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HABITAT DISTRIBUTION OF *DYTISCUS LATISSIMUS* LINNAEUS, 1758 (COLEOPTERA: DYTISCIDAE) IN THE ECOSYSTEM OF RUĢEĻI FISH PONDS (DAUGAVPILS, LATVIA)

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The researches were carried out on the territory of abandoned fish hatchery in the neighbourhood Ruģeļi (Daugavpils, Latvia), in which a concentrated population of *D. latissimus* is observed already for several years. The whole system of ponds was visually divided into 4 control sites (S№ 1-4). *D. latissimus* has got aggregative distribution in the ecosystem of ponds, concentrating on S№ 2 and S№ 4. These are mesotrophic and dystrophic reservoirs of artificial origin that undergo processes of eutrophication at present. They are characterized by the presence of a great number of open, warmed up by sun, zones with relatively calm water surface. The water in the system of ponds is medium-hard with indices 9°dkH and 8,5°dgH, it has got faintly alkaline reaction by mean pH 7,4. A high level of turbidity in the S№ 2 makes it milk-coffee-coloured. The reservoirs are actively fed by inflows and partially by ground waters that ensure thermal stratification and prevent frost penetration. It is obvious that microclimate here is especially favourable for prosperity of the species , so there are plants, which are used by the species for propagation (*Caltha palustris* L., *Carex acuta* L., *Carex rostrata* Stokes, *Carex pseudocyperus* L.). Plants that are used in propagation of D. latissimus are also used by other competing species: *Dytiscus circumcinctus* Ahr., *Dytiscus dimidiatus* Berg., *Dytiscus marginalis* L. Undoubtedly, distribution of *D. latissimus* is connected with limitedness of food resources that are found in the very microhabitats. Specific fodder objects (larvae of Limnephilidae (Trichoptera)), in particular, spread here *Limnephilus flavicornis* L. – is the most favourable prey for larvae of *D. latissimus*.

The ecosystem of Ruģeļi fish ponds is unique regarding its artificial origin and geographical location – the territory of Daugavpils city, but the habitat S№ 2 is an environment model with prospering *D. latissimus*.

Key words: *Dytiscus latissimus*, distribution, fish ponds, habitat.

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INTRODUCTION

D. latissimus – aqueous carnivorous beetle is a specialized inhabitant of marginal habitat "reservoir-side". That is explained by a high productivity of a side zone as a contour habitat, as well as by the fact that its pupation takes place on land. Avoidance of big depths, by all appearances, is connected with high power inputs for submersion and threat from the side of predators by moving in the water column (Prokin & Petrov 2007).

Area and depth of reservoirs are often meant as one of spread characteristics of environment of the species. In particular, the area of the water surface should be at least 1 ha and the depth of reservoir should comprise not less than 1 m (Hendrich & Balke 2000, 2005, Holmen 1993). The reservoirs are described as suitable places for habitation of *D.latissimus* – so called peaty lakes and reservoirs "windows" of upper marshes with clear water and high acidity, where peat or sand serve as soil. Cuppen et al. (2006), also indicate that the largest part of territories of reservoirs should be covered by marshes in a coastal zone, with peatbogs or sand, as well as growing nearby forest.

Typical vegetation in these places consists of the highest water plants, swimming on the water surface. Along the coastal line of reservoirs grow such plants as *Carex rostrata, Eleocharis palustris* and *Menyanthes trifoliata*. *Juncus effusus* and *Molinia caerulea,* sometimes *Phragmites australis* predominate in the coastal vegetation. The bottom of the reservoir could be covered by moss *Sphagnum* spp. of different thickness (Cuppen et al. 2006). A part of the reservoir should be covered by well developed vegetation, presence of free space of water in the form of "windows" is also necessary. Beetles and larvae are more often met in coastal zones with mesotrophic or mesoologitrophic vegetation such as: *Carex rostrata*, *C. lasiocarpa*, *Menyanthes trifoliata*, *Equisetum* spp., *Comarum palustre*, *Nymphaea alba*, *Lysimachia vulgaris*, *Myriophyllum* spp., *Potamogeton* spp., *Sphagnum* spp. However, presence of *Equisetum* is not always necessary, but, as a rule in its majority, costal vegetation is often present in the form of *Carex rostrata, Eleocharis palustris* and *Menyanthes trifoliata* in more open water, and *Molinia caerulea* and *Juncus effusus* straight along the side on land.

Places of propagation of *D. latissimus* are situated from the lee-solar side of reservoir with settled vegetation on shallow sites or along the coastal side (Maehl 2006), such as, *Carex rostrata*, *C. lasiocarpa* or similar species at the depth of 0,20-1m. At the places of propagation, along the sides of marshes, some other vascular plants could be situated. The most suitable plants for oviposition are the following: *Caltha palustris, Carex acuta, C. pseudocyperus, C. rostrata, Menyanthes trifoliata* (Vahruševs 2009 c, 2011 b, Vahruševs & Kalniņš 2013). Presence of larvae of *Limnephilidae* (Trichoptera) in reservoirs also characterize the given habitats as perspective for propagation of *D. latissimus* (Dapkus, Ferenca 2007, Vahruševs 2009, 2009 c, 2011, Vahruševs & Kalniņš 2013). Data on trophic specialization of larvae and imago of *D. latissimus* are found in the researches of Blunck 1923a, 1923b, Blunck and Klynstra 1929, Johansson and Nilsson 1992, Dyadichko 2009, Vahruševs 2009, 2009 b., 2009 c., 2011 b, Vahruševs and Kalniņš 2013). All the authors mark an important detail: to a considerable degree, larvae of *D. latissimus* are inclined to eat larvae (Trichoptera).

