF WATER LILY APHID, *RHOPALOSIPHUM NYMPHAEAE* (HEMIPTERA: APHIDIDAE) IN SERBIA

Darija Milenković¹, Vladimir Žikić¹, Saša S. Stanković¹, Maja Lazarević¹,
Olivera Petrović-Obradović², Marijana Ilić Milošević¹

¹University of Niš, Department of Biology and Ecology, Faculty of Sciences and Mathematics, Niš, Serbia

²University of Belgrade, Institute of phytomedicine, Faculty of Agriculture, Belgrade-Zemun, Serbia

Abstract. *The water lily aphid is a cosmopolitan species that feeds on various plants. Its primary hosts are Prunus species from which they migrate to their secondary hosts – aquatic and semi-aquatic plants. So far, in Serbia, Rhopalosiphum nymphaeae is recorded to attack only three plant species as secondary hosts. In our study, conducted in September 2020, we have researched the association of water lily aphid with secondary hosts in wetland habitats. A total of 44 samples were collected from 16 localities. In addition to the plant species previously reported, in this study 11 secondary hosts are documented for the first time in Serbia. The most common trophic association of R. nymphaeae was with Salvinia natans which was registered in 13 localities. There is a high possibility of finding new records of secondary hosts, therefore, more research is needed to complete the information about the water lily aphid and its hosts in Serbia.*

Key words: trophic associations, wetlands, aquatic and semi-aquatic host plants

Introduction

The water lily aphid, *Rhopalosiphum nymphaeae* (L.) (Hemiptera: Aphididae) is a polyphagous heteroecious aphid, with a holocyclic life cycle and cosmopolitan distribution. This species can produce different morphs in temperate conditions: parthenogenetic apterae, alatae, and sexual forms [1]. Its primary hosts are usually various *Prunus* species, where it feeds on young twigs, leaf petioles, and fruit stalks. *Rhopalosiphum nymphaeae* can cause leaf curling and deformation, and it can slow down the growth and dry the plants [1]. In spring, they migrate to secondary hosts such as *Alisma* L., *Callitriche* L., *Juncus* L., *Lemna* L., *Nuphar* Sibth. & Sm., *Nymphaea* L., *Potamogeton* L., *Spirodela* Schleid., *Typha* L., etc. [1]. Up until late summer, parthenogenetic apterae and alatae develop on secondary hosts for which they always choose aquatic and semi-aquatic plants [2,3]. Because of overcrowding, competition, and low feeding resources, sexual forms migrate back to their overwinter hosts where they lay eggs [3]. Apterae are brown on the primary host and reddish-brown turning dark olive on the secondary one [1].

Apart from living on aerial plant organs of its secondary hosts, *R. nymphaeae* can also survive in underwater conditions [3]. It has specialized body hairs that can trap air, enabling it to feed on submerged plant parts [4]. Using their stylets to probe plant sap they select the most suitable host among them and usually concentrate along the petiole, leaf lamina, buds, and flowers of water lilies

and lotus. The leaves then become curled and small, often with deposits of honeydew on the leaf surface, which can cause the development of black sooty mould [3]. After colonizing aquatic plants, water lily aphids reproduce quickly and can be very destructive. *Rhopalosiphum nymphaeae* can give one offspring every six hours [5], and cover almost all plants in the water a few weeks after their first appearance [6].

Rhopalosiphum nymphaeae is widely distributed on a variety of hosts; for example, in Europe, its reported primary hosts are species from the Rosaceae family: *Amygdalus communis* L. [7], *P. armeniaca* Marsh., *P. avium* L., *P. persica* (L.), *P. spinosa* L., while it can have more than 100 different secondary hosts such as *Azolla filiculoides* Lam., *Calla palustris* L., *Lemna minor* L., *Nymphaea odorata* Aiton, *Potamogeton crispus* L., and *Typha angustifolia* L. [8]. During almost 30 years of studies of aphid fauna, and fauna of parasitoid wasps from the subfamily Aphidiinae in Serbia, *R. nymphaeae* was only found sporadically, because it was never a research target species. Petrović-Obradović [9] reported water lily aphid on its primary hosts, *Prunus spinosa* L., *P. domestica* L., *P. cerasifera* Ehrh., and *Prunus* sp., and its two secondary hosts (*Alisma plantago-aquatica* and *Ranunculus aquatilis*). Another research reported that *R. nymphaeae* was most commonly found on *Typha latifolia* [10,11,12]. It was also found on *Alisma* sp. [10].

