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On the occurrence of *Potamophilus acuminatus* (Fabricius, 1772) (Coleoptera: Elmidae) in Poland

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Literature records about the occurrence of *Potamophilus acuminatus* in Poland are analysed and supplemented by new data. Distribution of the species, its habitats and threats are discussed.

Key Words: Coleoptera, Elmidae, *Potamophilus acuminatus*, Poland, distribution, habitat, endangered species.

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INTRODUCTION

Potamophilus acuminatus belongs to the most enigmatic species of Elmidae in the fauna of Poland and many European countries. Usually it was caught rarely, most often in small number of specimens. Many records dated back to a few dozen or even more than 100 years when scientists focused on geographical distribution of beetles therefore data on habitats and biology of this species are incomplete. Small amount of data and low numbers of collected specimens may indicate the danger of extinction, however, the information about the species is too inadequate so far to assess them in this respect (Pawłowski *et al*. 2002).

In the past 20 years we conducted many studies on macrofauna of running waters in different regions of Poland. During them we found *Potamophilus acuminatus* at three previously unknown sites. In this paper we present new data and make the synthesis of the knowledge on the occurrence of this species in Poland and its analysis on the background of data from other European countries, especially in Central Europe.

MATERIAL AND METHODS

Literature data was analyzed as well as checking the evidence collections if necessary. During this survey, the review papers, which were sometimes cited more frequently than source papers, were omitted due to duplicating the data contained therein e.g. Gerhardt (1910) or Horion (1955).

Our own data collected within the frames of three study projects was used. The studies of the River Krąpiel (north-western Poland) were conducted in 2010, every month, from April till September. The research covered the whole length of the river where 14 study sites were explored. Samples were taken from different microhabitats in the river (bottom of sand, stones, with *Sparganium* sp., *Fontinalis antipyretica* L.). Material from *Fontinalis antipyretica* was collected by placing a hydrobiological net in current and cleaning (destroying) a clump with a hand. Water reaction, temperature, electrolytic conductivity and dissolved oxygen content were measured with Elmetron CX-401 multiparametric sampling probe; water flow – with SonTek acoustic flowmeter FlowTracker; BOD_5 – according to Winkler's method; the remaining parameters with the use of Slandi LF205 photometer.

The material from the River Obra (western Poland) was collected in 2007 within the frames of national environment monitoring. The research was performed according to Multi-Habitat Sampling formula (Bis 2007), with the use of Surber's net. 20 single sample units from different microhabitas from the total bottom area of 1.25 m^2 were mixed and combined in one total site sample. Next, material was picked up from one-sixth volume of the sample (5 subsamples of the possible 30). In laboratory the following parameters were measured: alkalinity, hardness of water, BOD_5, concentrations of: chlorides, nitrates, nitrites, phosphates, chlorophyll „a", total phosphorus content and the amount of *E. coli* bacteria.

The research in the River Bug valley (eastern Poland) was conducted in the years 2005-2007. Material was gathered trice a year (spring – summer – autumn), separately in lotic and lentic zones of the river. Along the stretch of the river between Włodawa and Kodeń 8 study sites were selected. Semi-quantitative samples with the use of a hydrobiological net were collected. The following measurements were made: water flow by float method, water temperature with Slandi TM204 thermometer, water reaction – Slandi PH204 pH-meter, electrolytic conductivity – Slandi CM204 conductometer, dissolved oxygen content and oxygen concentration – Hanna Instruments HI 9145 oxygen meter.

10 larvae and one imago of *Potamophilus acuminatus* were obtained in total.

In the analysis of the new study sites data from national monitoring was also used (Lewicki *et al.* 2007, Miazga & Parcheta 2007).

RESULTS

The sites of *Potamophilus acuminatus* in Poland are listed below. In case of lacking the exact data on the localization of a site, the approximate localization is provided (with „~" symbol) – for UTM square with the biggest part of the study area or the central part of the river stretch. If the meaningful change of the name of the town occurred, old name (from the time of data publishing) is given in square brackets. New data is marked with # symbol. Available information about water quality is also given for them. Published data from WIOŚ reports (annual averages) is marked with an asterisk (*). Geographic regions are given after Kondracki (2000), including their codification in the universal decimal classification.

