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MALACOFAUNA ON COAL – ASH SETTLING BASINS COMPARISON OF A FUNCTIONAL BASIN TO A BASIN ABANDONED FOR 26 YEARS

A composition of snail fauna in a functional coal-ash settling basin has been compared to that of a partly reclaimed coal-ash settling basin which had been abandoned for 26 years, using a nature reserve as a control. A total of 24 molluscan species were found at the control site, 21 species in the internal area of the abandoned settling basin and six species in the internal area of the functional settling basin. Numerous and relatively diverse malacofauna have become established on the abandoned coal ash settling basin, consisting mainly of high populations of a low number of widespread species.

1. INTRODUCTION

Post-industrial biotopes represent a new anthropogenic ecosystem in the landscape. In many cases, these biotopes serve as surrogate localities for many rare and endangered organisms (e.g. [1]). Organisms living there, as well as techniques for the reclamation of these biotopes, have been studied intensively in recent years, especially in the case of quarries and spoil dumps after coal mining (e.g. [2, 3]). In many cases, spontaneous succession is an acceptable alternative to technical reclamations, which are expensive and can lead to the extinction of endangered organisms living there [4]).

Fly ash is produced in large quantities by thermal power stations and heating plants. Although a part of the ash is used in the building industry (e.g. [5]) most of it is mixed with water and deposited in large sedimentation basins as waste. Often, after filling the capacity of the basin, a new level of dam is built and the deposit of ash continues by the same manner on the same site; thus, the old coal-ash settling basin sometimes seems like "a pond on a hill". In contrast to many other post-industrial biotopes

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such as quarries or coal mine spoil dumps, the integration of coal-ash settling basins into the natural environment is more complicated due to high concentrations of heavy metals (Al, Si, Fe, Cr, Mn, Cd, etc.), various salts, and other compounds and elements in the substrate that make them toxic and uninhabitable for most organisms [3, 6]). Moreover, fly ash presents a health hazard for people living in the vicinity ([7]). For these reasons, spontaneous succession is unacceptable as a reclamation technique for abandoned coal-ash settling basins. In view of this, several alternative reclamation techniques have been applied, e.g., overlaying the toxic substratum with arable soil, or covering the surface with a special fabric. Consequently, the seeds of several plant species are usually seeded [3, 6].

Molluscs are often used as an indicator of natural value (e.g. [8, 9]. The habitat preferences of European species of molluscs are well understood (e.g. [10]) and well preserved fossil and subfossil material of molluscs is used in assessing changes in the natural environment and landscape on a long-term scale [11]. Moreover, snails are sensitive to heavy metal pollution [12] and are good indicators of the quality of soil [13, 14], as they are in direct contact with the soil during hibernation at least [15].

In this paper, the composition of malacofauna at a nature reserve, a functional coal-ash settling basin, and an abandoned and partly reclaimed coal-ash settling basin are compared. It is the first study dealing with the succession of terrestrial animals on an abandoned coal-ash settling basin.

2. EXPERIMENTAL

Study sites. The snail fauna was studied at one functional and one abandoned and partly reclaimed coal-ash settling basin, both in České Budějovice, Czech Republic. Additionally, the nature reserve in nearby Zliv was used as a control. This site was used because it was the nearest site with a large area of reeds, comparable with the area of reeds at the functional coal-ash settling basin. Moreover, the altitude, climatic conditions and structure of biotopes are relatively similar to those at the settling basins.

Both the functional and abandoned coal-ash settling basins are situated on the edge of the town of České Budějovice, between the suburbs of Suché Vrbné, Stará Pohůrka, and Nové Hodějovice (GPS 48°57' N 14°30' E). Both basins are surrounded by both mown and un-mown, wet and moderately wet, meadows and fields. The nearest houses are approximately 100 m away from either basin.