Many of water lily aphids' secondary hosts are weeds and invasive plants [8]. Its successful usage in biological control has not been reported yet, but some authors (e.g., [13]) recommended it as a biological control agent against duckweed, *Heteranthera limosa* (Sw.) Willd., a pest of rice crops in California. Tomanović et al. [14] assume that water lily aphid can significantly impact the

Correspondence to: Darija Milenković
University of Niš, Faculty of Sciences and Mathematics,
Višegradska 33, 18000 Niš, Serbia
E-mail: darija.velickovic@pmf.edu.rs
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control of pest populations in neighboring wetland systems. Here it should be pointed out that water lily aphid is a reservoir of many parasitoid species, primarily Aphidiinae (Hymenoptera: Braconidae) which are known to be effective natural enemies of some important aphid pests [12]. Some of the parasitoids reported on *R. nymphaeae* are *Aphidius colemani* Viereck, *A. matricariae* Haliday, *A. rhopalosiphii* de Stefani-Perez, *Diaeretellus palustris* Starý, *Lysiphlebus fabarum* (Marshall), *Trioxys auctus* (Haliday) and *Praon necans* Mackauer [2,12,15]. It was also found that some predatory insects were reported to be serious natural enemies of the studied aphid, such as various coccinellids (*Brumoides suturalis* Fabricius, *Coccinella septempunctata* L., *Micraspis discolor* Fabricius, *Menochilus sexmaculatus* Fabricius and *Scymnus* Kugelann species) [16], a syrphid *Ischiodon scutellaris* Fabricius [17], common green lacewing *Chrysoperla carnea* (Stephens) [18] and also the very well studied aphid midge *Aphidoletes aphidimyza* Rondani. In the end, some entomopathogenic fungi e.g., *Lecanicillium lecanii* (Zimm.) were found to be natural enemies of the water lily aphid [3].

Since there was no systematic investigation on the spectrum of secondary hosts of *R. nymphaeae* in Serbia, we assumed that the number of secondary hosts would have been higher. The main goal of this research is to provide a list of aquatic plants attacked by water lily aphid and to detect the prevalence of the secondary host choice.

Materials and Methods

The material for this research representing *apterae* and *alatae* (Figure 1) was collected in September 2020, from 16 localities in wetland habitats in northern Serbia near the flow of the Danube River (Figure 2). Parts of plants infected with aphids were cut and put in plastic containers 10x15 cm, covered with muslin cloths, and transported to the laboratory. Eleven different plant species were identified on-site and were not kept for further research. Both apterae and alatae were put in 2 ml plastic tubes filled with 70% ethyl alcohol and labelled. Identification was done using a binocular stereomicroscope (Leica DFC 320, M216A). The key of Blackman & Eastop [1] was used as very reliable for the identification of collected adult apterous viviparous females. Some data on the secondary host (*Alisma plantago-aquatica*, *Alisma* sp., *Ranunculus aquatilis*, *Typha latifolia*) were extracted from previously published papers [9–12, 19]. Aphid material was deposited at the Faculty of Sciences and Mathematics, Department of Biology and Ecology, University of Niš.

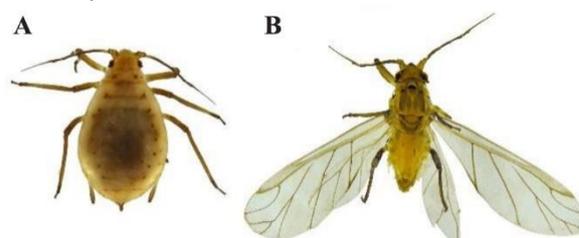


Fig. 1 Apterous (A) and alatae (B) viviparous female of *R. nymphaeae* – dorsal view. The photos were taken on a Leica M165C camera with 25x magnification.