313.2–3 Szczecin Coast:

- #Half the distance between the villages of Chlebowo and Chlebówek (WV12) – the River Krąpiel. Meandering, mountain type, with rather fast flow. The width of the channel: ca. 5 m, maximum depth: 0.7 m, bottom of sand and stones with gravel. The surrounding is covered with the complex of deciduous

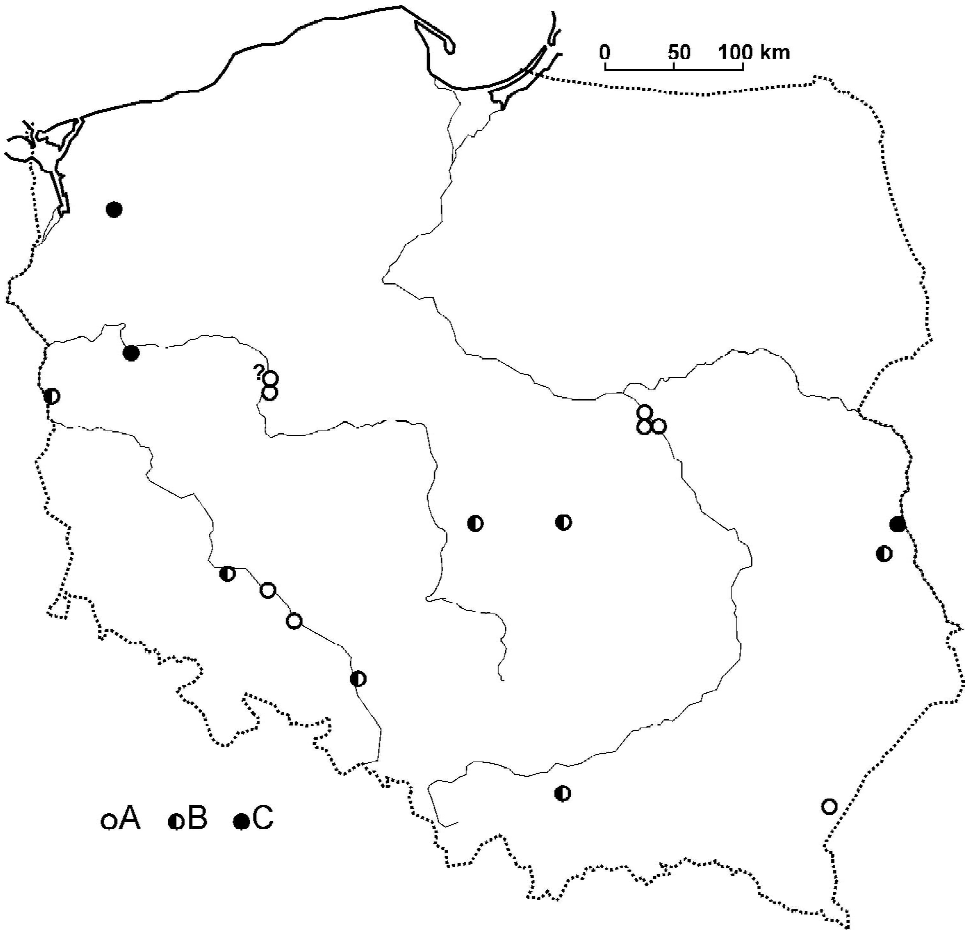

Fig. 1. Distribution of *Potamophilus acuminatus* in Poland: A – historical records, B – sites found in the last 30 years, C – new records, ? – doubtful data.

forests therefore in the river channel numerous trunks of overturned trees are present. The eastern river bank is steep and relatively high (about 2 m), overgrown by Pomeranian beech forests (Galio odorati-Fagetum), the western one is flat, flooded by the river and covered by alluvial alder-ash forests. The study site is the clump of *Fontinalis antipyretica* with the area of ca. ¼ m^2, growing on the stone situated in current environment on the bottom of gravel, water depth of 0.5 m. The moss occurred on the stone in May and was present till November.

