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COLONISATION OF THE NEWLY-CREATED ARTIFICIAL LAKE MEDARD AND ITS SURROUNDINGS BY AQUATIC MOLLUSCS

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ABSTRACT: Lake Medard (494 ha) is a newly created artificial lake in north-western Bohemia (Czech Republic), formed in a former coal mining quarry. The colonisation of this lake by aquatic molluscs was studied by the sampling of molluscan assemblages in 2013, 2014 and 2018. Both the number of species present and population sizes increased slowly over the period of study. Most species found in this lake also occurred in the Ohře River which was used to fill the lake through an open canal. The assemblages of this lake were compared with those found in other artificial lakes created in the same way, and used to suggest the ongoing processes of succession in the assemblages. The molluscan assemblages of nearby small pools and reservoirs were poor in species; the data are used to discuss possible colonisation pathways for aquatic molluscs.

KEY WORDS: artificial lake, Medard, aquatic molluscs, colonisation

INTRODUCTION

Lake Medard is a newly created lake in a former coal mining quarry in northwestern Bohemia (Czech Republic). With an area of 494 ha and a maximum depth of 58 m it is the largest anthropogenic lake in the Czech Republic. The creation of such a new and extensive freshwater lake is not a common phenomenon even in anthropogenically influenced Central Europe and deserves attention. A survey of aquatic molluscs was therefore started in 2013 and 2014 to establish the status of molluscan assemblages at the beginning of the existence of the lake, but before it had filled completely, thus giving a baseline for further monitoring. Another aim was to find out whether the water filling of the lake from the Ohře River had an impact to molluscan assemblages. Further research in 2018 aimed to document the composition of molluscan assemblages about 1.5 years after reaching the normal water level. Many pools and water reservoirs were created in surroundings of this lake so molluscan assemblages and their changes were also studied.

MATERIAL AND METHODS

Data were obtained during field surveys conducted in the years 2013, 2014 and 2018. Altogether 14 sites situated around this lake were studied and a further 22 sites in its surroundings (Fig. 1, Appendix 1).

The main sampling method used was washing vegetation and sediments using a metal sieve (diameter 20 cm, 0.8 mm mesh) combined with collections by hand from the surfaces of stones, wood and artificial materials (e.g. plastic bags and bottles). In the lake, each site was surveyed for about 20 minutes, but for other sites the survey time was dependent on the size and character of the habitat. Snorkelling in shallow parts (up to ca. 3 m deep) of Lake Medard was also used in 2018. Only living aquatic molluscs (adults and juveniles) or fresh shells (e.g. in dry parts of small wetlands along the south bank of the lake) were counted.