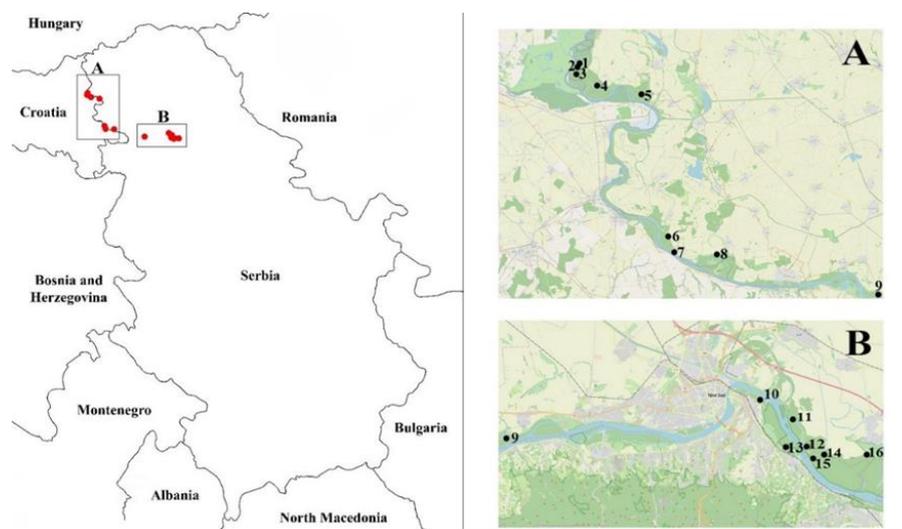


Fig. 2 Maps of the research area. The higher resolution map shows the overlapping localities more closely: (A) localities 1-9, (B) localities 9-16. The numbers represent the following localities with DMS coordinates: 1. Markova bara (45° 35' 35.88" N, 18° 55' 8.04" E); 2. Osmica (45° 35' 26.16" N, 18° 54' 57.6" E); 3. Tošina bara (45° 34' 39.72" N, 18° 54' 44.64" E); 4. Bara kod tri mosta (45° 33' 30.24" N, 18° 57' 37.44" E); 5. Tuškoš (45° 32' 40.92" N, 19° 3' 43.56" E); 6. Doktor pumpa (45.3131, 19.1232); 7. Hašaški Dunavac (45.2882, 19.1353); 8. Lovrenac (45° 17' 7.44" N, 19° 14' 11.4" E); 9. Begečka jama (45° 13' 16.68" N, 19° 36' 14.76" E); 10. Petrovaradinski Dunavac (45° 15' 9" N, 19° 53' 39.12" E); 11. Patrijaršijska tonja (45° 14' 8.88" N, 19° 55' 52.32" E); 12. Agla (45° 12' 53.28" N, 19° 56' 49.56" E); 13. Karlovački Dunavac (45° 12' 48.96" N, 19° 55' 27.84" E); 14. Bara sa posipom (45° 12' 27" N, 19° 58' 4.08" E); 15. Rupa (45° 12' 17.28" N, 19° 57' 19.44" E); 16. Šlajz (45° 12' 27" N, 20° 0' 57.96" E). The sampling map was made in QGIS 3.22.3.

Results

A total of 44 samples of *Rhopalosiphum nymphaeae* were collected from 11 different aquatic and semi-aquatic plants. The hosts were presented in alphabetical order. The data on the date of sampling are given chronologically. Abbreviations for legators are given in brackets: [DC] Dušanka Cvijanović, [DM] Darija Milenković; abbreviations for aphid forms are given in parentheses: (al) alatae, (ap) apterae, (n) nymphs.

***Hydrocharis morsus-ranae* L., Hydrocharitaceae:** 09.09.2020. Novi Sad, Koviljski rit, Agla, (ap 6, n 10); 09.09.2020. Novi Sad, Petrovaradin, Karlovački Dunavac (ap 2a, n 6) [DM].

***Nuphar lutea* Smith, Nymphaeaceae:** 09.09.2020. Novi Sad, Koviljski rit, Patrijaršijska tonja (ap 7, n 63); 10.09.2020. Bačko Novo Selo, Doktor pumpa (n 6); 11.09.2020. Apatin, Tošina bara (al 2, ap 2, n 11) [DM].

***Nymphaea alba* L., Nymphaeaceae:** 08.09.2020. Novi Sad, Koviljski rit, Šlajz (ap 9, n 36); 09.09.2020. Novi Sad, Koviljski rit, Agla (ap 2, n 5); Novi Sad Koviljski rit, Patrijaršijska tonja (al 14, ap 15, n 42) [DM].