Water flow: 0.70-0.87 $m \cdot s^{-1}$ (0.78 on average); water temperature: 10.7-17.2 °C (15.1); pH: 5.95-8.22 (7.13); conductivity: 187-258 $mS \cdot cm^{-}$ (214); dissolved oxygen: 6.6-8.8 $mg \cdot dm^{-3}$ (7.8); ammonium ions: 0.2-0.8 $mg \cdot dm^{-3}$ (0.3); nitrates: 1.2-2.1 $mg \cdot dm^{-3}$ (2.0); orthophosphates: 0.1-0.4 $mg \cdot dm^{-3}$ (0.3); Fe^{3+} ions: 0.02-0.15 $mg \cdot dm^{-3}$ (0.05); turbidity: 0.7-64.0 mg $SiO_2 \cdot dm^{-3}$ (10.3); total hardness: 174-255 mg $CaCO_3 \cdot dm^{-3}$ (180); BOD_5: 3.8-6.6 mg $O_2 \cdot dm^{-3}$ (5.1). The available water parameters qualify this study site for water quality class I or II, except for BOD_5 indicating class III-IV (Rozporządzenie... 2004).

Material: 6 VIII 2010, 2 larvae in lotic zone on the stone covered with *Fontinalis antipyretica*.

315.3 Toruńsko-Eberswaldzka Glacial Valley:

- #Skwierzyna (WU32) – the River Obra near the bridge on Gorzowska Street. Meandering, lowland, without modifications of the banks and channel. Water brown, water flow 0.32 $dm^3 \cdot s^{-2}$. The river flows through the landscape comprising the mosaics of agrocenoses (meadows, fields), open wastelands as well as bush patches and coniferous and mixed forests. The bank with the belt of alders and willows (channel shadowing 60-80%). The width of the channel ca. 15 m, the depth: from tens of cm to 2 m (1.0 m on average). The bottom sediments with the predominance of sand and mud, with ca. 10% share of thick gravel fractions, with detritus in some places. Trunks of cut down trees, large branches and roots present. Vegetation: patches of *Sagittaria sagittifolia* L. and other submerged species. Vegetation coverage of banks: 70-80%.

  Alkalinity: 206 mmol $CaCO_3 \cdot dm^{-3}$, total hardness: 300 mmol $CaCO_3 \cdot dm^{-3}$, chlorides: 26.7 $mg \cdot dm^{-3}$, BOD_5: 3.7 $mg \cdot dm^{-3}$, ammonium ions: 0.09 mg·dm, nitrites: 0.05 $mg \cdot dm^{-3}$, nitrates: 0.4 $mg \cdot dm^{-3}$, phosphates: 0.668 mdm^{-3}, total phosphorus: 0.335 $mg \cdot dm^{-3}$, chlorophyll „a": 3.6 $mg \cdot dm^{-3}$, *E. coli* contamination: 500 UFC·100 ml. General water quality*: class IV-V, outclassing factor: bacteriological contamination.

  Material: 14 VI 2007, Surber's net, 8 larvae (density: 48 $individ. \cdot m^{-2}$).

315.5 Wielkopolskie Lakeland:

- Poznań (~XU30) (Schilsky 1888).
- the River Warta between Mosina and Oborniki (~XU31) (Szulczewski 1922) – with the note „on tansy on June by the River Warta not uncommon". Data unconfirmed: the author referred to the collection of T. Schumann which was preserved in the Natural Collections of the University of Adam Mickiewicz in Poznań. However, the collection is chaotic, incomplete and it lacks the evidence specimens, moreover, the paper by Szulczewski (1922) has many evidently wrong identifications of other species.

315.6 Warciańsko-Odrzańska Glacial Valley

- Rybocice vic. (VT79) – the River Ilanka, the years 1998-2001 (Schöll et al. 2003).

318.1/2 Południowowielkopolska Lowland

- the middle course of the River Grabia (~CC71), 1 larva, the years 1998-1999 (Nijboer et al. 2006). A seminatural lowland river in meadow and forest surroundings. The average values of some water parameters: pH: 8.5, electrolytic conductivity: 340 $ġS \cdot cm^{-1}$, chlorides: 12.1 $mg \cdot dm^{-3}$, ammonium nitrogen: 0.07 $mgN \cdot dm^{-3}$, nitrate nitrogen: 2.28 mgN·dm, total phosphorus: 0.127 $mgP \cdot dm^{-3}$.

