Contribution to the knowledge of *Platambus maculatus* (Linnaeus, 1758) (Dytiscidae: Coleoptera) in Serbia

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Abstract

Platambus maculatus (Linnaeus, 1758) is regarded as a widespread and common European dytiscid taxon. Its presence in Serbia is well documented. Investigations in the 2010-2013 period throughout Serbia have served to recheck distribution and ecological data regarding this species. The presence of *P. maculatus* was confirmed at only 19 localities including 17 rivers and one reservoir (the Uvac Reservoir). The estimated relative abundances of this species were low, with the high abundance only at the Beljina locality (the Beljanica River) in the Belgrade Region. Besides this finding in an urban area, findings of this species in large rivers such as the Velika Morava, Južna Morava, Crni and Beli Timok River are also of interest. The main habitats for this dytiscid were found to be small to medium streams, at elevations up to 500 m, with domination of large fractions of substrate, and relatively well preserved (natural) localities. It is distributed in lowland (<200 m a.s.l.), hilly/submountain (200-500m) and mountain (>500 m) regions, tolerating moderate organic pollution (Class III, ecological water status). As non-flyer/flightless species, *P. maculatus* has limited dispersal ability, and as such is more vulnerable to negative human impact on aquatic habitats. This paper should provide an update to our knowledge regarding the presence of *P. maculatus* in Serbia.

Keywords: *Platambus maculatus,* aquatic beetle, distribution, field research, Serbia.

Introduction

The predaceous diving beetles (Dytiscidae: Coleoptera) with at least 3,800 species (Nilsson, 2001) are among the most diverse aquatic Coleoptera, with a wide range of successful aquatic adaptations (Ribera and Nilsson, 1995). They spend almost their entire life submerged in water (of the main life stages – eggs, larvae, pupa and adult, only the pupa is terrestrial, although they breathe atmospheric air, and larvae are not very good swimmers (Franciscolo, 1979; Crowson, 1981; Kriska, 2013). Adult dytiscids are good fliers with high dispersal potential. An exception are members of the genus *Platambus* Thomson, 1859, which are considered to be non-flyers (Jackson, 1973; Kriska, 2013).

As the common name of the group (predaceous diving beetles) reveals, members of dytiscids are predators, both in larval and adult stages, feeding on all aquatic organisms they can overcome, which in the case of the largest ones (*Dytiscus*) could include even smaller fish and other vertebrates, along with almost all invertebrates they encounter (Franciscolo, 1979).

Being considerably smaller, with an adult size of 7.0-7.4 to 8.5 mm, and a larval size of the final instar in the same range (Franciscolo, 1979; Kriska, 2013), members of the *Platambus* genus feed on small specimens of various aquatic invertebrates, mainly chironomids, gammarids, mayflies, etc. On the other hand, small beetles (as well as smaller instars of larger ones) are prey for vertebrates (fishes, amphibians, etc.) and for larger predatory invertebrates, including odonates, hemipterans and larger beetles, even of the same species (Franciscolo, 1979; Bosi, 2001).

The taxon traditionally is considered as typical rheobiont/lotic taxa, preferring clear water with

vegetation (phytophylous), dominantly mountain and submountain watercourses (Franciscolo, 1979; Eyre, 1986; AQEM, 2002). However, this opinion is modified, in line with the increased number of findings of this beetle in lentic environments such as pools, lakes, reservoirs, in lowlands as well as in highlands, and even in some urban areas (Cojocaru, 2007; Edokpayi, 2010). During their study of aquatic beetle fauna in urban area of the city of Olsztyn in Poland, Pakulnicka and Biesiadka (2011) classified *P. maculatus* as a lacustrine and riparian taxon. Furthermore, this species was recorded in brackish water as well (Gulf of Bothinia; Nilsson and Holmen, 1995). In his study of the Central European aquatic Coleoptera, Hebauer (1994) placed *P. maculatus* in the "torrenticole" group, as a common inhabitant of either bank zones of rivers/streams, preferably with plenty of vegetation, or lotic zones of lake banks, where it could be found in large numbers on vegetation or driftwood. As a phytophylous taxon *Platambus* is sensitive to hydro-alterations which include degradation and destruction of this bank zone (Brauns et al, 2007).

The life cycle of *Platambus maculatus* in Central Europe is univoltine (Nilsson and Holmen, 1995). Oviposition occurs in autumn, between algal mats on submerged plants and various plant material. As typical dytiscid larvae are poor swimmers and must regularly crawl up or use their positive buoyancy to reach the surface, where they breathe atmospheric air (Crawson, 1981; Franciscolo, 1979). The larvae occur mainly from autumn to spring (Dettner et al, 1986; Nilsson and Holmen, 1995). The pupation, as in most water beetles, taking place in soil chambers on land as larvae crawl up on the river or lake/pond bank. Emerged adults then return to water (Franciscolo, 1979; Kriska, 2013). Unlike most other dytiscid adults of *Platambus*, as mentioned earlier, they cannot fly (Jackson, 1973; Kriska, 2013).