The functional coal-ash settling basin is situated at an altitude of 428 m.s.l. The area of the basin is circa 35 ha. Today a permanent waterbody is situated in the centre of the basin, covering about two-thirds of the whole area, and leaving a 40–70 m wide area between the permanent water level and the dam (circa 10 ha as a whole). This area is formed by coal ash and may be seasonally flooded (during the rainy summer of

2010 the water reached ca. 1–3 cm above the level of the coal-ash on most of this area). The vegetation in the whole area between the waterbody and the dam is mowed approximately once every three years.

The dam of the functional coal-ash basin is formed by an embankment constructed from a mixture of stones, raw gravel, sand, top soil and ash. It is terraced and has 5 levels. The maximum height of the top of the dam is approximately 8 m. The basin was built in 1984, the last level (terrace) has been in use since 1992.

The following biotopes were studied at this site:

A. The internal area (at least 5 m from the dam; the whole area is approximately 5 ha) – reeds. This biotope is situated in the northern and eastern parts and is covered with ca. 3–4 m high *Phragmites australis* (Cav.) Steud. exclusively.

B. The internal area (at least 5 m from the dam, ca. 5 ha) – "a grassland" with a sparse covering of mainly *Calamagrostis epigeios* (L.) Roth. (ca. 1 m high). *Hypericum perforatum* L., *Phragmites australis* (Cav.) Steud., *Populus tremula* L., *Salix cinerea* L., *Tanacetum vulgare* L. occur rarely. The trees are young, up to 3 m high at maximum.

C. The periphery of the internal area (less than 5 m from the dam, ca. 0.5 ha). It is covered with the same plants as "the meadow"; additionally, *Trifolium* cf. *medium* L. is present and abundant.

D. The dam (ca. 10 ha). The dam is partly covered with young *Pinus silvestris* L. plantations, partly with frequently mowed, short and mostly dry swards with *Achillea millefolium* L., *Agrostis capillaris* L., *Alchemilla vulgaris* L., *Artemisia vulgaris* L., *Betula pendula* Roth., *Carex* spp., *Cirsium vulgare* (Savi) Ten., *Dactylis glomerata* L., *Festuca rubra* L., *Hypericum perforatum* L., *Leontodon hispidus* L., *Plantago lanceolata* L., *Tanacetum vulgare* L., *Taraxacum officinale* Wigg., *Trifolium arvense* L. and *Tussilago farfara* L. *Juncus effusus* L. also occurs on several wet microsites.

The reclaimed coal-ash settling basin is situated 600 m. northwest from the functional coal-ash settling basins, at an altitude of 414 m.s.l. The extent of the internal area is approximately 10 ha. The dam of the basin is constructed in the same manner as that of the functional basin and consists of 1–3 terraces. The height of the dam at maximum is ca. 7 m. The basin was in use from the end of the 1960s until 1984. During the technical reclamation, the ash was covered with topsoil without any other management. Today, two-thirds of the internal area is used for sporting activities and is occupied by a sports hall, an astroturf football pitch, and a car park. This area was not included in the analysis. The rest of the internal area (3 ha) is abandoned and occupied with a mosaic of wood, shrubs and grasslands. It is supposed that the vegetation cover is the result of spontaneous succession (and possibly the occasional activities of the people living in the vicinity). The thickness of the topsoil cover varies between 0 (coal ash is directly under the leaf litter) and 30 cm. The topsoil layer is very thin (up to 5 cm) or absent throughout the larger part of the area. A small brooklet runs along the edge of the internal area.

The following biotopes were studied at this site:

E. The internal area – a forest (total area approximately 3 ha) consisting mainly of *Betula pendula* Roth., *Impatiens parviflora* DC., *Picea abies* (L.) Karsten, *Pinus silvestris* L., *Populus tremula* L., *Quercus robur* L., *Robinia pseudoacacia* L. and *Urtica dioica* L. mainly. An area of shrubs made up of *Crataegus laevigata* (Poir. in Lam.) DC., *Cytisus scoparius* (L.) Link, *Forsythia* x *media* Zabel, *Philadelphus coronarius* L., *Rosa canina* L., *Rubus* sp., *Salix caprea* L., *Sambucus nigra* L. and *Torilis japonica* (Houtt.) DC. are also included in this biotope.