318.7 The Środkowomazowiecka Lowland:

- Warszawa-Powązki (DC98) – the clay excavation between Niska and Smocza Streets, the year 1864 (Hildt 1907, 1914).
- Warszawa-Praga (EC08) – flooding of the River Wisła near Fort Śliwicki (Warsow Citadel), the year 1894 (Hildt 1907, 1914).
- Warszawa-Bielany (DC99) – Kępa Potocka, the year 1890 (Hildt 1907, 1914).

318.5 The Silesian Lowland:

- Szczepanów near Środa Śląska (XS17) (Burakowski et al. 1983).
- Oława [Ohlau] (XS64) – the banks of the River Odra, rare (leg. Theobald Schummel, the year 1808) (Letzner 1871, 1885); poles by the River Odra (wooden ones?), the year 1879, 3 specimens (Fein & Haase 1881).
- Wrocław [Breslau] (XS46) – the banks of the River Odra, rare (leg. Theobald Schummel, the year 1808) (Leder 1872, Letzner 1871, 1885).
- Krapkowice vic. (~YR19) – the River Osobłoga, the years 1998-2001 (Schöll et al. 2003).

318.8 Południowomazowieckie Heights

- Nowy Glinnik vic. (DC31) – a stream, 1 larva, the year 1999 (Nijboer et al. 2006). A fast flowing stream on the soils rich in calcium, natural, in forest surroundings, oligosaprobic

one. pH: 7.4-7.9, electrolytic conductivity: 270-310 $mS \cdot cm^{-1}$, chlorides: 9.4-10.5 $mg \cdot dm^{-3}$, ammonium nitrogen: 0.1-0.2 $mgN \cdot dm^{-3}$, nitrate nitrogen: 0.1-0.18 $mgN \cdot dm^{-3}$, total phosphorus: 0.052 $mgP \cdot dm^{-3}$.

513.3 Zachodniobeskidzkie Foothill:

- Brzezowa (DA32) – the stream Brzezówka, natural and clean (water quality – class I), 1 ex., the years 1983-1984 (Fleituch 1992). Nowadays, the site is situated below the waters of the Goczałkowice Resevoir.

513.6 Środkowobeskidzkie Foothill:

- Prałkowce (FA21) (Trella 1928).

845.1 Western Polesie:

- #Pawluki (FC72) – the River Bug. Meandering, untransformed and lowland one. It flows through the mosaic of extensively used hay-growing meadows and alluvial alder-ash forests (Fraxino-Alnetum), which dominate on the river banks and shade its bank zone. The width of the channel: 40 m, depth of the bank zone (where *P. acuminatus* was caught): 0.2-1.0 m (0.6 m on average). Water opaque (loess suspension). River banks: vertical ones with gentle base, gentle only in some places. The bottom sediments with the predominance of sand, with the slight addition of organic matter as well as trunks and willow branches. No submerged vegetation, in some places swamps of *Phalaris arundinacea* L. and single clumps of bushy willows, at higher water levels with the belt of flooded grass.

  Water flow: 0.83-1.20 $m \cdot s^{-1}$ (1.01 on average); water temperature: 15.3-25.6 ˚C (19.0); pH: 8.02-8.50 (8.50); conductivity: 743-848 $mS \cdot cm^{-}$ (788); dissolved oxygen: 1.2-12.8 $mg \cdot dm^{-3}$ (7.2); oxygen saturation: 80-152% (116); total nitrogen*: 3.3 $mg \cdot dm^{-3}$; total phosphorus*: 0.23 $mg \cdot dm^{-3}$; chlorophyll „a”*: 28 $mg \cdot dm^{-3}$; BOD_5*: 2.3 mg $O_2 \cdot dm^{-3}$. General water quality*: class V, outclassing factors: COD_5, nitrates, phosphates, microbiological pollution.

