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On the benthic water bug *Aphelocheirus aestivalis* (FABRICIUS 1794) (Heteroptera, Aphelocheiridae): Minireview

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A b s t r a c t : PAPÁČEK M.: On the benthic water bug *Aphelocheirus aestivalis* (FABRICIUS 1794) (Heteroptera, Aphelocheiridae): Minireview. Diagnostic characters of *Aphelochirus aestivalis* are listed, re-examined and figured in detail. Distribution, habitats, conservation status and biology of the species are briefly reviewed.

K e y w o r d s : *Aphelocheirus aestivalis*, diagnosis, distribution, habitats, biology.

Introduction

Aphelocheirus (*Aphelocheirus*) *aestivalis* (FABRICIUS 1794) was described as *Naucoris aestivalis* by FIEBER (1794: 66) who also characterized type material locality only by brief note: 'Habitat in Galliae aquis Muf. Dom. Bofc.'. Historical name Gallia was used by Romans for Belgium, France, northern Italy, western Switzerland and parts of the Netherland and Germany. FABRICIUS (1794) meant most probably France. Exact holotype locality is unknown and holotype is missing. For this reason LANSBURY (1965, p. 109) designated the lectotype (♀, France) that is deposited in The Oxford University Museum, Hope Entomological Collections, Oxford, Great Britain.

Furthermore KANYUKOVA (1995, p. 61) surveyed the synonymy of *A. aestivalis* (shortened version see below):

Aphelocheirus breviceps HORVÁTH 1895: 160 (syn. KANYUKOVA 1974: 1730)
Aphelocheirus kervillei KUHLGATZ 1898: 114 (syn. HORVÁTH 1899: 262)
Aphelocheirus nigrita HORVÁTH 1899: 257, 263 (syn. REUTER 1912: 73; BERGROTH 1917: 253)
Aphelocheirus montadoni HORVÁTH 1899: 258, 264 (syn. REUTER 1912: 73; BERGROTH 1917: 253)
Aphelocheirus aestivalis f. *cinereonigra* STICHEL 1955: 90 (syn. KANYUKOVA 1995: 61)
Aphelocheirus aestivalis f. *annosa* STICHEL 1955: 90 (syn. KANYUKOVA 1995: 61)

Except two endemic species from Iberian Peninsula (see NIESER & MILLÁN 1989), *A. aestivalis* is only known representative of the family Aphelochieridae distributed throughout Europe. Recently we can record a flurry of findings of new localities colonized by this species in central Europe. This fact as well as constant interest of heteropterists and hydrobiologists on various aspects of biology and ecology of this endangered species is reason for presented contribution.

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Material and methods

Diagnostic characters of *A. aestivalis* and their variability respectively were re-examined in one hundred eighty eight adult specimens (90♂♂, 98♀♀) that were sampled in twenty seven localities during last ten years. At the same time, these localities represent south western Asian- (Georgia), central European- (Czech Republic) and western Mediterranean (Corsica) areas of the mostly west Palaearctic distribution of this species.

France: Corsica, Golo River, village/city?

Czech Republic: Bohemia: Dračice River, Najdorf; Dračice River, Klikov; Junction of Lužnice River and Dračice River; Nová řeka River, Nový Řadov, Stráž nad Nežárkou; Lužnice River, Roudná; Lužnice River, Bechyně; Nežárka River, Jemčina; Juncion of Nová řeka and Nežárka Rivers; Ohře River, Kadaň; Prunéřovský potok brook, Kadaň; Ohře River, Postoloprty; Otava River, Zátaví; Mže River, Milíkov; Ploučnice River, Mimoň; Radbuza River, Semošice; Sázava River, Zruč nad Sázavou; Vltava River, Rožmberk; Vltava River, Boršov nad Vltavou; Vltava River, České Budějovice.

Czech Republic: Moravia: Dyje River, Hrádek; Dyje River, Podhradí nad Dyjí; Jihlava River, Iváň; Ostrava River, Petřvaldík; Rokytná River, Budkovice.

Georgia: Šorəpani River, Kvirila; Chuevi River, Dzirula.

Examination of external structures was carried out by use of Leica MZ9.5 stereo microscope (max. 120x magnification), examination of female and male terminalia by use of Olympus BX41 microscope (max. 400x magnification). Drawings were made by using a camera lucida.