F. The internal area – a tall-grass grassland (approximately 1 ha) mainly covered with *Agrostis capillaris* L., *Calamagrostis epigeios* (L.) Roth., *Dactylis glomerata* L., *Galeopsis bifida* Boenn., *Solidago canadensis* L. and *Tanacetum vulgare* L. mainly. The vegetation is not mowed.

G. The dam (approximately 3 ha). The vegetation on this part of the site is very similar to the forest (biotope E).

The study site Zliv is situated on the northwestern edge of the town of Zliv, ca. 10 km NW from České Budějovice at 381–385 m.s.l. (GPS 49°4' N, 14°20' E). The plot is part of the National Natural Monument Mokřiny u Vomáčků. The substratum consists of clays and sandy clays. The following biotopes were studied at this site:

H. The forest (approximately 1.5 ha), made up of *Anthriscus sylvestris* (L.) *Hoffm., B. pendula*, *Crataegus laevigata* (Poir. in Lam.) DC., *Deschampsia cespitosa* (L.) P.B., *Geum urbanum* L., *P. tremula*, *Prunus padus* L., *Q. robur*, *Ranunculus repens* L., *Salix cinerea* L., *Sambucus nigra* L., *Stellaria media* (L.) *Vill*., *Urtica dioica* L. There are several pits that regularly serve as swimming holes in rainy parts of the year.

I. The meadow (approximately 1.5 ha) covered with *Centaurea jacea* L., *C. epigeios, D. caespitosa, Galium verum* L., *Lathyrus pratense* L., *Phleum pratense* L., *Poa pratensis* L., *Galium verum* L. The vegetation is mowed 1–2 times per year and its maximum height is ca. 1 m. The meadow is seasonally flooded; water can reach more than 10 cm above ground level.

J. Reeds (approximately 20 ha), this is a high, un-mown marsh with 3–4 m high *P. australis* exclusively. The whole area is flooded seasonally.

Mollusca sampling. The snail sampling was carried out throughout April to June 2009. A sample of leaf litter was taken in each of the biotopes mentioned above. Each sample was taken from 4–5 sites within each biotope, covering all microhabitats with potentially different malacofauna that were distinguished. The total volume of the samples from each biotope at both coal-ash settling basins and the reeds in Zliv was about 10 dm^3 but it was about 8 dm^3 for both the meadow and the forest in Zliv. The leaf litter was dried, divided into several fractions, using a series of sieves, and carefully searched for shells. Additionally, the shells and living individuals of large species observed in the field were noted (hand sampling). Additionally we also analysed the proportion of selected mollusc “habitat guilds” in the sense of humidity and shade specialisation (according to [10, 15]). The humidity specialisation comprised these factors: (1) aquatic species, (2) species of wet or humid soil, (3) species of dry habitats and (4) generalists without clear affinity to any type of humidity. Similarly, the shade specialisation consisted of (1) woodland species, living in shaded habitats, (2) species of open habitats and (3) generalists. A special category was for synanthropic species. Every species could belong to one to three different groups.

Statistical analyses. All analyses were computed using numbers of snails corrected to 8 dm^3 samples. The presence or absence of each mollusc species per habitat and study plot (Presence data) was calculated using multivariate unimodal Canonical Correspondence Analysis (CCA) with Hill’s scaling, implemented in the package CANOCO for Windows v. 4.5 [16]. Due to differences in sampling methodology (data obtained by hand sampling were not comparable with standardised litter sampling) we were unable to compare the abundances of all individual species. Therefore we used the species absence or presence as “species data” and the codes for study plots/habitat types as explanatory (“environmental”) characteristics. Similarly, we selected mollusc species presented in litter samples only (Abundance data) and compared the abundance of each species per plot and habitat. Similarly we also analysed the number of species per “habitat guild” per study site and we treated such data as “species data”, using the same explanatory characteristics. For the model tests we used a Monte Carlo permutation test with 999 permutations.