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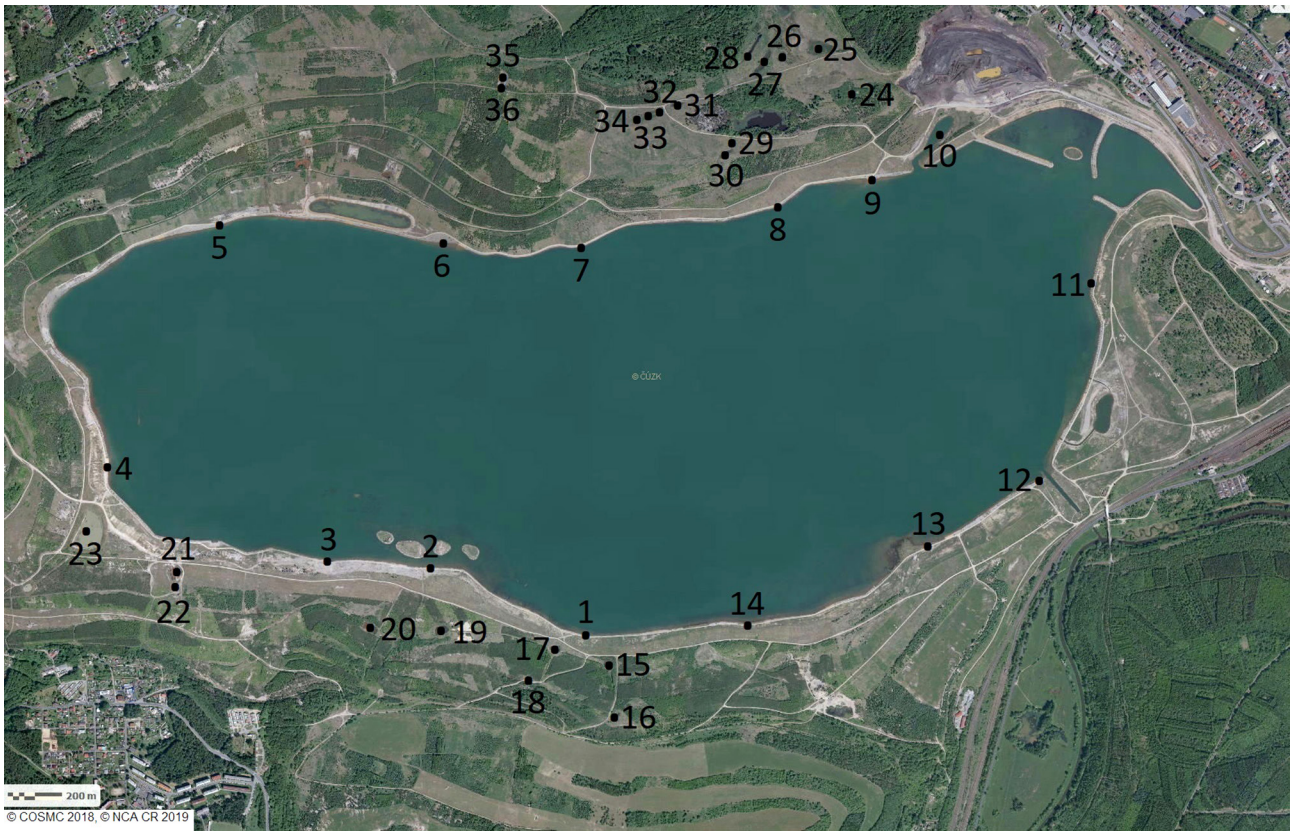

Fig. 1. The map of Lake Medard and its surroundings with the geographical distribution of the sampling sites. The canal from the Ohře River and this river are visible near site 12. In the case of Lake Medard sites are shown as they were studied in 2018 (they were shifted in relation to 2013 and 2014 due to lower water level in these years, see Appendix 1)

Aquatic molluscs were determined using shell characteristics or dissected and then identified using their copulatory organs if the identification only based on shells was impossible. Specimens for dissection were killed in hot water and then fixed in 80% ethanol. Selected material of shells and killed specimens in 80% ethanol is deposited in author's collection. The classification used follows HORSÁK et al. (2018).

STUDY AREA

Lake Medard is a newly created lake in a former coal mining quarry in northwestern Bohemia near Sokolov. The mining in this quarry was finished in 2000 and the water filling of the lake began in 2008. Since 2010 an open canal from the nearby Ohře River has been used to fill the lake. After filling a lake with an area of 494 ha and a maximum depth of 58 m was created. At the time of the survey in 2013 and 2014 (Figs 2, 4) the water level was about 8 m under the final level while in 2018 the lake was already at its normal water level (400 m a.s.l., Figs 3, 5) which was achieved in March 2017; since then the water level has fluctuated only slightly. Physico-chemical properties of the lake water are listed in Table 1 (average values for 4 samples per year, samples made from 0 to 5 m depth).

Many pools and small water reservoirs of different size (from ca. 50 m² to 1.5 ha, Figs 6–9) were created in the surroundings of Lake Medard. These waterbodies were created from 2003 to 2006.

Table 1. Physico-chemical properties of water in Lake Medard

Parameter	2013–2014	2018
pH	7.54	7.83
Alkalinity (mmol dm^{-3})	1.07	1.61
Conductivity ($\mu S\ cm^{-1}$)	1060	1250
Ammonium Nitrogen (mg NH_4–N dm^{-3})	0.107	0.063
Nitrate Nitrogen (mg NO_3–N dm^{-3})	1.544	1.391
Sulphates (mg SO_4^{2-} dm^{-3})	407	414
Chlorides (mg Cl^- dm^{-3})	26.2	24.8
Phosphorus (mg P dm^{-3})	0.024	0.010
Sodium (mg Na dm^{-3})	75.4	100.1
Potassium (mg K dm^{-3})	5.9	6.5
Calcium (mg Ca dm^{-3})	89.4	98.8
Magnesium (mg Mg dm^{-3})	38.4	46.6
Iron (mg Fe dm^{-3})	0.093	0.078