Diagnostic features and identification

Medium sized water bug species. Medial body length 8.5-10.5 mm (females generally more robust than males – about 0.3-0.5 mm longer than males); maximum width of pronotum 5.9-6.5 mm; maximum width of abdomen 6.5-7.5 mm (KANYUKOVA 2006, INDROVÁ 2009). WACHMANN et al. (2006) presented medial body length within the range of 8.2-11.0 mm. Medial body length of nymphs of the 1st instar: 2.2-2.5 mm; 2nd instar: 2.9-3.2 mm; 3rd instar: 4.1-4.6 mm, 4th instar: 5.2-5.7 mm; 5th instar: 7.1-8.2 mm (nymphs of the subpopulation from Dračice River (= Reissbach) on the Czech-Austrian border, measured by INDROVÁ (2009).

Body of adults flat with broadly round (micropterous morph) or elongate roundish, broadly ellipsoid (brachy- and macropterous morph) outline. Brachy- and macropterous morph rare. All known pteromorphs, i. e., macropterous, hypomacropterous, brachypterous, hypobrachypterous and micropterous, are figured by LARSÉN (1931, p. 12, Fig. 2, p. 13, Fig. 3, p. 18, Figs 5, 6). Subbrachypterous female is figured also by POISSON (1957, p. 156, Fig. 112B), macropterous female also, e.g., by POPOV (1971, p. 157; Fig. 101) and KANYUKOVA (2006, p. 143, Fig. 238).

Ground colour brown (dorsum) to greyish brown (scutellum; basal parts of fore wing remnants, venter of abdomen); head, marginal thoracic- and abdominal parts, and legs yellow. Head with dark patches in some specimens. Deeply coloured specimens referred as the 'melanotic morph' were sometimes incorrectly described as separate species in the past. Their body including head can be completely black. Nevertheless, their black colour is not caused by pigment in the cuticle but by extracuticular surface coat (KANYUKOVA 2006). Such coat is characteristic especially for oldest individuals.

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Head somewhat longer than wide, frontoclypeal region roundish conically prominent forwardly; eyes dorsally narrow and flat. Pronotum shorter than wide, with bluntly rounded margins of lateroposterior lobes (Fig. 1; see also NIESER & MILLÁN 1989, p. 114, Fig. 17). Scutellum short, wide triangular. Posterolaterally projecting abdominal laterotergites form serrated margin of abdomen. Abdominal sternites with inconspicuous posteromedial prominence (inconspicuous medial keel); sternites 5, 6, and 7 with group (3-8) distinct thick short spines on this prominence.

Male terminalia (Figs 2-13) (see also POISSON 1957, p. 157, Fig. 113B-E; NIESER & MILLÁN 1989, p. 113, Fig 5, p. 114, Figs 11, 13; KANYUKOVA 2006, p. 145, Fig. 240): Abdominal segment 8 and genital capsule asymmetrical. Genital capsule (Fig. 2) slightly twisted on the right in situ. Aedeagus (Figs 3-7) long and robust. Dorsal (in situ) (= posterior) part of phallosoma well sclerotized and brownly pigmented; ventral (= anterior) part light. Its posteroapical part bent conspicuously on the right. Distinct cuticular serration located asymmetrically subapically on the left anterior part; inconspicuous cuticular 'raspier' subapically on the right anterior part. Left paramere (Figs 8-10) with small tip on posterobasal margin, apically twisted broad lamella, and scale like microsculpture on distal anteroventral part. Right paramere simple (Figs 11-12), distally peg shaped with tapering apex. Parandria (Figs 2, 13) well developed, asymmetrical, apically ball shaped with short thick setae, thicker on the right one.

Female terminalia (Figs 14, 15) (see also POISSON 1957, p. 157, Fig. 113 A, dorsal view is incorrectly referred as 'face ventrale' in this figure legend; NIESER & MILLÁN 1989; p. 113, Fig. 8). Dorsal laterotergites of the 7th abdominal segment slightly subsymmetrical, the right minutely smaller than the left one as in Fig. 14. Subgenital plate (= abdominal sternite 7; Fig. 15) symmetrical, roundly triangular, apically narrowed and round. Its surface with irregular transversal fine furrows and tiny setae; posteromarginally located paired tufts of long setae and one inconspicuous tuft of short thicker setae suabapically. This greyish coloured sclerite has anterobasally and posterolaterally located symmetrical yellow spots, well visible only in prepared sclerite under higher magnification.

Nymphs similar to the micropterous adult appearance. Eggs elongated. Chorion with hexagonal microsculpure and numerous micropyles in the inner area of exochorion hexagons (see MESSNER & ADIS 1999, p. 66, Figs 1, 2).