Adult *P. maculatus* specimens (Figure 1) are elongate-oval, rather broad and depressed. The head is black with a yellow area anterior to the eyes, and two yellow posteromedial spots, while the pronotum is yellow. Although the species name (*maculatus*) indicates “blotch”, the coloration of non-striate elytra is actually variable – it ranges from typical (*maculatus*- blotched/spotted) yellow with black spots/markings, to uniformly black with yellow lateral margins (Nilsson and Holmen, 1995). Based on this variable coloration of elytra, several forms were recognized (Franciscolo, 1979). Hind legs are short and robust. Epipleurae which are broad behind the middle and gradually tapering towards the apex are often considered as the genus-specific character (Nilsson and Holmen, 1995). Besides, Nilsson (2001) singled out the prosternal process with lateral bead inflated posterior ad of procoxae, and with wide mesocoxal separation, as a basis for distinction of the *Platambus* genus in his revision of the Agabini group. The larvae of *Platambus* are of dytiscid-type, with a characteristic dark transverse band on the head, and an apically truncate last abdominal segment (Franciscolo, 1979; Nilsson, 1996).

Figure 1: *P. maculatus* (Linnaeus, 1758) – an adult specimen (photo by B. Novaković)

Genus *Platambus* Thomson, 1859 was considered as palearctic and oriental (Branucci, 1988), with only a few species (Franciscolo, 1979). However, at the beginning of the XXI century, Nilsson, as mentioned above, revised the morphological and taxonomic characters of the Agabini group (details in Nilsson, 2000), and added some nearctic species, including the genus *Agabinus* Crotch, 1873, and species-groups within genus *Agabus* Leach, 1817. So, nowadays this genus is consisting of about 62 species, classified in several groups of species, of which the maculatus group is the most diverse (Nilsson, 2001; Branucci, 2006; Nillson, 2014). The genus is distributed throughout the holarctic and oriental biogeografic region, while the *maculatus* group is of palearctic and oriental distribution (IBIDEM). It should be noted that there are reports indicating an even broader range of genus *Platambus*, which thus would include paleotropic regions as well (findings of *P.maculatus* in Lagos, Nigeria; Edokpayi et al, 2010). Despite this range "expansion" in Europe, only two species of the genus are present – *Platambus lunulatus* (Steven, 1829) and *P. maculatus* (Linnaeus, 1758) (Nillson, 2014). Range of *P. lunulatus* is narrower and includes mainly the East Mediterranean, while *P. maculatus* is found throughout the whole Palearctic and Oriental regions (Nilsson and Audisio, 2014), as well as in Paleotropic (Edokpayi et al, 2010). In Serbia and the neighbouring countries/regions, species *P. maculatus* is a common

member of coleopteran communities, inhabiting mountain springs (Marković, 1998), mountain and submountain streams, e.g. the Golijska Moravica Stream (Đikanović et al, 2008); the Pusta Reka River (Živić et al, 2001), submountain stagnant waters (East Romania; Cojocaru, 2007) and smaller Pannonian rivers (the Ilova River – Delić, 1983).

The main goal of this study is to contribute to the knowledge of the species *P.maculatus* in Serbia, its recent distribution, habitats and ecological preferences.

Material and Methods

Sampling of aquatic macroinvertebrates was conducted within the Regular Annual Water Quality Monitoring Program, carried out by the Republic Hydrometeorological Service of Serbia (RHMS) and the Serbian Environmental Protection Agency (SEPA). The samples were taken twice per year (summer/autumn) in the period from 2010 to 2013, covering the entire territory of Serbia. A part of the samples was obtained through investigations carried out by the Institute for Biological Research "Siniša Stanković" (IBRSS), focused on the large rivers in the region (the Danube, the Sava, the Tisa and the Velika Morava River). The sampling (conducted by IBRSS) was performed once per year, except in the case of the Velika Morava River, which was investigated monthly during the one year period (2010/2011).

All samples were taken using a hand net (25x25 cm, 500 μm mesh size) or specimens were manually collected. The multi-habitat sampling procedure (Hering et al, 2004) and AQEM protocol (AQEM, 2002) were applied. The samples were preserved using 70% ethanol and further processed in the laboratories of the SEPA and the IBRSS. Identification of the species was performed using appropriate keys (Franciscolo, 1979; Branucci, 1988; Friday, 1988; Nilsson and Holmen, 1995) on a binocular magnifier Leica MS 5 and binocular magnifier Carl Zeiss, Stemi 2000-C.