3. RESULTS

In total, 1392 shells of 30 species of molluscs were collected (Table 1, individuals obtained by hand sampling are not included in this and the following numbers of shells).

The following numbers of species and individuals were recorded:

In total of 139 shells of 16 species were recorded in the functional coal-ash settling basin, nearly all at the dam (biotope D; 112 individuals of 14 species). There were only 27 individuals and six species recorded in the inner area of the functional coal-ash settling basin (*Monacha cartusiana*, *Succinea putris*, *Trochulus hispidus*, *Perpolita hammonis*, *Punctum pymaeum*, *Zonitoides nitidus*): all species were present in the peripheral region (biotope C), two (*M. cartusiana* and *S. putris*) in “the grassland” (biotope B), with no species being recorded in reeds (biotope A).

885 shells of 21 species were recorded at the reclaimed coal-ash settling basin: 20 species in the forest (biotope E), 12 species in grassland (biotope F) and 16 species on the dam (biotope G). The malacofauna of the forest included all species recorded in this basin, with the exception of *Oxychilus cf. draparnaudi*, which was found on the dam.

Table 1

Species and individuals of molluscs noted and collected in both functional and abandoned coal ash settling basin and the control plot in Zliv

Species	Functional Basin				Abandoned basin			Control plot		
	M	E	R	D	F	M	D	F	R	
Trochulus hispidus (Linnaeus, 1758)	0	1	0	5	28	19	4	5	0	0
Alinda biplicata (Montagu, 1803)	0	0	0	0	4	0	15	0	0	0
Arianta arbustorum (Linnaeus, 1758)	0	0	0	0	P	0	P	P	0	0
Cepaea hortensis (O. F. Müller, 1774)	0	0	0	P	P	2	P	0	0	P
Cepaea nemoralis (Linnaeus, 1758)	0	0	0	P	0	0	0	0	0	0
Cochlicopa lubrica (O. F. Müller, 1774)	0	0	0	33	47	57	14	14	1	11
Discus rotundatus (O. F. Müller, 1774)	0	0	0	0	51	0	16	P	0	0
Galba truncatula (O. F. Müller, 1774)	0	0	0	0	2	0	0	0	35	0
Helix pomatia Linnaeus, 1758	0	0	0	0	P	0	P	P	0	0
Monacha cartusiana (O. F. Müller, 1774)	P	P	0	4	0	0	0	0	0	0
Oxychilus cf. *draparnaudi* (Beck, 1837)	0	0	0	0	0	0	1	0	0	0
Perpolita hammonis (Ström, 1765)	0	5	0	11	76	147	9	44	0	26
Punctum pygmaeum (Draparnaud, 1801)	0	15	0	14	33	39	51	19	0	0
Semilimax semilimax (J. Férussac, 1802)	0	0	0	0	13	0	4	0	0	0
Succinea putris (Linnaeus, 1758)	P	P	0	0	0	0	0	0	2	3
Succinella oblonga (Draparnaud, 1801)	0	0	0	8	11	2	0	1	0	7
Truncatelina cylindrica (A. Férussac, 1807)	0	0	0	2	2	0	0	0	0	0
Urticicola umbrosus (C. Pfeiffer, 1828)	0	0	0	0	1	1	0	0	0	0
Vallonia costata (O. F. Müller, 1774)	0	0	0	2	17	0	0	67	0	1
Vallonia excentrica Sterki, 1893	0	0	0	17	11	12	16	0	0	0
Vallonia pulchella (O. F. Müller, 1774)	0	0	0	0	0	0	0	0	2	17
Vertigo pygmaea (Draparnaud, 1801)	0	0	0	11	8	19	2	1	0	25
Vitrina pellucida (O. F. Müller, 1774)	0	0	0	1	97	16	21	5	0	0
Zonitoides nitidus (O. F. Müller, 1774)	0	6	0	0	9	8	1	0	21	2
Aplexa hypnorum (Linnaeus, 1758)	0	0	0	0	0	0	0	0	14	0
Carychium minimum O. F. Müller, 1774	0	0	0	0	0	0	0	12	8	12
Eucobresia diaphana (Draparnaud, 1805)	0	0	0	0	0	0	0	0	0	1
Euconulus fulvus (O. F. Müller, 1774)	0	0	0	4	0	0	0	5	0	0
Vertigo antivertigo (Draparnaud, 1801)	0	0	0	0	0	0	0	0	4	0
Pisidium casertanum (Poli, 1791)	0	0	0	0	0	0	0	0	3	0
Arion fuscus (O. F. Müller, 1774)	0	0	0	0	0	0	0	P	0	0
Arion vulgaris (Moquin-Tandon, 1855)	0	0	0	0	P	P	P	P	0	0