In the majority of reservoirs, the content of humic acids in water could be rather higher. There is observed a relatively low content of organic substances and lime in water. However, (Holmen 1993) mentions that one of indications of characteristic habitats of *D. latissimus* serves dystrophic peat pits with a bit grown brown water. Water in reservoirs could be both transparent and turbid (Vahruševs 2011).

Physic-chemical water parameters of reservoirs, according to the data of Belyashevsky (1983), Cuppen et al. (2006), Ralle (2010), Vahruševs (2011) also differ strongly. Their main indices

Fig. 1. The territory of Ruģeļi fish ponds (Daugavpils) (Daugavpils… 2015).

Fig, 2. Ruģeļi fish ponds (Control site S№ 1. (august)).

are found within the following limits: pH 3,5-9,8; 1-8,5°dgH; Electroconductivity 0,05 - 0,460 (mS cm[1]).

The motivation for the researche served possibility to analyze knowledge, obtained in nature, about the condition of environment of *D. latissimus* with subsequent use of it when modeling conditions of keeping and breeding of the species in artificial environment (Vahruševs 2011). The accumulated knowledge on distribution of *D. latissimus* in the given ecosystem allowed to assumine a certain regularity of species' fastidiousness to concrete factors of environment.

MATERIAL AND METHODS

The analysis of environment of *D. latissimus* was based on the previously published and unpublished data, obtained in the course of the researches.

The researches were carried out on the territory of former fish ponds in the neighbourhood Ruģeļi (Daugavpils, Latvia) in the period of time from 2008 till 2013.

The whole system of ponds was divided into four different zones of studies: control sites (S№ 1- 4) (Fig. 1-7.).

Methods of study and description of vegetable and animal communities included finding (see methods of collecting of *D. lstissimus*), as well as definition of background species of flora and macrofauna in the habitat, using literary sources: Baroniņa (2001), Chertoprud (2006), Kabucis (2001), Auniņš (2010), Katanskaya (1981), Kokin (1982), Raspopov (1985), Papchenkov (1985), Pupiņš and Pupiņa (2011), Sadchikov and Kudryashov (2004), Tsalolikhin (2001).

Hydrochemical analysis

Water tests for hydrochemical analysis were carried out in S№ 2 and S№ 3.

Measuring of physical and hydrochemical parameters of water were carried out with the help of a probe Hydrolab „Mini Sonde 4 Multiprobe", equipped with the following sensors of water indices: pH; tºC, conductivity (mS cm^{-1}), oxygen saturation %, oxygen saturation (mg/l), the total quantity of dissolved solid substances (g/l), oxidizing-reducing potential (mV) and turbidity. The depth of probe submersion into water comprised 40-50 cm. Obtained data were saved with the help of the software Hydrolab «Surveyor 4 Data Display» (Grigorjeva 2011).

Indices of carbonated (°dkH) and overall rigidity (°dgH), as well as data on ammonia (mg/L) and ammonium (mg/L), nitrits (mg/L) and nitrates (mg/L) were obtained with the help of tests: Sera gH-Test, Sera kH-Test, Sera Ammonium/Ammoniak-Test (NH_4/NH_3), Sera Nitrite-Test (NO_2), Sera Nitrate-Test (NO_3).

Fig. 3. Ruģeļi fish ponds (Control site S№ 3. (august)).

Fig. 4. Ruģeļi fish ponds (Control site S№ 2. (april)).

Fig. 5. Ruģeļi fish ponds (Control site S№ 2. (august)).

Fig. 6. Ruģeļu fish ponds (Control site S№ 4. (august)).

Water tests were taken from the depth of 0,4 m for the analysis of biochemical use of oxygen (BOD_5) with the help of polyethylene bottles, lids of which have been closing under water at the moment of taking a sample. (BOD_5) was defined with the help of YSI 500 Dissolved oxygen meter. Repeated measuring in the given sample was carried out each five days. For the whole time the sample was situated in a vessel with closely adjacent lid and was kept in thermostat in dark conditions under the temperature of 20°C (Matule 2011).

Methods of finding and collecting of *D. latissimus*

Search and capture of *D. latissimus* in the ecosystem of ponds was carried out with the help of the following equipment and methods.

Equipment for material collection:

- Hybrobiological net;
- Garden rakes (small);
- Funnel-like meshy traps (for crawfish capture) with a cell 4-12 mm;
- Fishing nets of fishing line. Size of a cell is 18-22 mm.

Special equipment for making ice holes: Ice pick, brace, petrol-powered saw.

The method of visual study of coastal line of the reservoir and its shallow sites from land or from a boat was carried out in the daytime, as well as in the twilight-nighttime (with a flashlight). Capture of animals was carried out manually or with the help of a net. Collecting of oviposition plants in some cases was carried out with the help of garden rakes (when it was necessary to preserve root system of plants).

The method of egg collection

Time of collection: April-beginning of May.
In the estimated places of beetles' propagation collection of plants such as *Carex acuta, C. rostrata, Caltha palustris*, etc. was carried out with its subsequent visual study. Collection of ovipositions was carried out manually. Doing this, the collector embraced with fingers underwater part of plant stem at the very bottom and, slowly, passing the stem or a leaf through the fingers upwards, palpated them. The plants that got some newgrowths in the form of characteristic swellings often ensured presence of ovipositions. Such plants as *Caltha palustris* have got fleshy stem, therefore, it was studied visually for reliability, as soon as eggs are often submerged in its thickness. Characteristic cuts on its surface indicate this. Stems with ovipositions were carefully pulled out and placed to plastic bags for transportation. The transportation was carried out in special thermoboxes in order to avoid temperature drop.

Incubation of egg collected in nature

Stems of plants with ovipisition imported to the laboratory of Latgale Zoo („Latgales zoodārzs"), were placed into containers filled with water, in which the subsequent development of eggs occured. Water temperature was 17-18°C).