The relative abundance of taxa was estimated according to Table 1.

Table 1: Scale used for the relative abundance estimation

Relative abundance	Description	No. of individuals per sample
1	presence	1
2	low abundance	2-5
3	moderate abundance	6-30
5	high abundance	31-60
7	very high abundance	61-100
9	mass presence	>100

Results and Discussion

In the 2010-2013 period, the presence of *P. maculatus* was confirmed at 19 localities, situated at 17 rivers and one reservoir (the Uvac Reservoir) in Serbia. The main data regarding its findings are provided in Table 2.

Typical habitats of *P. maculatus* were found to be small to medium streams, at elevations up to 500 m, with domination of large fractions of substrate – Type 3 rivers in Serbia (Offical Gazette of the RS, 74/2011). During the field research in Serbia, it was concluded that *P.maculatus* predominantly inhabits submountain rivers, streams and brooks with cobble or boulder as the dominant substrate, often covered with aquatic moss or macrophytes. The species was also recorded in cold and fast flowing rivers and streams (i.e. Đetinja, Visočica). Sometimes a larger number of adults (up to 8 ex.) was observed within short distances in shallow water under stones close to the bank. *P.maculatus* was found in three of the investigated four ecoregions (Table 2) indicating its wide distribution. However, estimated relative abundances of this species were low (Table 2). High abundance was present only at the Beljina locality (Beljanica River), in the Belgrade Region. This finding of *P. maculatus* in an urban area (Belgrade region) and in a presumably polluted environment could suggest its wider ecological range in the investigated area, similar to data from some other areas (Edokpayi et al, 2010; Pakulnicka and Biesiadka, 2011). It is also worth noting the presence of this diving beetle in some large rivers (IBIDEM); in Type 2 rivers in Serbia, i.e. in the middle reaches of the Velika Morava – the Južna Morava River Basin, in the Varvarin (Figure 2) and Mojsinje localities, and in the middle and upper reaches of the Timok River Basin (the Bogovina locality – the Crni Timok and the Vratarnica – the Beli Timok River respectively). All of these records in large rivers were in relatively preserved parts (i.e. natural - river category of waterbodies, as shown in Table 2), except the Varvarin site, located in the VMOR_3 water body, classified as a canalised heavily modified water body (c-HMWB; Table 2). Recent investigations (Marković et al, 2011; Kolarević et al, 2012) indicate increased organic pollution at this sampling site as well. Therefore, this finding suggests increased pollution tolerance of the species *P.maculatus* (with regard to the main literature data – detailed in the introduction), and confirming some previous investigations in the region (Simić and Simić, 1999), or in some other countries (Edokpayi et al, 2009; Pakulnicka and Biesiadka, 2011). The important preconditions for the presence of this species thus could be the preservation of the riparian zone (river/lake banks) and an abundant source of food (appropriate prey). It is demonstrated in the cases of several German lowland lakes, where *P. maculatus* was one of the few taxa highly typical for natural shorelines, moreover "restricted to natural shorelines", only (Brauns et al, 2007).

Table 2 : Relative abundances of *P.maculatus* with main data regarding its localities; all findings were adults except the last one (*) which was a larva. Due to the lack of adequate taxonomic keys for the larval stage of this genus/species, identification was done to genus-level, but because of known distribution data of this genus/species, it is reasonable to suppose species *P. maculatus* in this particular case; Provided typology (additional data on localities) was given according to the national regulations (Official Gazette of the RS, 74/2011).