Figs 2–3. Lake Medard at site 9 (14.9.2014 and 13.8.2018). Stones with poor vegetation predominated at most of sites on the northern bank of this lake in 2018. Photos: LUBOŠ BERAN

Figs 4–5. Lake Medard at site 13 (20.10.2013 and 9.8.2018). Molluscs were often found on the floating wooden railway sleepers in 2013 while the bank was more overgrown in 2018

Figs 6–7. A small reservoir to the south of Lake Medard (site No. 18, 30.3.2014 and 9.8.2018). The pool was much more overgrown in 2018 than in 2014. The similar situation was documented in many smaller pools

RESULTS

LAKE MEDARD

Only 7 species of aquatic molluscs were found in 2013 at 14 sites during the first survey of the lake (Table 2). Mostly only one or two species in low densities have been recorded at particular sites. *Radix auricularia* (Linnaeus, 1758) and *Lymnaea stagnalis* (Linnaeus, 1758) have been recorded at 8 and 6 sites respectively while *Galba truncatula* (O. F. Müller, 1774), *Radix ampla* (Hartmann, 1821), *R. balthica* (Linnaeus, 1758), *Gyraulus crista* (Linnaeus, 1758) and *G. parvus* (Say, 1817) were found less often, in from one to three studied sites. Any species has not been found at three from 14 sites. Molluscs were often found on floating wooden railway sleepers (Fig. 4). More species (6) were found by an inlet of the canal from the Ohře River (site No. 12) than elsewhere. An increase of number of species as well as size of their populations were recorded during research in 2014 when 10 species were found (Table 2). *Radix labiata* (Rossmässler, 1835), *Physella acuta* (Draparnaud, 1805) and *Gyraulus albus* (O. F. Müller, 1774) were recorded for the first time. The increase of populations were visible especially in the case of *R. auricularia*, *R. balthica* and *L. stagnalis*.

Ten species were also found in 2018. Nine species are as in 2014, but *R. labiata* (common in surrounding waterbodies) was not confirmed while the first bivalve *Musculium lacustre* (O. F. Müller, 1774) was found at 3 sites. Aquatic molluscs of sites along the northern bank of the lake populated mostly stones (Figs 2–3) while on the southern bank molluscs also occupied shallow wetlands created after filling of this lake. Most species previously recorded were found at more sites than in 2013 and 2014 except *G. truncatula* and *G. crista* (found at only two and one sites in 2018). Altogether 11 species (10 gastropods, 1 bivalve) have been found at Lake Medard to date. Nearly all species are common and widespread. Only one species (*R. ampla*) is listed in the Red List of molluscs of the Czech Republic (Beran et al. 2017) in the category of vulnerable species while two species (*P. acuta*, *G. parvus*) found in Lake Medard are non-native species.

WATER RESERVOIRS AND POOLS

Only 8 species were found in 22 small reservoirs and pools in the surroundings of Lake Medard (Table 3). Molluscan assemblages inhabiting these waterbodies were usually very poor consisting of one or two species and some sites held none. The most common were *G. truncatula*, *R. labiata* and *M. lacustre*. The others, *R. auricularia*, *P. acuta*, *G. albus*, *G. crista* and *Ferrissia californica* (Rowell, 1863) were found only at one or two localities. *F. californica* (formerly widely known as *F. fragilis* (Tryon, 1863)) was only species which was not found in Lake Medard. Two non-native species *P. acuta* and *F. californica* were found. In contrast to the situation in 2013 and 2014 sites were much more overgrown especially with *Phragmites australis* or/and *Typha latifolia* (Figs 7–8). Only more extensive reservoirs remained less overgrown also in 2018 (Fig. 9).

Fig. 8. Small and shallow pools were mostly overgrown by *Phragmites australis* or *Typha latifolia* in 2018 (site No. 17)

Fig. 9. Only more extensive reservoirs remained less overgrown also in 2018 (site No. 23)

DISCUSSION

Even though older than Lake Medard, small and isolated pools and reservoirs have poor molluscan faunas that differ from site to site. It is most likely that colonisation was caused by accidental animal transport. Both birds (e.g. Kappes & Haase 2012, van Leeuwen & van der Velde 2012) and other animals such as wild boars or frogs (Kappes & Haase 2012) are known to be vectors and they are common