Distribution

(See also KANYUKOVA (1995, 2006) and databasis in http:www.faunaeur.org)

The species is distributed across the Europe from British Isles to Caucasus and Ural and from southern Scandinavia to northern part of Mediterranean, norteastern Africa and south western Asia. The species was concretely recorded from the following countries: Europe: Austria (see, e.g., RABITSCH 2007), Belgium, Bulgaria, Byelorussia, Croatia, Czech Republic, southern part of Denmark (see DAMGAARD 2005), Estonia, European part of Kazakhstan, southern part of Finland, France, Great Britain, Germany, Hungary, Ireland, Northern Italy, Latvia, Liechtenstein, Lithuania, Moldavia, The Netherlands, Norway, Poland, Portugal, Romania, European part of Russia, Serbia (ŽIVIĆ et al. 2007), Slovakia, Slovenia, Spain, southern part of Sweden, Switzerland, Ukraine. North Africa: Egypt. South western Asia: Turkey, Georgia.

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A. aestivalis is only *Aphelocheirus* species in the most of the Europe. But records on the species from the Portugal and Spain before 1989 are dubious because of possibility to change of *A. aestivalis* with two endemic species of *Aphelocheirus* from Iberian Peninsula described by NIESER & MILLÁN (1989). KANYUKOVA (1995) noted that the record from Egypt is probably based on misidentification (cf. HORVÁTH 1899: 262) but later she (KANYUKOVA 2006) presented the species was found also in Egypt.

Macropterous (brachypterous) morph is known especially from southern Europe and some parts of central Europe (see, e.g., AUKEMA et al. 2005; HOFFMANN 2004; LARSÉN 1927, 1931b; POISSON 1957). Only monomorphic micropterous specimens occur in some colder eastern part of central Europe and in northern Europe (see DAMGAARD 2005; PAPÁČEK & SOLDÁN 2008).

Monitoring of occurrence and faunistic maps

Monitoring of the occurrence of *A. aestivalis* proceeds rather accidentally than systematically. Some published data on occurrence are not precise (e. g. only river basin is noted). In some cases, it is also not possible find out whether or not there are historical data still valid. For these reasons faunistic maps could be prepared only for some regions, e. g., Lower Austria (RABITSCH 2007), Mecklenburg-Vorpommern, northern Germany (ZETTLER 1998), southeastern Serbia (ŽIVIĆ et al. 2007) or for some countries, e. g., Czech Republic (ŠVAŇHALOVÁ 2006), Denmark (DAMGAARD 2005), and The Netherland (AUKEMA et al. 2002).

Habitats

A. aestivalis is bentic species that prefers and inhabits largely oligotrophic waters of depth about 0.4-9.0 m with stony, gravelly, sandy, clay or swampy bottom. It is being found also in the clusters of living or dead submerged plants and under isolated stones or dead woods and – buried in the bottom. KUHLGATZ's (1898) finding shows that the species can live also in estuarial waters. As described above, its subpopulations inhabit different habitats. They live mostly at somewhat isolated streamline stony bottom habitats of the epi- and mesopotamal segments of large rivers and small rivulets with rapids and well aerated water as well as in lenitic habitats of stagnant waters as are lakes, reservoirs, hammer ponds and artificial mine waters in extreme cases (KANYUKOVA 1974, 2006; KRAJEWSKI 1966; PAPÁČEK 2006; PAPÁČEK & BAUER 2006; PAPÁČEK & SOLDÁN 2008; PAPÁČEK et al. 2009; POISSON 1957; THORPE 1966). Occurrence of the species on habitat probably closely depends on specific biotic environment – on rich fauna of insect larvae, small crustaceans, and molluscs (see, e. g., BAUER 2007; DAMGAARD 2005; LEMB & MEIER 1966; LARSÉN 1931b). Some populations of *A. aestivalis* change habitats; they are able to migrate seasonally from running waters to other habitats like pools and backwaters (MESSNER et al. 1983).