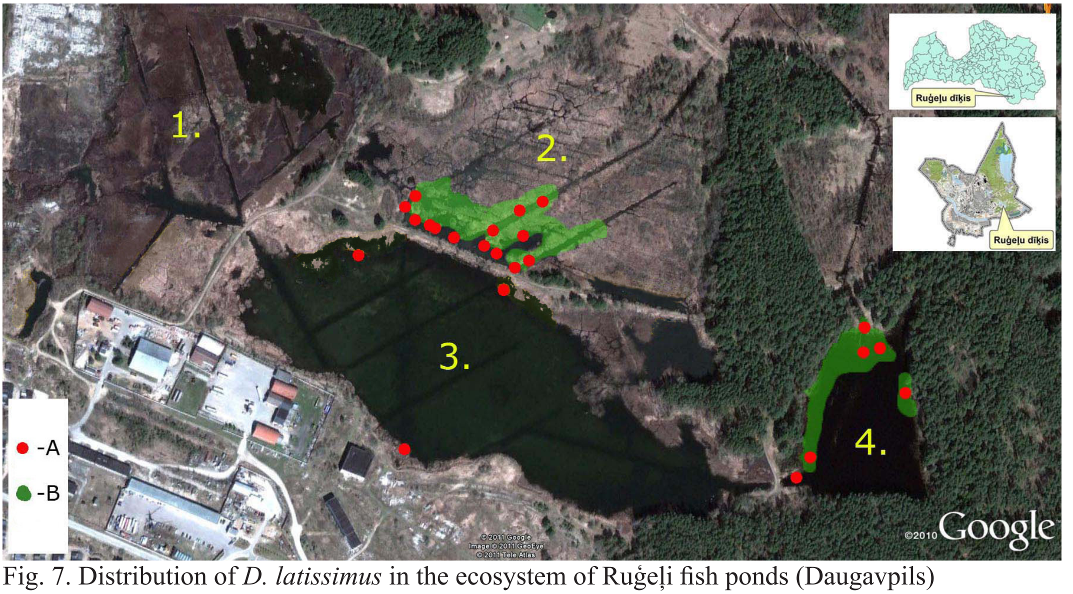

Fig. 7. Distribution of *D. latissimus* in the ecosystem of Ruģeļi fish ponds (Daugavpils)
№ 1 - 4 – inspected control sites, where № 3, 4 – water-storage basins Lielo Stropicas and Mazo Stropicas; A – findings of *D. latissimus;* B – breeding places of *D. latissimus.*

Collection of Instar I larvae in nature

Time of capture: 7th -15th May.
Collection was carried out in the daytime, more often at sunny weather. The method of collection is the following: sailing slowly by a boat along the overgrowths of *Carex sp*., the underwater parts of plants and other substratum, on which larvae could be placed, were examined thoroughly. Sometimes frightening of larvae from the "perches" by moving the above-water parts of plants turned to be useful. Disturbed larvae began to show activity, in such condition it is easier to notice them.

The methods of catching of insects with the help of a hydrobiological net

"Sweep-net method" method by hydrobiological net was carried out on shallow coastal sites of the reservoir overgrown with vegetation (Vahruševs 2009).

The usage of traps

Time of placing: spring, summer, autumn, winter. Funnel-like traps for crawfish capture were placed with bait: fresh beef heart, fish *Clupea harengus membras* (Micromesistius). A string of traps, 15-21 pcs., were placed at a distance of 5-8 meters from each other. One side of the trap should be always raised above water in order that insects that got there could breathe. Special attention to this question should be paid in the summer-warm time. In late autumn and winter by low temperature from 7°C and lower, the traps might be fully submerged into water, as soon as metabolism of insects passes not so intensively. Inspection of traps in summer time occurs not less than once a day. In late autumn and winter inspection of traps was carried out once a week.

Advantages of meshy traps over wholly plastic ones: The net ensures good passing of water through a trap, avoiding stagnant zones inside it. This is extremely important by catching big diving beetle. In summer months, in the sun, in warm water, traps could become cluttered with hundreds of these beetles. The beetles under a stress exude repugnatorial secretion. It contains a high concentration of steroids. Accumulation of this substance in combination with overheating in wholly plastic taps might cause intoxication of beetles that got into it. Thus, meshy traps lower stress of animals that are inside them and exclude death.

The usage of fishing nets

Time of placing was late autumn, beginning of winter. Nets of fishing line with a cell 18-22 mm in size were used. They were placed along the side or in "windows" among water plants. "Windows" could be prepared beforehand with the help of dredge or "grapple". Method of placing is conventional (Vahruševs 2009).

Questioning of fishermen

The territory of Ruģeļi ponds is a favourite place of townspeople relaxation. Fishing in these reservoirs is very popular among inhabitants of the given neighbourhood. Interrogation was carried out selectively. The essence of the problem was told to fishermen, as well as the area of our interests, using illustrations that visually accentuate characteristic features of the given species. In some cases we managed to demonstrate living objects.

Owing to communication, the author got the information about placing of fishing tackles on the territory of ponds, into which *D. latissimus* beetles were also caught. This data allowed us to identify zones of species settlement in the limits of the ecosystem. According to the practice, such collaboration with local population influences positively people's understanding of general ecological problems and carries, in a large measure, an educational character, as soon as the result of such discussions served collected valuable data on behaviour of diving beetle inhabiting these ponds.

Cartography

Maps of the area were copied from the available

Internet resource the programme Google Planet Earth. Copies of the maps of the area were marked and adapted with the help of Adobe Photoshop CS5 programme tools.

Photographing

Camera Nikon D300; lens AF Micro Nokkor 60 mm, f 2,8D; AF Nikon 14-24mm, f 2,8D were used.