Table 2. List of aquatic molluscs recorded at studied sites of Lake Medard

Site No.	Year	Gastropoda										Bivalvia	Number of species
		Galba truncatula (O. F. Müller, 1774)	*Radix ampla* (Hartmann, 1821)	*Radix auricularia* (Linnaeus, 1758)	*Radix balthica* (Linnaeus, 1758)	*Radix labiata* (Rossmässler, 1835)	*Lymnaea stagnalis* (Linnaeus, 1758)	*Physella acuta* (Draparnaud, 1805)	*Gyraulus albus* (O. F. Müller, 1774)	*Gyraulus crista* (Linnaeus, 1758)	*Gyraulus parvus* (Say, 1817)	*Musculium lacustre* (O. F. Müller, 1774)	
1	2013	×××		×			×						3
	2014			××			××			×××			3
	2018		×	×	×××		××	×					5
2	2013	×											1
	2014			××			×						2
	2018		×	×××				××	×	×	××		6
3	2013						×						1
	2014			××							×		2
	2018		×	×××	×		××	××			×		6
4	2013	×		×									2
	2014	×		××			×××	×			×		5
	2018		××	×			××	×					4
5	2013												0
	2014						×						1
	2018			××	×××		××	××					4
6	2013			××							×		2
	2014	××		××			××			×	×××		5
	2018			××	×××		××	×					4
7	2013			××			×						2
	2014			×××	××		×××				××		4
	2018		×	×	×		×						4
8	2013												0
	2014			×××	×		×××		××		××		5
	2018		×	×××	××			×					4
9	2013			×									1
	2014	×		×××			×						3
	2018			×××	××		×	×			×		5
10	2013												0
	2014												0
	2018		×	××	×			×			×		5
11	2013			××			××			×			3
	2014	×	×	×××	×××		××		×	×	×		8
	2018		×	×	×								3
12	2013		×	×	×××		×			×	×		6
	2014		×	×××	×××		×	××	×	×	××		8
	2018		××	×	××		×		×		×	×	7
13	2013						×						1
	2014			××			×××			×			3
	2018	×	×	××	×××		××	×××	×		×	××	9
14	2013			×									1
	2014	×		××	×	×	×××			×			6
	2018	×	×	××	×××		××	×××	×		×	×××	9
Σ2013		3	1	8	1	0	6	0	0	2	1	0	7
Σ2014		5	2	12	5	1	12	2	3	6	6	0	10
Σ2018		2	11	14	12	0	10	11	4	1	7	3	10

× – few specimens, ×× – scattered occurrence, ××× – abundant occurrence. Σ 2013, Σ 2014, Σ 2018 – number of studied sites where the species was recorded in 2013, 2014 and 2018

Table 3. List of aquatic molluscs recorded at studied sites of reservoirs and pools in surroundings of Lake Medard

Site No.	Year	Gastropoda							Bivalvia	Number of species
		Galba truncatula (O. F. Müller, 1774)	*Radix auricularia* (Linnaeus, 1758)	*Radix labiata* (Rossmässler, 1835)	*Physella acuta* (Draparnaud, 1805)	*Gyraulus albus* (O. F. Müller, 1774)	*Gyraulus crista* (Linnaeus, 1758)	*Ferrissia californica* (Rowell, 1863)	*Musculium lacustre* (O. F. Müller, 1774)	
15	2013								×	1
	2014								×	1
	2018								××	1
16	2014									0
	2018									0
17	2013									0
	2014									0
	2018									0
18	2014								×	1
	2018								×	1
19	2013								×	1
	2018									0
20	2013	×								1
	2018									0
21	2013			××				××		2
	2018			××	×××				××	3
22	2013									0
	2018									0
23	2013									0
	2018		×							1
24	2014									0
	2018									0
25	2014									0
	2018									0
26	2014									0
	2018									0
27	2014									0
	2018	××		×						2
28	2014			×						1
	2018									0
29	2014			××						1
	2018			×						1
30	2014			×××						1
	2018			×						1
31	2014									0
	2018							×	×××	2
32	2014	×								1
	2018	×								1
33	2014			×××						1
	2018	×		××						2
34	2014			××						1
	2018	×××		××						2
35	2014						×			1
	2018									0
36	2014									0
	2018					××			××	2

× – few specimens, ×× – scattered occurrence, ××× – abundant occurrence

Table 4. Comparison of molluscan assemblages of artificial lakes Medard (this study), Most (Beran 2013) and Chabařovice (Beran 2010)