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Note to the conservation status

A. aestivalis is rare species that is considered as endangered by categorization of IUCN in some countries of Europe (see, e.g., DAMGAARD 2005; KMENT & VILÍMOVÁ 2005; RABITSCH 2007). Despite its relative tolerance to change of some physic-chemical characteristic of water and episodic or periodic disturbances as are, e.g., seasonal or occasional destructive floods (PAPÁČEK 2006; PAPÁČEK & BAUER 2006; see also LEDGER's et al. (2006) mesocosms experiment), this species is endangered due to its habitat requirements and scarcity of macropterous morph and restriction of dispersal ability (DAMGAARD 2005). In principle, every event that strikes structure of benthic community in sites with *Aphelocheirus* occurrence, can influence a survival and recovery of its subpopulations. Destruction of its habitats by water course clearance, stream regulation or construction of weirs and dams can cause extinction of the species (PAPÁČEK & BAUER 2006; RABITSCH 2007). Nevertheless, this species with cryptic way of life was found in dozens of new localities – rivers, rivulets and streams in the Austria and the Czech Republic during last fifteen years (PAPÁČEK et al. 2009; RABITSCH 2007), and it is continually found in new localities at present. Hydrobiological methods of sampling bring often better results at searching of the species than commonly used entomological hand net sampling. COJOCARU (2005) published opinion, that *A. aestivalis* is widely distributed in the territory of Romania but it is only rarely collected because its habitat, and that is why it is not appropriate to consider it a rare species.

Biology

As other aphelochirids, *A. aestivalis* is predaceous benthic water bug feeding on different small benthic animals as are water insect larvae (especially caddisfly larvae; less mayfly, chironomid, stonefly, backfly and dragonfly larvae), small crustaceans (freshwater shrimps), small mussels (e.g., Pisidiidae and Sphaeriidae), snails (e. g., freshwater limpets), and also small fish larvae and juveniles (e.g., trout and bullhead) (see, e.g., BAUER 2007, BEUTLER & FRUTIGER 1988; LEMB & MEIER 1996; OHM 1956; PAPÁČEK & BAUER 2006; WESENBERG-LUND 1943). This species does not come on the water surface to breathe; it is characterized by plastron respiration (THORPE & CRISP 1947). Nymphs have closed tracheal system and combine plastron respiration with dermal respiration. Tracheal system of aduts is open (for review see, e.g., WICHARD et al., 2001). Phenology was studied especially by BAUER (2007), DAMGAARD (2005), KRAJEWSKI (1966), LARSÉN (1927, 1931a, b), POISSON (1957), SÆTTEM (1986) and USSING (1910). Females have relatively long oviposition period – throughout spring and whole summer (maybe also in early autumn; see also DAMGAARD (2005). Eggs are laid and glued on the surface of different object including mollusc shells. Embryonic incubation period lasts 5-7 weeks (laboratory observation). Nymphs hatched from eggs laid during the first half of summer develop mainly in the same year. Eggs laid in the second half of summer overwinter. Preimaginal development can be relatively long – as long as two years on dependency of environmental conditions. Adults mate repeatedly during the spring and summer season and can live probably more one year. *A. aestivalis* is long-lived insect species with semivoltine life cycle and unique continual spermatogenesis in males (PAPÁČEK & SOLDÁN 2008). Its populations are formed probably by time splitting cohorts. For this

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reason, *A. aestivalis* can overwinter in egg, nymph, or adult stage. All developmental stages occur in different proportions in different sites throughout the year.

MESSNER et all. (1983) found seasonal migration in this species. Adults and nymphs of the 5th instar migrate to the stony and rapid sections of the streams in spring, where last ecdysis, mating and oviposition are realized. In September and October nymphs and adults migrate to the blind stream branches and places with slow water stream and stony and sandy bottom. On the other hand, author of this contribution found both nymphs and adults in the rapids of Nová řeka River (Czech republic, South Bohemia) with fast water stream during whole winter (December, January, February) repeatedly in some subsequent years.

LARSÉN (1931b) who experimented with laboratory rearing of *A. aestivalis*, hypothesised that the development of macropterous morph depends on the character of habitats. He supposed that macropters develop mainly in stable and less aerated waters.

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Zusammenfassung

Vorliegende Arbeit behandelt eine Überblicksdarstellung der Morphologie, Verbreitung, Gefährdung, des Lebensraumes sowie der Biologie der Grundwanze *Aphelocheirus aestivalis* (FABRICIUS 1794) (Heteroptera, Aphelocheiridae). Die wesentlichen Artmerkmale werden bildlich dargestellt.