***Nymphoides peltata* (S. G. Gmel.) Kuntze, Menyanthaceae:** 09.09.2020. Novi sad, Koviljski rit, Agla (ap 16, n 42); 10.09.2020. Bačko Novo Selo, Hašaški Dunavac (al 7, ap 3, n 23); 11.09.2020. Apatin, Bara kod tri mosta (ap 1); Apatin, Osmica; Apatin, Tošina bara (ap 8, n 59); Apatin, Tuškoš (al 1, ap 5, n 21) [DM]; 18.09.2020. Novi Sad, Begeč, Begečka jama (ap 9, n 44) [DC].

***Phragmites australis* (Cav.) Steud., Poaceae:** 11.09.2020. Apatin, Tošina bara (ap 7, n 20) [DM].

***Polygonum sp.*, Polygonaceae:** 09.09.2020. Novi Sad, Koviljski rit, Agla (ap 2, n 5) [DM].

***Persicaria amphibia* (L.), Polygonaceae:** 09.09.2020. Novi Sad, Koviljski rit, Patrijaršijska tonja (ap 6, n 13), 11.09.2020. Apatin, Tošina bara (ap 2, n 8) [DM].

***Salvinia natans* (L.), Salviniaceae:** 09.09.2020. Novi Sad, Koviljski rit, Agla (ap 1, n 3); Novi Sad, Koviljski rit, Bara sa posipom (al 8, n 2); Novi sad, Koviljski rit, Patrijaršijska tonja (al 1, ap 7, n 12); Novi Sad, Petrovaradin, Karlovački Dunavac (ap 2, n 14); Novi Sad, Petrovaradin, Petrovaradinski Dunavac (al 2, ap 2, n 3); 10.09.2020. Bačka Palanka, Mladenovo, Lovrenac (ap 7, n 6); Bačko Novo Selo, Doktor pumpa (al 1, ap 2, n 11); Bačko Novo Selo, Hašaški Dunavac (al 13, ap 1, n 15); 11.09.2020. Apatin, Bara kod tri mosta (ap 1, n 3); Apatin, Markova bara (n 3); Apatin, Osmica (al 2, ap 10, n 37); Apatin, Tošina bara (al 1, ap 7, n 20) [DM]; 18.09.2020. Novi Sad, Begeč, Begečka jama (ap 5, n 12) [DC].

***Schoenoplectus lacustris* (L.) Palla, Cyperaceae:** 09.09.2020. Novi Sad, Koviljski rit, Agla (al 1, ap 3, n 9) [DM].

***Spirodella polyrhiza* (L.) Schleid, Araceae:** 09.09.2020. Novi Sad, Koviljski rit, Agla (ap 1, n 4); Novi Sad, Koviljski rit, Karlovački Dunavac (ap 1, n 3); Novi Sad, Koviljski rit, Rupa (al 2, ap 5, n 11); 10.09.2020. Bačka Palanka, Mladenovo, Lovrenac (n 2); Bačko Novo Selo, Hašaški Dunavac (ap 1, n 56); 11.09.2020. Apatin, Tuškoš (ap 2, n 3) [DM]; 18.08.2020. Novi Sad, Begeč, Begečka jama (ap 1, n 10) [DC].

***Trapa natans* L., Lythraceae:** 09.09.2020. Novi Sad, Koviljski rit, Agla, (ap 11, n 59); 10.09.2020. Bačko Novo Selo, Doktor pumpa (al 1, ap 1, n 4); 11.09.2020. Apatin, Markova bara (ap 8, n 22); Apatin, Osmica (n 10); Apatin, Tuškoš (al 1, ap 1, n 3) [DM].

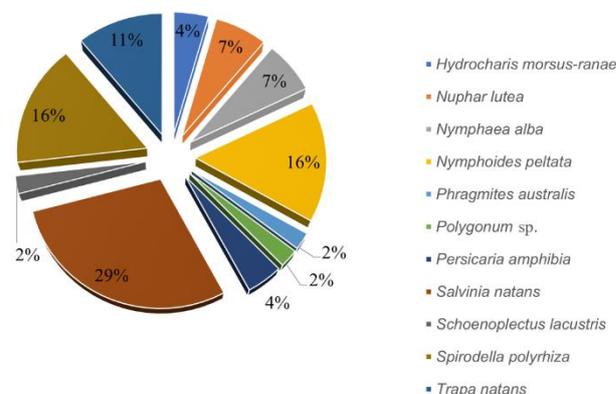


Fig. 3 Percentage of secondary hosts in the collected samples.