Numbers – numbers of shells obtained by a leaf litter sampling. P – presence of the species based on the individual sampling only. M – meadow, E – edge, R – Reeds, D – dam, F – forest.

368 shells of 24 species were recorded in the control plot in Zliv: 15 species in the forest (biotope H), 11 in the meadow (biotope I) and 9 in reeds (biotope J). Two of these species, *Aplexa hypnorum* and *Vertigo antivertigo*, are listed under the national Red List as Vulnerable [17].

Most of the recorded species are common and none of them are protected by laws. Two species (*Vertigo antivertigo* and *Aplexa hypnorum*) (both recorded in reeds in Zliv, biotope J) are listed on the Red List of threatened species in the Czech Republic, both in the Vulnerable category [17].

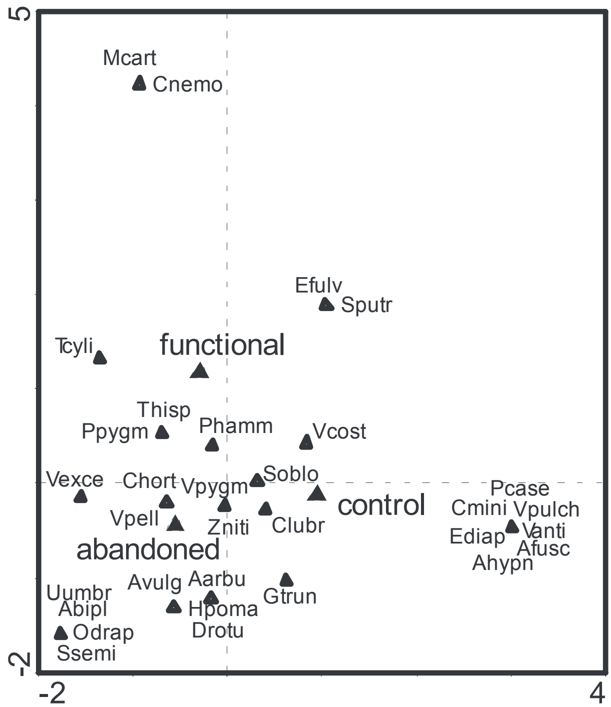

Fig. 1. The relationships between individual mollusc species and study sites:
FuBasin – functional coal ash settling basin, AbBasin – abandoned coal ash settling basin, Control – the natural reservation in Zliv, functional – functional coal-ash settling basin, abandoned – abandoned coal-ash settling basin, Thisp – *Trochulus hispidus*, Abipl – *Alinda biplicata*, Aarbu – *Arianta arbustorum*, Chort– *Cepaea hortensis*, Cnemo – *Cepaea nemoralis*, Clubr – *Cochlicopa lubrica*, Drotu – *Discus rotundatus*, Gtrun – *Galba truncatula*, Hpoma – *Helix pomatia*, Mcart – *Monacha cartusiana*, Odrap – *Oxychilus* cf. *draparnaudi*, Phamm – *Perpolita hammonis*, Ppygm – *Punctum pygmaeum*, Ssemi – *Semilimax semilimax*, Sputr – *Succinea putris*, Soblo – *Succinella oblonga*, Tcyli – *Truncatelina cylindrica*, Uumbr – *Urticicola umbrosus*, Vcost – *Vallonia costata*, Vexce – *Vallonia excentrica*, Vpulch – *Vallonia pulchella*, Vpygm – *Vertigo pygmaea*, Vpell – *Vitrina pellucida*, Zniti – *Zonitoides nitidus*, Ahypn – *Aplexa hypnorum*, Cmini – *Carychium minimum*, Ediap – *Eucobresia diaphana*, Efulv – *Euconulus fulvus*, Vanti – *Vertigo antivertigo*, Pcase – *Pisidium casertanum*, Afusc – *Arion fuscus*, Avulg – *Arion vulgaris*