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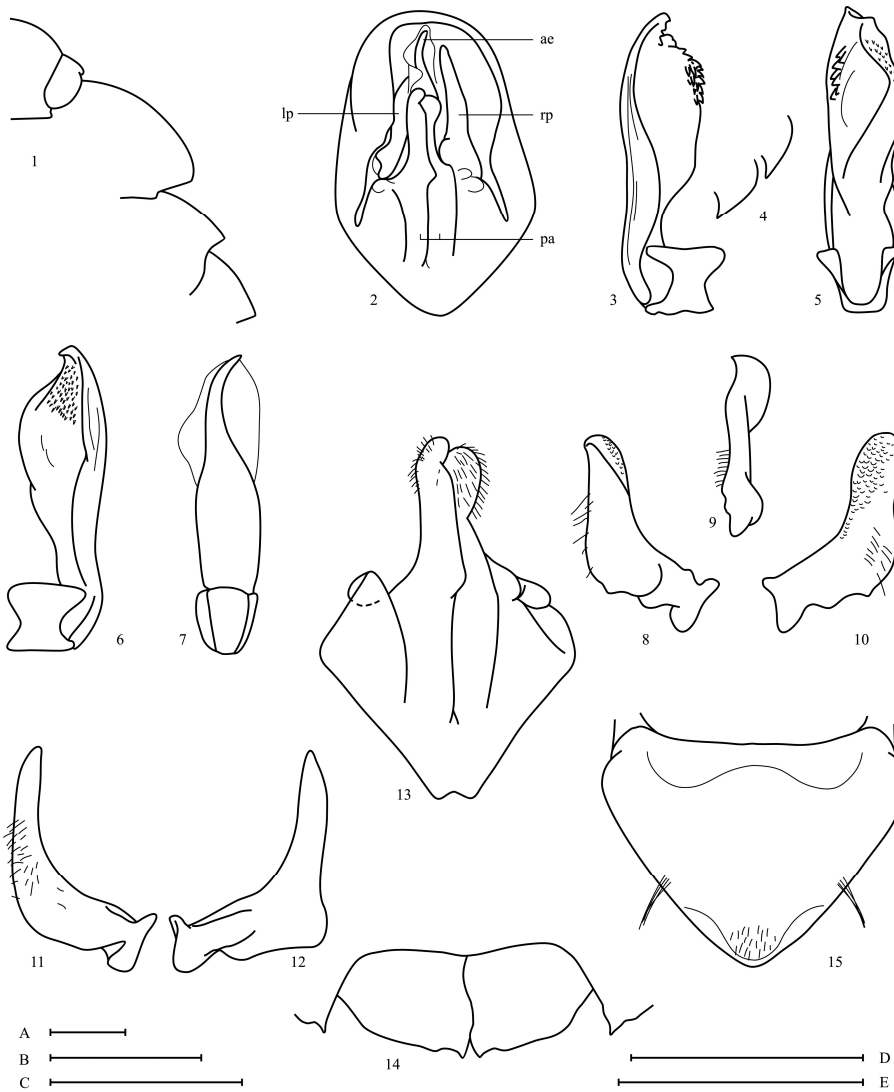

Figs 1-15: Differential characters of *A. aestivalis*. (**1**) Outline of the right posterolateral angle of pronotum, lateral angle of reduced fore wing (embolium), and the 2nd abdominal segment. (**2**) Genital capsule; dorsal view; ae – aedeagus, lp, rp – left (right) pramere, pa – parandria. (3-7) Aedeagus: (**3**) right lateral view, (**4**) detail of subapical serration (scheme without scale), (**5**) ventral (in situ) (= anterior) view, (**6**) left lateral view, (**7**) dorsal (in situ) (= posterior) view. (8-10) Left paramere: (**8**) inner (right lateral) view, (**9**) posterior view, (**10**) outer (left lateral) view. (11,12) Right paramere: (**11**) outer (right lateral) view, (**12**) inner (left lateral) view. (**13**) Posterodorsal part of genital capsule with parandria. (**14**) Dorsal view of female terminalia. (**15**) Female subgenital plate. Scale lines A (1), B (2), C (3, 5-7, 14-15), D (8-10, 11-12), E (13) = 1.0 mm.

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Figs 16-19: (**16**) *A. aestivalis*, female, dorsal view. Scale line = 1.0 mm. (17-19) Examples of *A. aestivalis* habitats: (**17**) Vltava River (= Moldau) by village Boršov nad Vltavou nearby České Budějovice. (**18**) Nová řeka River nearby Stráž nad Nežárkou. This river is really artificial channel constructed in 16th century. (**19**) Dračice River (= Reissbach) nearby extinct village Najdorf (= Neudorf). All sites Czech Republic, South Bohemia. (Photographs: M. Papáček)

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