RESULTS AND DISCUSSION

Historic-geographical characteristics of Ruģeļi fish ponds and their territories

Ruģeļi water-storage basin (Google Earth coordinates: 55°52'34.01 N, 26°35'17.41 E) is located in the south-eastern part of Daugavpils, in the neighbourhood Ruģeļi between Dunduru Street and the railway line Kraslava - Daugavpils. The territory includes 2 artificially created reservoirs – a big water-storage basin Lielo Stropicas (S№ 3; Fig. 1, 3, 7.) and a small water-storage basin Mazo Stropicas (S№ 4; Fig. 6, 7.). The water-storage basin Mazo Stropicas is located eastwards of the big water-storage basin. These water-storage basins are connected by a 10-meter canal with locks. The small water-storage basin is surrounded by the forest from all sides. On the territory there is a marsh with dug through canals, which surround the big water-storage basin from the north and the west (S№ 1, 2) (Fig. 1, 2, 4, 5, 7.). On the east the territory borders upon the forest, on the south – industrial building, on the north it is surrounded by marshy, overgrown with bushes area, on the west there was a dump once (Jansons 2000).

The water-storage basins were created at the end of 60s of the 20th century with an aim to raise carps. They existed as fish industry till 80s of the 20th century. Before that, there was a peat marsh on the territory, which is still one of the largest marshy areas of Daugavpils. Peat was produced here in 50s-60s of the 20th century. Initially 4 fishy ponds were created, but only 2 reservoirs were restored (Jansons 2000).

The water-storage basins are built on the river Stropica, which supplies them with water. The water-storage basins are being nourished by the thawed, flood and rain waters, underground springs and small river that flows into the basin from the north. The area of the large water-storage basin according to the Jansons (2000) data -19 hectares, the length – 750 m, the width – 250-350 m, the maximal depth – 2 m, an average depth – 0,9 m.

The length of the small water-storage basin – 170 m, the width – 130 m, the area – 2,2 hectares, the maximal depth – 1,2 m, an average depth – 0,5 m. At present, the territory is not used for economical needs. The water-storage basins began to overgrow. Every year the level of water in them is lowering, as soon as the locks, which connect the water-storage basin with bringing water canals became obsolete (Fig. 4.) Here is taking place an uncontrollable fishing. In the border zones appeared elemental damps of industrial waste products (Jansons 2000).

According to Kozhov's classification (1950) (Zilov 2009), Ruģeļi ponds can be referred to group 1; Subgroups 1, 2: Lakes-ponds with a depth of 1-2 m, flowing, with a weak and changeable or slightly filtering drain. A lack of oxygen in winter, strong overgrowth with hydrophytes in summer is typical. Zoobenthos is abundant in summer.

Characteristics of the ecosystem of ponds

Data of the tests of geological boring on the adjoining territories.

According to the data of soil boring, it is possible to conclude the following: in the structure of hills and hilly country, located in the eastern and northern parts of fishy ponds, prevail fine-grained sand, basically fluvioglacial deposits. In the central and western parts anisomerous sand could be found in the hollows, in some areas small pebbles and stones – glacial deposits.

Nearby the water-storage basins could be found

Table 1. Hydrochemical parameters in the SNº 2 (Ruģeļi fish ponds, Daugavpils)

Physic-chemical indices of water	Time of taking of tests															
	11.06.2010			04.11.2010			22.03.2011					26.07.2011			
	№ of test		x	№ of test		x	№ of test				x	№ of test			x
	1	2		1	2		1	2	3	4		1	2	3 (15см)	
t°C	21,1	21,3	21,2	6,4	6,4	6.4	0,02	0,02	0,02		0,02	20.7	19,5	20,8	20,3
pH	7,5	7	7,25	7,2	7,2	7.2	7,6	7,9	7,9	7,8	7,8	7,12	7,68	7,43	7,41
kH (°d)	-	-	-	-	-	-	-	-	-	-	-	-	9	9	9
gH (°d)	-	-	-	-	-	-	-	-	-	-	-	-	8,5	8,5	8,5
NH_3/NH_4 (mg/l)	0/0	0/0	0/0	0/0	0/0	0/0	-	-	-	-	-	0/0	0/0	0/0	0/0
NO_2 (mg/l)	0	0	0	0	0	0	-	-	-	-	-	0	0	0	0
NO_3 (mg/l)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BOD_5 ($mg\ l^{-1}$)	1,53	2,11	1.82	6,32	6,89	6,6	6,71	4,49	4,55	-	5,25	3,24	2,53	-	2,88
O_2 ($mg\ l^{-1}$)	8,4	7,9	8,05	14,8	14,2	14,5	3,7*	4,1	6,6	6,7	5,27	3,33*	1,38*	4,36	3,02
O_2 (%)	-	-	-	-	-		24,2	27,1	28,6	-	26,6	36,8	15,3	49,6	33,9
RP (mV)	451	451	451	493	499	496	465	425	435	424	437,25	385	170	270	275
EC ($mS\ cm^{-1}$)	0,341	0,367	0,354	0,330	0,353	0,341	0,387	0,362	0,383	0,409	0,385	0,469	0,435	0,4217	0,442
TDS (g/L)	-	-	-	-	-	-	0,2	0,2	0,3	-	0,23	29,54	27,80	26,98	31,46
Tur (NTU)	2,1	2,5	2.3	-	-		-	-	-	-	-	39,6	16,4	10,9	22,3

Keys in the tables: t°C = water temperature; pH = hydrogen index; kH = carbonate rigidity; gH = overall rigidity; NH_3/NH_4 = ammonia/ammonium; NO_2 = nitrite; NO_3 = nitrate; BOD_5 = Biochemical oxygen demand; O_2 - content of dissolved oxygen; RP = Redox potential; EC = Electrical conductivity; TDS = Total Dissolved Solids; Tur = Turbidity;
X – arithmetical mean of the indices; * - critical value of the indices.