In the Presence data, we found significant differences between the study sites (all axes: trace – 0.59, $F = 1.53$, $p = 0.048$) and habitats (first canonical axis: eigenvalue – 0.52, $F = 1.71$, $p = 0.047$) (Fig. 1). The model analysing differences between study sites explained 33.8% of the data variability, but it did not show a trend of successional changes, as the abandoned site was on one side, the control plot on another and the functional ash basin in between, whereas the second axis discriminated mainly between functional ash basin and the rest of the study sites. When analysing habitats, the model explained 54.5% of the data variability and it showed clear differences between molluscs in reeds on the one hand whereas forest and dam were very similar. Furthermore, we did not find significant differences when we compared the localities controlled by the presence of individual habitat type (first canonical axis: eigenvalue – 0.26, $F = 0.97$, $p = 0.600$, all axes: Trace – 0.44, $F = 1.21$, $p = 0.303$) (Fig. 2). Comparing abundance data, which was available only for species presented in soil samples, we did not find differences between study sites (first axis: eigenvalue = 0.412, $F = 1.44$, $p = 0.175$; all axes: trace = 0.52, $F = 0.99$, $p = 0.359$) but we found differences in habitat type on the first canonical axis (eigenvalue = 0.709, $F = 1.87$, $p = 0.033$). The model explained 60.2% of the data variability. Again, dam and forest were, regarding mollusc species, very similar whereas different fauna was in reeds.

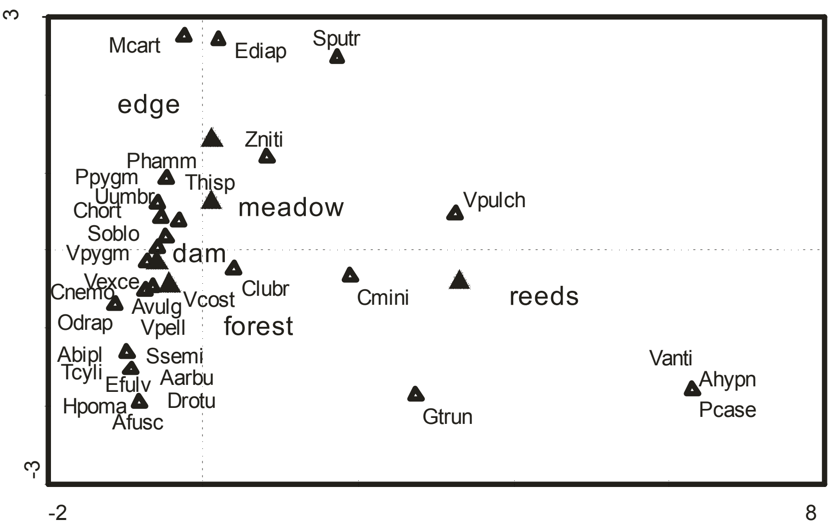

Fig. 2. Relationships between individual mollusc species and habitats.
For abbreviations – see capture to Fig. 1