  Material: 13 VII 2006, 1 imago, a hydrobiological net, lentic zone.

- Poleski National Park, Karczunek vic. (FB69) – Bagno Staw, calcareous fen, 17 VI 2003, 1 imago (ad lucem) (Buczyński & Pałka 2003).

In the period of 192 years (the oldest data from 1808), *Potamophilus acuminatus* was recorded in Poland 19 times from 18 study sites (twice from the River Odra in Wrocław) (Fig. 1). Data from 6 study sites comes from 19th century, from 2 ones – from the interwar period and 10 ones from the last 30 years. Study sites are scattered and situated in 10 macroregions located in different parts of Poland – at most four in one region (The Silesian Lowland). The species has not been found in north-eastern Poland so far.

Potamophilus acuminatus is a lowland beetle: 16 study sites are situated within the Polish Lowland and only two in the belt of foothills. As many as 9 study sites are located below 100 m above sea level and the next 8 – between 100 and 200 m above sea level. Higher (ca. 250 m a.s.l.), the species was found only once – in the stream Brzezówka.

The records of *Potamophilus acuminatus*, in spite of the lack of detailed descriptions, can be easily associated with the valleys of rivers and streams. These are as follows: Bug (new data), Gać and Grabia (Nijboer et al. 2006), Ilanka by the estuary of the River Odra (Schöll *et al*. 2003), Krąpiel (new data), Obra (new data), Odra (Burakowski *et al*. 1983, Fein & Haase 1881, Leder 1872, Letzner 1871, 1885), Osobłoga by the estuary of the River Odra (Schöll *et al*. 2003), San (Trella 1928) and Brzezówka (Fleituch 1992), Warta (Schilsky 1888, Szulczewski 1922), Wisła (Hildt 1907, 1914). The exception is the specimen caught to the light trap in Bagno Staw in the Poleski National Park (Buczyński & Pałka 2003) which probably were the inhabitants of the one of the nearest large rivers – Bug or Wieprz.

P. acuminatus was found almost exclusively in running waters – and if it was the different habitat

like in Warsaw (Hildt 1907, 1914), it was always close to the river valleys and in circumstances showing its riverine origins (e.g. transfer by thaw waters). It was only two times when it was found in hyporhitral (Fleituch 1992, Nijboer *et al*. 2006). The remaining study sites were in meta- and (most often) epipotamal.

Streams and rivers inhabited by *Potamophilus acuminatus* were of different sizes. However, small watercourses were not numerous (Brzezówka, Gać, Krąpiel) in contrary to medium and large rivers. Their courses were natural without the transformations of a channel. Their surroundings comprised forests or at least the mosaic of bushy willows.

Little is known about physical and chemical water parameters of the study sites of *P. acuminatus*: there is some partial data for five study sites only (Fleituch 1992, Nijboer *et al*. 2006, new data). The common elements were: strong water flow in the place of catching the species (minimum 0.70 m·s) and at least the moderately good oxygen conditions. Apart from that, the study sites were characterized by the significant diversification of such factors like: water temperature, pH, electrolytic conductivity and even BOD_5 – although within the ranges of water quality class II. Nevertheless, total water quality could even be in class V (the River Bug).

Discussion

Potamophilus acuminatus is a Palearctic species with the wide but not continuous distribution area, reaching from Spain to Afghanistan (Boukal *et al*. 2007, Burakowski *et al*. 1983, Ribera 2000). The species reaches farther to the south than it seemed as evidenced by the recent discovery in northern Africa (Touaylia, Vetal 2010). The centre of its distribution is Central Europe (Więźlak 1986), however, the area of its numerous occurring has significantly decreased nowadays – e.g. in Germany, Czech Republic and Austria (Boukal *et al*. 2007, Jäch *et al*. 2005, Klausnitzer 1996). Taking into consideration data presented in this paper, Poland has never been and it is not included in this area. The focus of the distribution area is now without doubts the area of Hungary, where the number of study sites and the species numbers are manifold higher than in any European country (Csabai *et al*. 2010, Kálmán *et al*. 2009). Hungary is nowadays regarded as European refuge of the discussed species (Jäch *et al*. 2005).