Table 2. Hydrochemical parameters in the S№ 3 (Ruģeļi fish ponds, Daugavpils)

Physic-chemical indices	Time of taking of tests					
	11.06.2010			04.11.2010		
	№ of test		*x*	№ of test		*x*
	1	2		1	2	
t°C	21,7	21,7	21,7	6,4	6,3	6.35
pH	7,7	7,5	7,6	7,2	7,2	7.2
NH_3/NH_4 (mg/l)	0/0	0/0	0/0	0/0	0/0	0/0
NO_2 (mg/l)	0	0	0	0	0	0
NO_3 (mg/l)	0	0	0	0	0	0
BOD_5 (mg l^{-1})	1,67	2,08	1,875	7,82	7,31	7.56
O_2 (mg l^{-1})	9,1	9,1	9,1	15,3	15,5	15,4
RP (mV)	433	447	440	492	485	488,5
EC (mS cm^{-1})	0,319	0,377	0,348	0,350	0,359	0,354
Tur (NTU)	1,3	1,2	1.25	-	-	-

many stones that is, probably, connected with the fact that the water-storage basins and canals were dug, but dug rocks were poured close to water-storage basins. In some holes in hollows under a layer of sand were observed inclusions of peat. That confirms the fact that before creating the ponds there was a peat marsh, in which peat was produced and, which, in its time, was closed in the result of men's activity (Grigorjeva 2011).

Physic-chemical characteristics of water

Comparing hydrochemical indices of S№ 2, 3, it is possible to consider that water in the system of ponds is middle-hard with the indices 9°dkH and 8,5°dgH, it has got a faint alkaline reaction under the mean pH 7,4. It is characterized by the presence of $Ca(HCO_3)_2$, $Mg(HCO_3)_2$. (Sander 2004; Guseva et al. 1999).

In the summer peak period critical indices of oxygen content (O_2) in water of S№ 2 are being observed. Content of dissolved oxygen is considerable for oxybiotic breathing and serves as indicator of biological activity (that is photosynthesis) in the reservoir. Obviously, the most critical temporal falling of oxygen was noted in July 2011, where an average indicator of tests comprised (3,02 (mg l^{-1})) (Table 1). The test № 1 was taken under a standard depth of probe submersion. By that time of a year the surface of the reservoir is partly overgrown with water vegetation that hinders saturation of water by oxygen and mixing of its layers. That confirms the data of tests №2, 3, where the test № 3 shows the content of oxygen in upper layers of water under the probe submersion to the depth of 15 cm (Table 1).

The reservoir of the S№ 3 has got a large area of water surface, which means that mixing of water layers in it is more intensive that, undoubtedly, affects the indices of dissolved oxygen. Thus, an average level of oxygen content in the reservoir of the S№ 2 for June 2010 corresponded to 8,05(mg l^{-1}), whereas the index of oxygen in water in the

Table 3. The species of plants in the ecosystem of Ruģeļi fish ponds (Daugavpils)

№	Species of plants	№ of sites			
		1	2	3	4
1.	*Alisma plantago-aquatica L.*	+	+	-	+
2.	*Bidens cernua L.*	+	-	+	+
3.	*Calliergon cordifolium*	-	-	-	+
4.	*Caltha palustris L.*	-	-	-	+
5.	*Carex acuta L.*	+	+	+	+
6.	*Carex elata All.*	+	-	+	-
7.	*Carex pseudocyperus L.*	+	+	+	-
8.	*Carex rostrata Stokes*	+	+	+	+
9.	*Ceratophyllum demersum L.*	+	+	+	-
10.	*Chara contraria A.Braun*	+	+	+	-
11.	*Chara rudis A.Braun*	+	-	+	+
12.	*Chara intermedia A.Braun*	+	+	-	+
13.	*Chlorophyta*	+	+	+	+
14.	*Cicuta virosa L.*	+	+	+	+
15.	*Eleocharis palustris L.*	+	-	+	+
16.	*Elodea canadensis Michx.*	+	+	+	+
17.	*Equisetum fluviatile L.*	+	+	+	+
18.	*Glyceria fluitans L.*	+	-	-	+
19.	*Hydrocharis morsus-ranae L.*	+	+	+	-
20.	*Lemna minor L.*	-	+	-	+
21.	*Lemna trisulca L.*	+	+	+	+
22.	*Lycopus europaeus L.*	+	-	+	+
23.	*Lysimachia vulgaris L.*	+	-	+	+
25.	*Lythrum salicifolia L.*	+	-	+	-
26.	*Myriophyllum spicatum L.*	+	+	+	-
27.	*Nuphar lutea (L.) Sm*	-	-	+	-
28.	*Phalaroides arundinacea L.*	+	-	+	-
29.	*Phragmites australis Cav.*	+	+	+	+
30.	*Polygonum amphibium L.*	+	-	+	+
31.	*Potamogeton lucens L.*	+	-	+	-
32.	*Potamogeton natans L.*	+	+	+	+
33.	*Potamogeton perfoliatus L.*	+	-	+	-
34.	*Potamogeton trichoides Cham. Et Schltdl.*	-	-	-	+
35.	*Rorippa amphibia (L.) Besser*	-	-	-	+
36.	*Salix triandra L*	+	+	+	+
37.	*Scirpus lacustris L.*	+	-	+	+
38.	*Solanum dulcamara L.*	+	-	+	-
39.	*Sparganium emersum Rehmann*	+	+	+	+
40.	*Sparganium erectum L.*	+	-	+	+
41.	*Sparganium microcarpum Neuman.*	+	-	+	-
42.	*Spirodela polyrhiza (L.) Schleid*	+	+	+	+
43.	*Stratiotes aloides L.*	+	-	+	+
44.	*Typha angustifolia L.*	+	-	+	-
45.	*Typha latifolia L.*	+	+	+	+
46.	*Utricularia vulgaris*	+	+	+	-

habitat № 3 corresponded to 9,01(mg l^{-1}). It is also possible to assume that content of oxygen in the winter period of time in a large reservoir seems to be also more favourable, analyzing the data of water in the S№ 2 for March 2011.
The total biological need in oxygen (Biochemical oxygen demand (BOD_5)) for inner reservoirs of fish industry under the temperature of 20°C should not exceed 3 (mg/l) (Guseva et al. 1999). The indices BOD_5 in the studied reservoirs in the summer time are located in the scope of 1,82-2,88 (mg l^{-1}) (Table 1, 2.).