The "habitat guilds" analyses resulted in significant differences between habitats in the first axis (first canonical axis: eigenvalue = 0.06, $F = 4.17$, $p = 0.002$, all axes: Trace = 0.07, $F = 1.52$, $p = 0.16$) (Fig. 3), which explained 51.38% of the data variability. Species occupying both closed woodland and dry habitats, as well as synanthropic species were associated with dams or forest sites, whereas aquatic or wet soil species together with open habitat specialists were associated with reeds, meadows and edges. Again, forest sites were very similar to dams, meadows to edges, and reed fauna were more deviated but still related to the latter two. On the other hand, we did not find any statistical differences between study sites (first canonical axis: eigenvalue = 0.02, $F = 1.02$, $p = 0.65$, all canonical axes: Trace = 0.02, $F = 0.59$, $p = 0.75$).

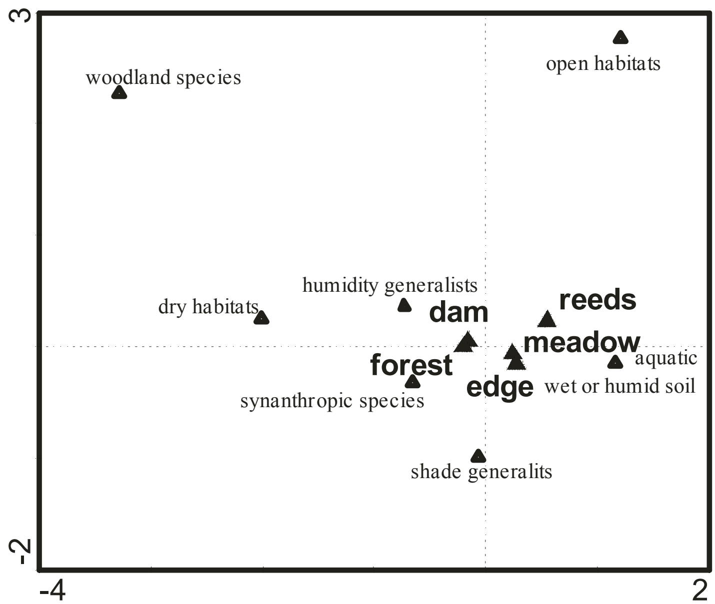

Fig. 3. The relationships between mollusc "habitat guilds" and habitats of the studied area. For abbreviations – see capture to Fig. 1

Such results suggest that the differences between the study sites are in the presence of individual habitat types on the sites but not in the differing mollusc communities of natural and anthropogenic habitat.

4. DISCUSSION

Environmental conditions at the functional coal-ash settling basin are clearly not favourable for molluscs. The following factors may be responsible for the low amount of both snail species and individuals:

- The structure of substratum. In general, terrestrial molluscs avoid sandy and dusty substrata [10].
- Flat terrain and uniform vegetation cover, and the resulting low amount of microbiotopes and low diversity of food resources.
- An extremely unbalanced regime of moisture. Very dry substratum in some parts of year alternates with flooding in others. This variation of the moisture makes this site uninhabitable for many species probably.

• Toxicity of the substratum. Chemical properties of the substrates were not investigated by the authors. Nevertheless, fly ash contains heavy metals toxic for most organisms, including molluscs [18].

Only two species – *S. putris*, *M. cartusiana* – are able to live in these conditions. Several additional species live on the edge of the internal area. Theoretically it is possible that these species are not able to live there for a long time and the individuals invade from the dam. On the other hand, dispersal abilities of these species are probably too low to enable such "trips" from the "safe" dam (see below). Moreover, in the case of *Zonitoides nitidus*, no shell or living individual was found in the dam. Speculatively *Z. nitidus* avoids both the dry conditions on the dam as well as the toxic substratum in the internal area, and thus inhabits the margin, balancing between the unfavourable conditions of both biotopes.