The status of *Potamophilus acuminatus* in northern and eastern Europe remains unclear. There is consensus about the incorrectness of old data from Sweden: in Fauna Europaea it is marked as doubtful (Alonzo-Zarazaga & Jäch 2004), data was also omitted in the monograph of aquatic insects of North Europe (Nilsson 1996). For this reason, our study site on the Pomorskie Lakeland is important for it shows the border line of the northern boundary of its range. However, the discussed species might have been absent in the European part of Russia (Alonzo-Zarazaga & Jäch 2004) which does not correspond with the reliable data from: Karelia, St. Petersburg, The Udmurt Republic or Middle Russian Forest-Steppe Zone (Dedyukchin *et al*. 2005, Dedyukchin & Kholmogorova 2006, Jäch & Prokin 2005, Kireychuk 2001). Therefore the distribution of *P. acuminatus* in the east of Europe needs to be examined further and data presented in Fauna Europaea (Alonzo-Zarazaga & Jäch 2004) requires serious corrections. The same refers to the occurrence of the species in Poland: taking into consideration the data from Russia (Dedyukchin *et al*. 2005, Dedyukchin & Kholmogorova 2006, Jäch & Prokin 2005, Kireychuk 2001) and the distribution of the species in the area of Belarus (Aleksandrovich *et al*. 1996), the species can be expected in the north-eastern regions of Poland.

Potamophilus acuminatus as a typical rheobiontic species. Water movement is a crucial factor of its occurrence: plastron of Elmidae works most efficiently when water velocity is higher than 0,75 $m.s^{-1}$ and when water pressure is stronger on the underside of the body (Klausnitzer 1996). Imagines are phytophagous,

they feed on aquatic moss *Fontinalis antipyretica* L. leaves. Larvae are obligatory xylophages: they feed on dead, partially decomposed wood submerged in water, preferring branches and boughs of diameter of ca. 8 cm (Hoffman & Hering 2000, Jäch *et al*. 2005, Klausnitzer 1996). All of well-defined Polish study sites suit well to this picture either in terms of a habitat or food availability for larvae.

Imagines can be found outside water, e.g. under stones: *P. acuminatus* is the only one Middle-European species from the family Elmidae which is also regularly found in land environment (Jäch *et al*. 2005). This fact makes the data of Szulczewski (1922) possible to some extent, however, the description of his observation is very untypical.

The distribution of *Potamophilus acuminatus* in longitudinal profiles of water courses is differently defined. It was generally assumed that it occurs from the lower course of streams and brooks (hyporhitral). Nevertheless, the inhabited river zones are divergently described. According to different authors, the species is present to: lower course (hypopotamal) (Klausnitzer 1996), middle course (metapotamal) (Boukal *et al*. 2007, Šporka & Zatovicova 2003) or only upper course (epipotamal) (Jäch *et al*. 2005). On the other hand, Ribera (2000) describes the habitat of this species as "large rivers" which should be understood as hypopotamal only. Data from Poland proves the opinion of Klausnitzer (1996), with the emphasis on the most numerous occurring of *P. acuminatus* in hypopotamal.

Potamophilus acuminatus together with other species from the family Elmidae, *Macronychus quadrituberculatus* and *Stenelmis consobrina*, belongs to the valuable and threatened in Europe assemblage of river insects (potamocoen zone) (Graf & Kovács 2002, Klausnitzer 1996). These species vanish together in case of environmental degradation (Braasch 1995, Klausnitzer 1996). While analysing the data from Poland it can be observed at least in case of the River Bug: in the stretch with *P. acuminatus*, *M. quadrituberculatus* is also very numerous (Buczyńska & Buczyński 2006), however, farther down the river *S. consobrina* was found (Błachuta & Błachuta 2003) (although this data is doubtful and the occurrence of *S. consobrina* in Poland must be confirmed (Prewoźny et al. in press)).

In many countries *Potamophilus acuminatus* is regarded as a species strongly endangered by extinction. In Austria, Czech Republic, Germany and Slovakia it has CR category (critically endangered) (Boukal 2005, Geiser 1998, Holecová & Franc 2001, Jäch *et al*. 2005). This makes sense in a very strong regression of national populations in relation to historical data, including regional extinction of the species (Klausnitzer 1996) or its long-term absence in the whole country (Boukal 2005).