Species	Medard	Most	Chabařovice
Potamopyrgus antipodarum (Gray, 1843)			×
Bithynia tentaculata (Linnaeus, 1758)			×
Valvata piscinalis (O. F. Müller, 1774)			×
Galba truncatula (O. F. Müller, 1774)	×		
Radix ampla (Hartmann, 1821)	×		
Radix auricularia (Linnaeus, 1758)	×	×	×
Radix balthica (Linnaeus, 1758)	×		
Radix labiata (Rossmässler, 1835)	×		
Lymnaea stagnalis (Linnaeus, 1758)	×		×
Physella acuta (Draparnaud, 1805)	×	×	×
Physa fontinalis (Linneaus, 1758)			×
Gyraulus albus (O. F. Müller, 1774)	×		×
Gyraulus crista (Linnaeus, 1758)	×	×	×
Gyraulus parvus (Say, 1817)	×	×	×
Menetus dilatatus (Gould, 1841)		×	
Sphaerium corneum (Linnaeus, 1758)			×
Musculium lacustre (O. F. Müller, 1774)	×		×
Pisidium obtusale (Lamarck, 1818)			×
Dreissena polymorpha (Pallas, 1771)		×	
Number of species	11	6	13

× – occurrence

in the region. In Lake Medard, however, colonisation appears to be linked to an open water connection with the Ohře River. *Radix ampla, R. auricularia, R. balthica, L. stagnalis, G. albus, G. parvus* found in Lake Medard also occur in the canal of the Ohře River near its inlet into Lake Medard (Beran 2015) and concurrently the most species (6) were found in 2013 at site No. 12 which is the closest to the inlet of the canal from the Ohře River. These results showed that filling of this lake through the open canal from the Ohře River is the most important and most probable way of colonisation of this lake by aquatic molluscs. *G. truncatula, R. labiata, P. acuta, G. crista, M. lacustre* were not found in the canal of the Ohře River but are known from the Ohře River at other sites (Beran 2015) and are also known from small reservoirs and pools in surroundings of Lake Medard (Table 3) so the way of their spreading is less clear and both ways described above are possible.

Molluscan assemblages of other two similar anthropogenic lakes created in former quarries after coal mining in northwestern Bohemia were also recently studied, and so it is possible to compare these three lakes and their molluscan assemblages (Table 4) at a similar stage of succession. Lake Chabařovice (252 ha) was studied in 2010 (Beran 2010) ca two months before filling was finished and Lake Most (311 ha) was visited in 2013 (Beran 2013) ca one year after the filling. Only 6 species were found in Lake Most (Beran 2013) while 13 species were confirmed in Lake Chabařovice (Beran 2010). Molluscan assemblages of all three lakes were quite different. Only 4 common species (*R. auricularia, P. acuta, G. crista, G. parvus*) were found in all three lakes. The way of filling was probably the most important determinant of molluscan assemblages. The rich community found in Chabařovice Lake is probably caused by the fact that this lake was filled by a canal from another artificial Lake Kateřina, a situation similar to that for Lake Medard. This old anthropogenic lake has been inhabited with relatively rich molluscan assemblages (L. Beran, unpublished records). By contrast, a 20 km long pipeline used for filling Lake Most from the Ohře River probably was not a suitable way for spreading aquatic molluscs. The exception could be *Dreissena polymorpha* (Pallas, 1771). The extensive population of this species is known from the section of the Ohře River from which water was pumped for filling Lake Most (Beran 2015) so larvae of this species could survive transport with long pipeline and inhabit Lake Most.

Because there are rich molluscan assemblages in the Ohře River (Beran 2015, L. Beran, unpublished records) it can be expected that they will spread to Lake Medard. This lake can become a suitable and very extensive habitat even for some endangered or rare species such as *Planorbis carinatus* O. F. Müller, 1774. At the same time it is possible to expected a gradual settlement of bivalves of family Unionidae which can expand here by fish. New artificial waterbodies are also very often occupied with non-native species. Lake Medard has been inhabited with two species (*P. acuta, G. parvus*) so far and third species (*F. californica*)

is known from water reservoirs and pools in its surroundings. The occurrence of only two non-native species in the newly created lake is rather surprising and very low in comparison with e.g. Lake Most (BERAN 2013) but the probable reason is that other non-native species are not known from this area (LORENCOVÁ et al. 2015) so it will be interesting if (and when) other non-native species inhabit this lake.