The malacofauna of the functional coal-ash settling basin can be considered as an initial stage of the succession of malacofauna of the partially recultivated coal-ash settling basin. However, the following facts should be taken into consideration:

• *Monacha cartusiana* is currently expanding within the Czech Republic [19] and it is known in South Bohemia since 2009 [20]. This species probably did not occur in the initial stage of succession at the partially recultivated coal-ash settling basin. Probably only one species (*Succinea putris*) lived in the old coal-ash settling basin at the time of reclamation.

• It is possible that some snail species were introduced to the abandoned coal-ash settling basin by humans via the soil used in the reclamation.

More species of snails live on the dam of the functional coal-ash settling basin. The presence of dams and similar structures seems to increase the biodiversity in general [21]; in this study, the dam is not constructed from the fly ash and this factor as well as the vegetation and morphology of the dam clearly strongly influences the composition of malacofauna.

The partially recultivated coal-ash settling basin possesses a relatively rich fauna of snails, with high numbers of individuals. In general, the malacofauna consists of habitat generalists and common species and is clearly influenced by the vicinity of the town (*Oxychilus* cf. *draparnaudi* and *Arion vulgaris*). Most snails belong to the widespread species that are typical of the initial stadia of succession (*V. pellucida*, *P. hammonis*, *C. lubrica*) (e.g. [22]).

The environmental conditions at the partially recultivated coal-ash settling basin differ from those at the functional basin. Most of the unfavourable substratum is covered by a thin layer of topsoil and/or leaf litter at least. The layers above the ash buffer extreme variations in moisture and reduce toxicity on the surface. On the other hand, the whole area stays relatively dry, probably due to the ash in the substratum. The vegetation cover is more diverse in comparison to the functional basin and offers more microhabitats and food resources.

The control plot combines a nontoxic and relatively favourable subtratum with a stable, high moisture content and diverse vegetation. The highest number of snail species (23) was found there. Compared to the partially recultivated coal-ash settling basin, a few more species, but a lower amount of individuals, were present in the control plot (but smaller samples of leaf litter were taken from the control plot). The presence of two vulnerable species indicates that the natural reservation is the most valuable site, comparing all three studied sites from the point of biodiversity.

On the other hand, the composition of snail fauna at the recultivated coal-ash settling basin is not influenced by environmental conditions only: the dispersal abilities of individual snail species are another important factor. The rate of active dispersal of majority of land snails does not exceed 3 m per month [24, 25]. The dispersal rate of small species such as *Vertigo* or *Vallonia* were not studied yet, but it does not exceed several meters per year probably. On the other hand, snails are able to colonise new habitats relatively quickly (e.g. [26]), although the mechanism is not clear. Some species are reported to be dispersed passively, above all by humans (e.g. [27]) and birds (e.g. [28]). It is possible that some species with a lower rate of dispersal will colonise the site in the future.

Although coal-ash settling basins seem to be very unfavourable for molluscs, they can serve as surrogate biotopes for some endangered species, e.g. the tiger beetle *Cicindela arenaria* vienensis Schrank, 1781 (Coleoptera: Carabidae) and the Small Blue butterfly *Cupido minimus* (Füessly, 1775) (Lepidoptera: Lycaenidae) live on the functional coal-ash settling basin in České Budějovice [29, Hanč, pers. comm.]. In the case of *C. arenaria*, coal-ash settling basins and other secondary biotopes seem to be the most important habitat for this species in the Czech Republic [30].

5. CONCLUSIONS

- The conditions at the functional coal-ash settling basin are unfavourable for most species of molluscs.
- Numerous and relatively diverse malacofauna has become established at the abandoned (26 years prior to the study) and partially recultivated coal ash settling basin, although the only management carried out was covering of the substratum with topsoil, this covering being in addition imperfect or absent on many parts of the site.
- On the other hand, although the malacofauna of the partially recultivated basin is relatively rich, it consists mainly of high populations of a low number of widespread species. It is not clear whether this situation is caused by the chemistry of the substratum, differing environmental conditions (e.g. moisture), or the dispersal abilities of snails.

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