Analyzing the data of Total Dissolved Solids (TDS) it is possible to conclude that water in natural reservoirs is of mean mineralization, as soon as the quantity of dissolved solids is in the scope from 0,2 to 0,5 g /l^{-1} (Kļaviņš 1998).

The higher is the concentration of solids, which are able to oxidize, to the concentration of solids, which are able to restore, the higher is the index of Redox potential.

However, the value of Redox potential (RP) in nature reservoirs could fluctuate from -400 to +700 (mV) (Guseva et al. 1999). In the system of Ruģeļi fish ponds the average values of RP fluctuate in the scope from 414 to 464,25 (mV), which indicates to a high oxidation-reduction potential (Table 1, 2).

From the obtained data on the mean values of Electrical conductivity (EC) - 0,380-0,440 (mS cm-1), it is possible to conclude that the water in water-storage basins of the neighbourhood Ruģeļi is poor on salt, as soon as electrical conductivity < 1(mS cm^{-1}) (Bidēns et al. 1997).

The mean values of Turbidity (TUR) of water for May 2010 in the S№ 2 comprised 2,3(NTU), but in the S№ 3 equaled 1,25 (NTU). Especially high level of turbidity in the S№ 2 could be observed in summer months. The tests for July 2011 showed an average value - 22,3 (NTU). Weighted fractions in water thickness give it a characteristic milky-coffee colour, especially expressed in canals (Fig. 1.).

A short ecologic-floristical characteristics

From the eastern side of the large (S№ 3) and small (S№ 4) ponds a woodland prevails, in which the dominating trees of the first level are *Pinus sylvestris* L., the age of which is about 140 till 170 years, sometimes around 90 years or younger.

The second level is presented mainly by *Betula pendula* Roth. In the third level *Prunus padus* L., *Populus tremula* L., *Sorbus aucuparia* L., *Fraxinus excelsior* L., *Corylus avellana* **L.** and others are widely spread. The fourth level is presented by: *Vaccínium myrtíllus* L., *Vaccínium vítis-idaea* L., *Fragaria vesca* L., *Rubus idaeus* L., *Urtica dioica* L., *Pulsatilla patens* L., *Dianthus arenarius* L. and others. Moss and lichen makes the fifth level.

In the large pond (S№ 1, 3) vegetation of a helophyte group (Helophyte) with the mostly spread *Phragmites australis*, *Carex rostrata Stokes*, *Typha latifolia* L., *Typha angustifolia* L., *Sparganium emersum* Rehmann, *Sparganium microcarpum*, *Sparganium erectum*, as well as *Equisetum fluviatile* L. and others is developed. The following plants also prevail there: *Potamogeton natans* L., *Hydrocharis morsus-ranae* L., *Polygonum amphibium* L.. Underwater vegetation in some places is presented by *Elodea canadensis* Michx. or Charophyta, mainly *Chara rudis, Chara contraria.*

In the S№ 2 the hygrohelophytes *Carex acuta* L and herblike hygrophytes *C. rostrata* Stokes, *C. elata* All., *C. pseudocyperus* L., and other sedge are prevailing. These are located at the middle level of the waterfront flood area and are being frequently enrountered near water at the low swampy shores at the depth of 20-40 cm. Also the wood hygrophytes *Salix triandra* L. are being widely present here, these are growing in the water and are framing the shores of the water-basin and watercourse.

In the small pond (S№ 4) plants of a helophyte group are present: *Phragmites australis* (eastern part), *Equisetum fluviatile*, *Equisetum fluviatile*

Table 4. Background species in the ecosystem of Ruģeļi fish ponds (Daugavpils)

№	Species of animals	№ of sites			
		1	2	3	4
	Invertebrata				
1.	*Hydrachna geographica* Muller.	+	+	+	+
2.	*Argyroneta aquatica* L.	+	+	+	+
3.	*Dolomedes fimbriatus* L.	+	+	+	+
4.	*Aeschna sp.*	+	+	+	+
5.	*Libellula sp.*	+	+	+	+
6.	*Lestes sp.*	+	+	+	+
	Ephemenoptera sp.	+	+	+	+
7.	*Notonecta glauca* L.	+	+	+	+
8.	*Naucoris cimicoides* L.	+	+	+	+
9.	*Corixa sp.*.	+	+	+	+
10.	*Cymatia coleoptrata* Fab.	+	+	+	+
11..	*Sigara praeusta* Fieb.	+	+	+	+
12.	*Nepa cinerea* L.	+	+	+	+
13.	*Ranatra linearis* L.	+	+	+	+
14.	*Gerris sp.*	+	+	+	+
15.	*Acilius sulcatus* L	+	+	+	+
16.	*Dytiscus dimidiatus* Berg.	+	+	+	+
17.	*Dytiscus circumcinctus* Ahr.	+	+	+	+
18.	*Dytiscus marginalis* L.	+	+	+	+
19.	*Cybister lateralimarginalis* De Geer.	+	+	+	+
20.	*Graphoderes cinereus* L.	+	+	+	+
21.	*Colymbetes striatus* L.	+	+	+	+
22.	*Hydrophilus caraboides* L.	+	+	+	+
23.	*Hydrous aterrimus* Esch.	+	+	+	+
24.	*Limnephilus flavicornis* Fab.	+	+	+	+
25.	*Limnephilus sp.*	+	+	+	+
	Pisces				
26.	*Carassius gibelio* Bl.	+	+	+	+
27.	*Cyprinus carpio* L.	+	+	+	+
28.	*Esox lucius* L.	+	+	+	+
29.	*Leucaspius delineatus* Heck.	+	+	+	+
30.	*Perca fluviatilis* L.	+	+	+	+
31.	*Perccottus glenii* Dyb.	+	+	+	+
32.	*Scardinius erythrophthalmus* L.	+	+	+	+
33.	*Tinca tinca* L.	+	+	+	+
	Amphibia				
34.	*Lissotriton vulgaris* L.	+	+	+	+
35.	*Bufo bufo* L.	+	+	+	+
36.	*Pseudepidalea viridis* Laur.	+	-	-	-
37.	*Pelophylax lessonae* Camer.	+	+	+	+
38.	*Pelophylax ridibundus* Pallas	-	-	+	-
39.	*Pelophylax kl esculentus* L.	+	+	+	+
40.	*Rana temporaria* L.	+	+	+	+
41.	*Rana arvalis* Nilsson	-	-	-	+