CONCLUSIONS

The research captured the molluscan assemblages of the extensive artificial lake in early stages of the succession during and immediately after its filling and it will be interesting to study the further development of its malacocenoses. Lake Medard is one of the largest aquatic habitats in the Czech Republic and it is possible to assume the progressive development of malacocenoses and also their changes in the coming years or decades. This lake has a great chance to become a very valuable habitat also for rare and endangered molluscs.

The situation of small water reservoirs and pools in surrounding of Lake Medard is different. Their molluscan assemblages were often very poor and negative changes caused by natural succession in most of these sites were confirmed during research. It can be assumed that without management a number of them will soon be unsuitable for most of aquatic molluscs.

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APPENDIX 1. LIST OF INVESTIGATED SITES

Data in the list are as follows: site number, date of investigation, geographical co-ordinates of site (sites on Lake Medard studied in 2013 and 2014 were shifted in 2018 due to the higher water level), name of the nearest settlement, description of the site. Sites are depicted at Fig. 1.

LAKE MEDARD

1. 6.10.2013 & 23.08.2014: 50°10'25.9"N, 12°35'50.4"E, 9.08.2018: 50°10'16.1"N, 12°35'41.2"E; Sokolov, the southern bank of Lake Medard to the east of artificial islands and ca 1500 m to the west from an inlet of the canal from the Ohře River;
2. 17.11.2013, 23.08.2014: 50°10'28.2"N, 12°35'10.4"E, 29.06.2018: 50°10'20.6"N, 12°35'12"E; Habartov, the southern bank of Lake Medard near second island from the west;
3. 17.11.2013 & 14.09.2014: 50°10'23"N, 12°34'54.7"E, 29.06.2018: 50°10'19.4"N, 12°34'54.9"E; Habartov, the southwestern bank of Lake Medard to the west of islands;
4. 6.10.2013 & 14.09.2014: 50°10'33"N, 12°34'14.7"E, 29.06.2018: 50°10'33.1"N, 12°34'07.7"E; Habartov, the western bank of Lake Medard;
5. 6.10.2013 & 14.09.2014: 50°10'51.3"N, 12°34'18.3"E, 25.08.2018: 50°10'54.9"N, 12°34'21.1"E; Habartov, the northwestern bank of Lake Medard;
6. 6.10.2013 & 14.09.2014: 50°10'55.7"N, 12°34'58.8"E, 25.08.2018: 50°10'58.2"N, 12°35'07"E; Habartov, the northern bank of Lake Medard by the water reservoir of oblong shape;
7. 3.11.2013 & 14.09.2014: 50°10'55.1"N, 12°35'09.8"E, 25.08.2018: 50°11'00.7"N, 12°35'32.9"E; Svatava, the northern bank of Lake Medard;
8. 3.11.2013 & 14.09.2014: 50°11'01.4"N, 12°35'59.2"E, 13.08.2018: 50°11'09.1"N, 12°36'06.5"E; Svatava, the northeastern bank of Lake Medard ca 800 m from the notheastern edge of this lake;
9. 3.11.2013 & 14.09.2014: 50°11'11.7"N, 12°36'29.8"E, 13.08.2018: 50°11'13.8"N, 12°36'22.6"E; Svatava, the northeastern bank of Lake Medard;
10. 3.11.2013 & 14.09.2014: 50°11'21.7"N, 12°36'34.9"E, 13.08.2018: 50°11'20.8"N, 12°36'34.7"E; Svatava, the northeastern bay of Lake Medard;
11. 3.11.2013 & 23.08.2014: 50°11'06.1"N, 12°36'59.5"E, 13.08.2018: 50°11'05.6"N, 12°37'05.6"E; Svatava, the eastern bank of Lake Medard;
12. 20.10.2013 & 23.08.2014: 50°10'46.4"N, 12°36'54.7"E, 13.08.2018: 50°10'42.4"N, 12°37'02"E; Sokolov, the southeastern bank of Lake Medard by an inlet of the canal from the Ohře River;
13. 20.10.2013 & 23.08.2014: 50°10'39.8"N, 12°36'45.2"E, 9.08.2018: 50°10'33.5"N, 12°36'45.5"E; Sokolov, the southern bank of Lake Medard ca 350 m from an inlet of the canal from the Ohře River;
14. 20.10.2013 & 23.08.2014: 50°10'33.1"N, 12°36'20.6"E, 9.08.2018: 50°10'20.2"N, 12°36'11.5"E; Sokolov, the southern bank of Lake Medard ca 900 m from an inlet of the canal from the Ohře River.