Discussion

During the research conducted in 2020, eleven new plant species were identified as secondary hosts for *R. nymphaeae* in Serbia. These plants are listed in the Host Plant Catalog of Aphids [8] as common hosts found in many countries in Europe and Asia. Our results have shown that the most common secondary hosts were *Salvinia natans* (present in 29% of all collected samples), *Nymphoides peltata* (16%), *Spirodella polyrhiza* (16%), and *Trapa natans* (11%) (Fig. 3).

The water lily aphid was found on more than 150 different host plants in Europe [8]. Belarus, Bulgaria, and Serbia reported two of the same primary hosts: *P. cerasifera* and *P. domestica* [7, 20]. In Bulgaria, water lily aphid was also found on *Amygdalus communis* L. and *P. armeniaca* [7, 21], while in Serbia it was reported on *P. spinosa* [9]. In Turkey, *R. nymphaeae* was seldom found on lettuce, *Lactuca sativa* (L.), where it can represent an important virus vector [22]. Water lily aphid is studied as one of the dominant pests of ornamental water plants in Hungary such as *Nymphaea alba*, *N. pubescens* Willd., *Nuphar lutea*, and *Nelumbo nucifera* Gaertn. [23], and other plants from the Nymphaeaceae family in Slovakia [24]. In our country, we found *R. nymphaeae* on two hosts from the Nymphaeaceae family (*Nymphaea alba* and *Nuphar lutea*), and three other ornamental plants (*Nymphoides peltata*, *Persicaria amphibia*, and *Salvinia natans*). Water lily aphid also feeds on wild and semi-wild noxious water plants such as *Myriophyllum spicatum* L. in Russia [25] *Potamogeton* L. in Hungary [23], and *Trapa natans* in Italy, Hungary, Latvia, Romania, and Russia [9, 23, 25]. As for the wild plants, during this study in Serbia, it was found to feed only on *Trapa natans*.

Conclusion

Rhopalosiphum nymphaeae is a significant pest of ornamental water plants and various members of the Rosaceae family. However, as a reservoir of many parasitoid species, and pest of harmful wild and semi-wild

water plants, it has the potential to be used in their biological control. While water lily aphid has a great number of hosts, it was found on only 19 different plants in Serbia. Future research should give us more information about water lily aphids' hosts, and their importance for aquatic and terrestrial ecosystems.