L, *Typha latifolia* L., *Eleocharis palustris, Scirpus lacustris* L. and other . Hygrohelophytes and herblike hygrophytes: *Caltha palustris* L. (northern, north-wastern part), *Carex rostrata* Stokes and other.

There also can be met *Potamogeton natans* L., *Potamogeton trichoides* Cham. et Schltdl. The hydrophytes are growing abundantly: *Stratiotes aloides* L., *Elodea canadensis* Michx. (Grigorjeva 2011).

In summer, all over the reservoir area, there is an intensive growth of vegetation. Due to this, some intensive processes of swamping take place. The species of plants, mostly spread on the territory of ponds, are listed in the Table 3.

A short ecologic-faunal characteristics

Since 2005 a system of ponds experiences activities of beavers (*Castor fiber* L.), as a result of which the water level and hydrological routine in ponds is changing periodically.

The territory of ponds is used by many waterfowls for nesting (swans, ducks and others) or rest (while migrating or transmigration). Presence of abundant vegetation and places for cover in combination with a particular definite specific structure of macrofauna creates a favourable dwelling conditions for animals with different role statuses in trophic relations.

So, as an active predator among fishes in the reservoirs the *Esox lucius* L. is presented, which controls the quantity of other species, including *Perccottus glenii* Dyb. The latter was released into the ponds by fishermen several years ago. *Misgurnus fossilis* L. which is part of the protected species is frequent here from **(**Freyhof 2013**).**

In the area of swampy coastal shallow water zones there are places of propagation of 9 out of 12 species of amphibious that are met on the territory of Latvia.. Out of these the following are rare and protected in Latvia: *Triturus cristatus* Laur. and *Pelobates fuscus* Laur. **(**Pupiņš and Pupiņa 2011).

Specific structure of macrofauna of invertebrates includes an abundant variety of species (Arachnida), among which *Dolomedes plantarius Clerck* is a vivid representative, that is a rare species in Latvia **(**Štembergs 1998, Regulations... 2000, 2001, 2012**).** From insects inhabiting the reservoirs, protected species in Latvia are *D. latissimus*, *Graphoderus bilineatus* De Geer **(**Matule 2011, Grigorjeva 2011, Barševskis 1998, Regulations... 2000, 2001, 2012).

The most vivid – frequently met species of hydrocoles are placed in the Table 4.

Habitat distribution of *D. latissimus* in the ecosystem

The data of the questionnaire of fishermen

According to the data of the questionnaire of fishermen, places and methods of placing nets were found out, as well as getting of beetles into them.

- S№ 1 (Fig. 2, 7.)- the beetles was not noted.
- S№ 2 (Fig. 1, 4, 5, 7.) - regular getting of beetle into nets.
- S№ 3 (Fig. 1, 3, 7.) - a finding of *D. latissimus* female was noted in the area of the southern lock 09.10.2010. A discovery of a female specie of *D. latissimus* was made in the region of the southern lock on 09.10.2010.
- S№ 4 (Fig. 6, 7.) getting of *D. latissimus* into nets was not noted.

According to fishermen observations, the most often encountering of the beetle was noted in autumn. Autumn is a mating season for diving beetles. It means that, during coupling, beetles swim actively, searching for partners. Thus, a couple of big beetles at the moment of copulation have a great possibility to get stuck in the cells of the net and entangle.

Table 5. Registration of specific composition of the content of the traps in the S№ 2

№	Cought species	Number of exempl. ♂.♀	Other species.
1	*C. lateralimarginalis*	12.6	*Perccottus glenii* *Esox lucius* *Rana temporaria*
2	*D. latissimus*	12.3	
3	*D. circumcinctus*	3.3	
4	*D. dimidiatus*	6.4	
5	*D. marginalis*	2.1	

Data of the collection methods

According to the obtained information, inspection of places of species' finding was carried out by us in the given habitats.

Traps placed in the S№ 1, as well as repeated selective sweep–net method did not reveal the presence of the species.

Traps placed in the S№ 2 showed an excellent result! Getting of the species into traps was noted almost regularly (Fig 7.). The result of collection obtained during the inspection of 15 traps during the time period of 09th -12th October, 2010 is provided as an example below . Water temperature at the moment of placing of traps was 4,8-6,1ºC (Table 5).

According to the obtained data, we see that the quantity of caught *D. latissimus* relative to other species of Dytiscinae is sufficient and takes the second place in percentage (Fig. 8.). The prevailing number of males is explained by their more active way of life in the given period of time.

Larvae of different age were noted repeatedly at this site with the help of sweep-net method, as well as by the method of manual collecting. The sweep-net method and manual pick-up method here frequently resulted in gathering larvae of different instar.

A number of traps placed in the S№3 (autumn 2010) noted the getting of two specimens of *D. latissimus* (Fig. 7.).