WATER RESERVOIRS AND POOLS

15. 17.11.2013, 30.3.2014 & 9.08.2018: 50°10'12.3"N, 12°35'49.7"E; Sokolov, a small reservoir by the crossroads near the southern bank of Lake Medard;
16. 30.03.2014 & 9.08.2018: 50°10'06.6"N, 12°35'52.4"E; Sokolov, a small and nearly dry reservoir near the southern bank of Lake Medard;
17. 6.10.2013, 30.03.2014 & 9.08.2018: 50°10'13.3"N, 12°35'39.6"E; Sokolov, a small reservoir near the southern bank of Lake Medard;
18. 30.03.2014 & 9.08.2018: 50°10'09.0"N, 12°35'32.2"E; Sokolov, an oblong and small reservoir by a path to the south of Lake Medard;
19. 17.11.2013 & 29.06.2018: 50°10'13.3"N, 12°35'18.3"E; Habartov, a small reservoir near the southern bank of Lake Medard;
20. 17.11.2013 & 29.06.2018: 50°10'12.1"N, 12°35'05.4"E; Habartov, a water reservoir by a path near the southwestern edge of Lake Medard;
21. 6.10.2013 & 29.06.2018: 50°10'15.1"N, 12°34'27.8"E; Habartov, a reservoir (bigger from two reservoirs) by the southwestern edge of Lake Medard;
22. 6.10.2013 & 29.06.2018: 50°10'12.9"N, 12°34'28.5"E; Habartov, a reservoir (smaller from two reservoirs) by the southwestern edge of Lake Medard;
23. 6.10.2013 & 29.06.2018: 50°10'18.3"N, 12°34'10.1"E; Habartov, a reservoir by the southwestern edge of Lake Medard;
24. 8.03.2014 & 25.08.2018: 50°11'24.1"N, 12°36'17.2"E; Sokolov, an overgrown shallow and small reservoir near the northeastern edge of Lake Medard;
25. 8.03.2014 & 25.08.2018: 50°11'28.4"N, 12°36'10.8"E; Sokolov, the more extensive reservoir near the northeastern edge of Lake Medard;
26. 8.03.2014 & 25.08.2018: 50°11'26.9"N, 12°36'03.4"E; Sokolov, an oblong small reservoir near the northeastern edge of Lake Medard;
27. 8.03.2014 & 25.08.2018: 50°11'26.2"N, 12°36'00.4"E; Sokolov, an oblong pool by the path near the northeastern edge of Lake Medard;
28. 8.03.2014 & 25.08.2018: 50°11'27.2"N, 12°35'57.8"E; Sokolov, an oblong pool by a forest near the northeastern edge of Lake Medard;
29. 9.03.2014 & 25.08.2018: 50°11'15.8"N, 12°36'56.7"E; Sokolov, a small reservoir by a path to the north of Lake Medard;
30. 9.03.2014 & 25.08.2018: 50°11'14.7"N, 12°35'56.3"E; Sokolov, an oblong pool by a path to the north of Lake Medard;
31. 9.03.2014 & 25.08.2018: 50°11'19.2"N, 12°35'45.5"E; Sokolov, a shallow pool by the crossroads to the north of Lake Medard;
32. 9.03.2014 & 25.08.2018: 50°11'18.2"N, 12°35'41.8"E; Sokolov, eastern from 3 small and shallow pools by a path to the north of Lake Medard;
33. 9.03.2014 & 25.08.2018: 50°11'17.7"N, 12°35'40.0"E; Sokolov, middle from 3 small and shallow pools by a path to the north of Lake Medard;
34. 9.03.2014 & 25.08.2018: 50°11'17.3"N, 12°35'38.1"E; Sokolov, western from 3 small and shallow pools by a path to the north of Lake Medard;

35. 9.03.2014 & 25.08.2018: 50°11'18.9"N, 12°35'13.0"E; Sokolov, northern from 2 small pools by a path to the north of Lake Medard;
36. 9.03.2014 & 25.08.2018: 50°11'18.2"N, 12°35'12.9"E; Sokolov, southern from 2 small pools by a path to the north of Lake Medard.