References

- Blackman R. L., Eastop V. F. Aphids on the World's Plants: An online identification and information guide 2022; <http://www.aphidsonworldsplants.info/> (accessed 15.03.2022).
- Farahpour-Haghani A, Jalaean M, Mehrparvar M. First report of *Rhopalosiphum nymphaeae* (L.) (Hem.: Aphididae) on *Azolla filiculoides* from Iran and its male formation on secondary host plant. *J. Crop Prot.* 2015; 4(4): 557-561.
- Halder J, Rai A, Chakrabarti S, Dey D. Distribution, host range and bionomics of *Rhopalosiphum nymphaeae* (Linnaeus, 1761), a polyphagous aphid in aquatic vegetables. *Def. Life Sci. J.* 2020; 5(1): 49-53.
- Center T. D., Dray F. A., Jubinsky G. P., Grodowitz M. J. Insects and other arthropods that feed on aquatic and wetland plants. United States Department of Agriculture. Agricultural Research Service, Technical Bulletin 2002.
- Storey M. C. Preference and Performance of the Water Lily Aphid (*Rhopalosiphum Nymphaeae*) among Native and Invasive Duckweeds (Lemnaceae). Electronic Theses and Dissertations, 2007.
- Ballou J. K., Tsai J. H., Center A. D. Effects of Temperature on the Development, Natality, and Longevity of *Rhopalosiphum nymphaeae* (L.) (Homoptera: Aphididae). *Envir. Entomol* 1986; 15: 1096-1099.
- Vasilev P, Andreev R. Distribution, population dynamics and damage of water lily aphid *Rhopalosiphum nymphaeae* Linnaeus (Hemiptera: Aphididae) on fruit trees in Bulgaria. *Scientific works of Agricultural university-Plovdiv*, 2016; 59(3): 115-122.
- Holman J. *Host Plant Catalog of Aphids*, 3rd edn. Dordrecht: Springer, 2009.
- Petrović-Obradović, O. Aphids (Homoptera: Aphididae) of Serbia, 1st edn. Faculty of Agriculture, University of Belgrade, 2003. (Serbian)
- Kavallieratos N. G., Tomanović Ž., Starý P., et al. A survey of aphid parasitoids (Hymenoptera: Braconidae: Aphidiinae) of Southeastern Europe and their aphid-plant associations. *Appl. Entomol. Zool.* 2004; 39(3): 537-563.
- Ilić Milošević M, Žikić V, Milenković D, Stanković S. S., Petrović-Obradović O. Diversity of aphids (Homoptera: Aphididae) in Southeastern Serbia. *Biol. nysanna* 2019; 10(1): 49-57.
- Tomanović Ž, Žikić V, Petrović A. *Fauna of parasitoid wasps (Hymenoptera, Braconidae, Aphidiinae) of Serbia*, 1st edn. Serbian Academy of Sciences and Arts. Beograd, 2021. (Serbian)
- Oraze M. J., Grigarick A. A. Biological control of duck salad (*Heteranthera limosa*) by the waterlily aphid (*Rhopalosiphum nymphaeae*) in rice (*Oryza sativa*). *Weed Sci.* 1992; 40(2): 333-336.
- Tomanović Ž, Starý P, Kavallieratos N. G, Gagić V, Plečaš M, Janković M. Aphid parasitoids (Hymenoptera: Braconidae: Aphidiinae) in wetland habitats in western Palaearctic: key and associated aphid parasitoid guilds. *Ann. Soc. Entomol. Fr.* 2012; 48(1-2): 189-198.
- Žikić V, Ilić Milošević M, Stanković S. S, et al. Aphidiinae (Hymenoptera: Braconidae) of Serbia and Montenegro - Tritrophic interactions. *Acta entomol. Ser.* 2012; 17(1-2): 83-105.
- Saraswati K, Mishra R, Kumar R, Jha V. *Rhopalosiphum nymphaeae* (L.) infestation on the leaves of *Euryale ferox*. *Journal of Aphidology* 1990; 4(1-2): 89-92.
- Ali A, Rizvi P, Khan F. R. On the predation of aphids by *Ischiodon scutellaris* (Diptera: Syrphidae) under natural environment. *Bionotes* 2009; 11(3): 95-96.
- Wedgwood E, Bennison J. Pest, disease and weed management in ornamental aquatic plants. Horticultural Development Company, ADAS, UK. Online factsheet, 2008.
- Petrović A, Tomanović Ž, Žikić V, Kavallieratos N. G, Starý P. New records of Aphidiinae (Hymenoptera: Braconidae) from Serbia and Montenegro. *Acta entomol. Serb.* 2009; 14(2): 219-224.
- Buga S, Stekolschikov A.V. Aphids as pests of fruit – and berry-producing plants in Byelorussia. *Redia* 2009; 92: 239-242.
- Vasilev P, Andreev R, Kutinkova H. Aphids (Hemiptera: Aphididae) on plum and cherry plum in Bulgaria. *Acta Hort. regiotecturae* 2020; 23(1): 12-16.
- Sangün O, Satar S. Aphids (Hemiptera: Aphididae) on lettuce in the Eastern Mediterranean Region of Turkey: Incidence, population fluctuations, and flight activities. *Türk. entomol. derg.* 2012; 36 (4): 443-454.
- Bürgés G, Csiszár V. Ornamental water-plants and their pests in Hungary, 3rd International Plant Protection Symposium at Debrecen University and 8th Trans-Tisza Plant Protection Forum, Debrecen, Hungary 2003; 231-236.
- Suvak M, Gregorek R, Pl'uchtova M. Actual and potential role of parasitoids (Hymenoptera: Eulophidae) in control of water-lily beetle *Galerucella nymphaeae* (Coleoptera: Chrysomelidae) in conditions of Botanical Garden of P.J. Šafárik University in Košice (Slovakia). *Thaiszia J. Bot.* 2012; 22(2): 217-242.
- Zaitzev V.F, Volkovitsh M.G, Reznik S. Y, Podlipaev S. A, Dolgovskaya M. Y. Russian insects and diseases that could control US waterweeds. Russian Academy of Sciences ST Petersburg Zoological Inst, 1996.