In the S№4 *D. latissimus* did not get into the traps. With the help of the net, as well as by the method of manual collecting regularly larvae of different age were caught. In May 2003 the authors caught a female of *D. latissimus* (Vahruševs 2009) (Fig. 7.).

The method of collecting with the help of the net allowed us to identify the places of propagation of *D. latissimus* in the studied biotopes. As a result, an attempt to determine the species of plants, into which the beetles lay eggs, was undertaken. Positive results gave the search of oviposition plants in the S№ 2, 4. In the process of studying, the plants, preferred by the species for oviposition, were ascertained by us. They are the following: *Caltha palustris, Carex acuta, C. rostrata, C. pseudocyperus* (Vahruševs 2009).

During the process of laboratory incubation of natural ovipositions of *D. latissimus*, it was discovered that the same plants, are being used by other *Dytiscus* species as the simultaneous exit of larvae of *D. latissimus* along with other species of *Dytiscus* was observed (Table 6.).

The new data on the places and the species of plants used by the species for propagation, undoubtedly, will allow changing previously formed views about ecological relations of *D. latissimus* with other species of large diving beetles. Their interspecific relations and ability to exist on the same territory is one of important factors of structuring of communities.

Pattern and causes of distribution of *D. latissimus*
Comparison of the data on early findings of *D. latissimus* with the results of personal collection

Table 6. The plants used by diving beetles (Dytiscinae) for egg clutches and the species that left them in the period of laboratory incubation (06-15.05.2010, 06-15.05. 2011)

No.	Species of beetles / Species of plants	*D. latissimus*	*D. circumcinctus*	*D. marginalis*	*D. dimidiatus*
1.	*Caltha palustris*	+	+	-	-
2.	*Carex acuta*	+	+	+	+
3.	*C. rostrata*	+	+	-	-
4.	*C. pseudocyperus*	+	+	-	-

showed that the spatial structure of species population in the ecosystem of Ruģeļi ponds is expressed in a regular distribution of individuals and their groups towards certain elements of the landscape and to each other. This type of distribution in nature is the most common among insects and is characterized as aggregate. (Smurov 1975 a., 1975 b., Romanovsky and Smurov 1975, Shilov 1985, Zlotin 1989).

The present maps note the belonging of *D. latissimus* to the habitats of the S№ 2, 4, where the species populations are distributed in the leeward areas with sun exposure (Fig. 7.). At present – these are eutrophic and low eutrophic water reservoirs of artificial origin with a characteristic set of life forms (tab. 3, 4.). The reservoirs are experiencing a natural aging process, phytogenous and zoogenic transformations - shallowing, massive overgrowth of watercourses, accumulation of organic bottom sediments and drifts from tributaries flowing, reducing of water-surface area. These processes lead to the sequential changing of biocenoses (Lasukov 1999).

An illustrative example is the S№ 4 where the above mentioned processes occur due to the activity of beavers (*Castor fiber*) and macrophytes growing on the reservoir dominant *Stratiotes aloides*. The S№ 2, 4 – are getting swamped, but are still running territories with low water salinity are characterized by numerous shelters in the form of snags, rich vegetation and solar-heated outdoor areas with relatively calm surface of the water level. The litoral extends to almost the entire area of reservoirs. They are actively nourished by inflows and partly by underground water that provides temperature stratification. Bottom topography and depth strongly influence the species survival on these areas during the wintering. In harsh winter, beetles go to the depth of the reservoir channels to avoid freezing, where they can form clusters. Such behavior is typical of many predatory insects (Chernyshev 1996).

During spring and summer periods, these territories have extensive shallow areas (depth is not more than 0.5 m), where favorable conditions for reproduction and development of the species are established. The species here inhabit thickets of living and dying macrophytes, as well as ground herbage flooded by water. The distribution of species is attributed to the limitations of topical and trophic resources (living macrophytes used by the species for reproduction (*Caltha palustris*, *Carex acuta*, *C. rostrata*, *C. pseudocyperus)* (tab. 6.)) and initial fodder units (Limnephilidae larvae, Trichoptera: dominant species - *Limnephilus flavicornis*). The author offers to consider the present set of life forms as the indicated species in the monitoring of biocenoses with habitats *D. latissimus*. Basing on the evaluation of a set of background species in the control sites, the binding of *D. latissimus* to specific habitats is established. Being an inhabitant of phytophilic community, the species, at the initial stages of its development, may also be trophic linked to lithophilous and detritophilous communities. Degree of aggregation of beetles in the S№ 2 does not depend on the weather, the season and time of the day. Insects are caught here all year round. Results of the data analysis on object habitat confirmed that *D. latissimus* is a limnophilous and euryedaphic species. The belonging of the species to water structure is determined not by the values of common indicators (pH and gH), but the combined action of many environmental factors that determine the overall appearance of these ecosystems. The specie can be encountered at the waterfront of all types of water reservoirs, including mesotrophic, eutrophic as well as dystrophic. Still the type of water reservoir that is best for its development is the eutrophic type with the manifest littoral, sludgy bottom, variable transparency and sufficient availability of biogenic elements in the water or at the bottom. The colonies of living organisms reach maximum variety and high biomasses in the optimal ecological conditions, which never happens in the other water body trophicity or in the disturbed habitat.

New data on the locations and types of plants used by the species for reproduction certainly will change previously established views on ecological relationships of *D. latissimus* with other species of large diving beetles (Tab. 5, 6.). Their interspecies relations and the possibility of coexistence on the same territory, is one of the most important factors in communities structuring. The influence of Dytiscinae species on *D. latissimus* becomes obvious through exploitation and interference competitions

Ecosystem of Ruģeļi fish ponds - a unique example of the consequences of synanthropic influence positively affecting the natural processes. The present object can be recommended as an artificial ecological model for target preservation projects, for biodiversity conservation, as well as habitats of particular species such as *D. latissimus*.

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