The regress of *Potamophilus acuminatus* in Europe has many reasons, like: water pollution and degradation, development of banks (Klausnitzer 1996). Braasch (1995), in the scale of sensitivity on environment degradation with the range from 1 (the most sensitive) to 5 (the least sensitive), placed this species in the group 1. Jäch *et al*. (2005) show, among others, high requirements towards water quality, especially low resistance to organic and toxic pollution. Adverse changes of the environment result in the increase of numbers and quality of habitats of *P. acuminatus* as well as their fragmentation (Ribera 2000). This fragmentation is dangerous for this species has low ability to dispersion (Boukal *et al*. 2007) – although data of Buczyński & Pałka (2003) shows that it occurs. A specific threat is associated with trophic requirements of larvae: very dangerous activity connected with water "care" like seemingly harmless removal of decaying wood can result in the total vanishing of the species (Jäch *et al.* 2005).
For the reasons described above, the authors postulate the including of *Potamophilus acuminatus* to the Red List of IUCN in VU category (vulnerable species) (Jäch *et al.* 2005, Ribera 2000).

In the Red list of beetles of Poland (Pawłowski *et*

al. 2002) *P. acuminatus* is found in DD category (data deficient). On the basis on data gathered in this paper we can try to assess the threats in more detailed way.

First of all, there is no sign of the regress of species. Indeed, the species is rare – taking into consideration the abundance of faunistic literature about aquatic coleopterofauna of Poland (ca. 1000 papers till now), 18 sites is just a few. However, *P. acuminatus* has been recorded no less and not less numerous nowadays than in historical period which could not be necessarily expected due to the number of coleopterologists-faunists interested in the family Elmidae (especially more numerous advanced unprofessional entomologist the other day) and worse environment conditions. It can be assumed that *P. acuminatus* has always been rare and not numerous in the country which area is situated in the marginal part of its range. There are also no serious threats of its habitats. The loading of rivers with organic and toxic matters even in the times of forced industrialization of Poland in the second half of the 20th century was moderate enough that there was no total degradation of the fauna which could be observed e.g. on the example of the distribution of dragonflies (Bernard *et al*. 2002, 2009). Nowadays, the loading has decreased (GUS 2008). It is true that some sites of *P. acuminatus* were characterized by bad or very bad water quality: class IV (Obra – Lewicki *et al*. 2007) or even the lowest one – V (Bug – Miazga, Parcheta 2007). Nevertheless, the limiting factors were those associated with eutrophisation or bacteriological contamination but not oxygen parameters or concentrations of toxic substances. Our data indicates that the discussed species is relatively resistant to the mentioned factors. The potential habitat base of *P. acuminatus* in Poland is large and seems to be free from the danger of development of river banks, river regulations or removal of branches. Even if such things are present, their scale is small – in case of transformations of valuable habitats, protests of nature lovers stopping such transformations can be expected which occurred several times in the past.

Taking into consideration the criteria used in assessing of the threats of species (IUCN 2010) – the occurrence of *Potamophilus acuminatus* in Poland neither fulfill them (criteria A and E) nor there is sufficient data for the assessment but it can be assumed that they are not fulfilled (criteria C and D). The closest for fulfilling is the criterion B – analyzing the known sites, the area of occupancy can be close to the value 10 km^2 (B2). However, the additional circumstances like continuous decrease of the area of occupancy or its strong fluctuations are not measured up. It leads to the conclusion that – in contrary to expectations – *Potamophilus acuminatus* should not be included in the Red list of threatened animals in Poland. Nevertheless, we can consider the creating of "waiting room" of the Red list for the species which need to be continuously monitored. Admittedly, neither now nor in the nearest future *Potamophilus acuminatus* is likely to be endangered or close to danger but some parameters and features characterizing its occurrence show its sensibility to environmental changes or may contribute to significant deterioration of its state of maintenance in the future (Bernard *et al*. 2009).

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