River/ reservoir	Site	Sampling date	Relative abundance of *P.maculatus*	Catchment	Waterbody (WB) type	Elevation (m)	WB Code	WB category	Ecoregion
Ribnica	Paštrić	21 June 2010	1	Kolubara - Sava	type 3	<200	RIB_2	river	5
Ribnica	Mionica	21 June 2010	1	Kolubara - Sava	type 3	<200	RIB_1	river	5
Dragobilj	Gukoš	22 June 2010	3	Kolubara - Sava	type 3	<200	DRAG	river	11
Tamnava	Ćemanov Most	24 Aug 2010	1	Kolubara - Sava	type 3	<200	TAMN_1	river	11
Beljanica (Barajevska Reka)	Beljina	31 Aug 2010	5	Kolubara - Sava	type 3	<200	BELJ_1	*HMWB	11
Moravica	Gradina	08 Sep 2010	2	Zapadna Morava - Velika Morava	type 4	380	MOR_3	river	5
Toplica	Prokuplje	22 June 2011	1	Zapadna Morava - Velika Morava	type 3	235	TOP_1	river	5
Crni Timok	Bogovina	06 July 2011	2	Timok	type 2	220	CTIM_3	river	7
Bjelica	Lučani (upstream Stenjevac Brook confluence)	04 Sep 2013	2	Zapadna Morava - Velika Morava	type 3	300	BJEL_2	river	5
Čemernica	Trbušani	04 Sep 2013	2	Zapadna Morava - Velika Morava	type 3	260	CEM_2	river	5
Užice (upstream town)	Đetinja	04 Sep 2013	2	Zapadna Morava Velika Morava	type 3	450	DJ_3	river	5
Jablanica	Rebelj	06 Sep 2013	2	Kolubara - Sava	type 3	500	JAB_3	river	5
Visočica	Krivi Do	27 Aug 2013	2	Temštica - Nišava	type 4	850	VIS_1	river	5
Kosanica	Kuršumlija	10 Sep 2013	1	Toplica - Južna Morava	type 3	400	KOSAN	river	5
Lužnica	Svođe	11 Sep 2013	2	Vlasina - Južna Morava	type 3	330	LUZVL_1	river	5
Južna Morava	Mojsinje	09 Sep 2013	3	Južna Morava - Velika Morava	type 2	135	JMOR_1	river	5
Beli Timok	Vratarnica	16 Oct 2013	1	Timok	type 2	150	BTIM_2	river	7
Uvac Reservoir	Krstac	03 Sep 2013	2	Drina - Sava	type 4	970	UV_6	*HMWB	5
Velika Morava	Varvarin	18 Jan 2011	1*	Velika Morava	type 2	127	VMOR_3	**c-HMWB	5

Abbreviations:
*HMWB – heavily modified water body
**c-HMWB – canalised heavily modified water body

Despite being widespread and common, the European water beetle, especially in the relatively clean submountain watercourses and lakes/reservoirs, as hyporhithral taxa (Eyre et al, 1986; AQEM, 2002; Cojocaru, 2007; Brehov, 2013), scarce findings of *P. maculatus*, as well as its low abundance during our investigations, suggest a potentially declining population of this beetle in the investigated region - Serbia. If comparing the distribution of *P. maculatus* with the distribution of *Pomatinus substriatus* (Müller, 1806) (Novaković et al, 2014), it is obvious that the presence of *P. Maculatus* is significangly smaller. These scarce findings of *P.maculatus* could be related to general deterioration of adequate habitats, as the species prefers relatively unpolluted water, with preserved river/lake banks, where it feeds on small herbivores (gammarids, etc.), mainly in water vegetation and moss (preference for phytal microhabitat according to AQEM (AQEM, 2002). Also, infrequent findings of *P. maculatus* could be related to some biotic factors, presumably competition and predation, with other predaceous beetles, as well as with odonates, hemipterans and gammarids (e.g. invasive genus *Dikerogammarus*). The importance of these biotic interactions between the structure and abundance of adephagous beetles is documented (Bosi, 2001). As a non-flying beetle, *P. maculatus* has limited dispersal ability, compared to other flying beetles (Jackson, 1973), so this could be an additional reason for the relatively scarce findings of this dytiscid in the investigated area.

Figure 2: The Varvarin locality (the Velika Morava River) – an example of *P. maculatus* habitats in a large river (photo by V. Marković)

It should be noted that all our records, except one, consisted of adults, and were sampled during the summer/autumn period (Table 2). Besides the significantly greater number of samples taken during these periods of the year (only the winter samples were taken from the Velika Morava River), these were in accordance with known literature data regarding this small dytiscid univoltine species in this region of Central Europe, which mostly overwinter as larvae (Dettner et al, 1986; Nilsson and Holmen, 1995), burrowing on the river banks (Kriska, 2013).

In conclusion, *P. Maculatus,* despite being considered as a widespread and common European aquatic beetle species, during our investigations proved to be relatively rare in the investigated area. The main habitats for this dytiscid were found to be small to medium streams, at elevations up to 500 m, with domination of large fractions of substrate, and relatively well preserved (natural) localities. It is distributed in lowland (<200 m a.s.l.), hilly/submountain (200-500 m) and mountain (>500 m) regions, tolerating moderate organic

pollution (Class III, ecological status of water). The main factor affecting its presence and distribution, could be canalisation and destruction of the riparian zone (river/lake/reservoir banks). As a non-flyer/ flightless species, *P. maculatus* has limited dispersal ability, and as such is more vulnerable to negative human impact on aquatic habitats.

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