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Could the fen rise in a place of a strip mine lake?

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Abstract: Since 2001 intensive survey of chosen bioindicative taxa (especially of dragonflies) has been carried out in the localities of anthropogenic origin in Karviná region (NE Silesia, Czech Republic). We have found several fen-living species (including endangered ones) on irrigated mine subsidence. Thanks to this discovery we could presume that irrigated mine subsidence could offer similar conditions such as fens. It is evident that observed species do not require strictly fen biotopes.

Keywords: dragonflies, bryophytes, irrigated mine subsidence, fen, metapopulations

The study area is situated near Stonava town in Karviná region (Silesia, NE edge of the Czech Republic). The region was adhered to the coal mining in the past. Many biotopes that were found there, originated as a result of mining. Paradoxically, the places seem to be biotopes with the occurrence of many rare and endangered species.

Material and methods

Since 2001 has been carried out an extensive survey focused on dragonflies. The typical faunistic data presence, abundance, sex ratio has been collected. Consequently ethologic and phenologic characteristics were observed (by means of marked specimens): time of imago occurrence, reproductive behaviour (post coital markings), reaction to the change in climate, territoriality on intra-specific an inter-specific levels, daytime activity. Obtained data has been analysed in relation to the meteorological characteristics (average daily temperature, maximum daily temperature, precipitation, wind speed). The research has been completed with preparative survey of bryophytes.

Results and discussion

The result of the survey was surprising. We have found 45 species of dragonflies in a relatively small area (see Tab 1 in Appendix). An occurrence of rare and endangered dragonflies in industrially devastated environment is anything unknown. Several rare dragonfly species which occurred in anthropogenic biotopes, with intensive mining activities have been described in the Czech Republic, e.g. *Sympecma paedisca* (Hájek & Mocek, 2000) or *Libellula fulva* (Dolný & Matějka, 2006). We have found some typical fen-living dragonfly species there, such as *Lestes virens*, *Somatochlora flavomaculata*, *Leucorrhinia pectoralis*, *Leucorrhinia rubicunda*. Observed species with similar biotope preference also has been: *Lestes sponsa*, *Aeshna juncea*, *Somatochlora metallica* and *Sympetrum danae*. Most of them are species with high bioindication value (Czachorowski & Buczyński, 1999). We supposed, that some species e.g. *Nehalennia speciosa, Leucorrhinia albifrons* didn't exist in Moravia and Silesia regions. This could be caused by geographical reasons.

During the survey another fen indicators, bryophytes has been found. These are e.g. *Aulacomnium palustre*, *Calliergonella cuspidata*, *Polytrichum commune* or *Bryum pseudotriquetrum*.

Thanks to this the discovery we could presume that irrigated mine subsidence could offer similar conditions such as fens. Authors expect that the answer is somewhere in the middle. The "fen-living named" species don´t have a fidelity to the fen biotopes but only to some particular conditions (pH, presence of littoral zone) which provides fens.

Many proofs which have been found indicate that the conditions in irrigated mine depressions could be very similar to the fen conditions.

One can presume the succession process takes the opposite course. The typical "fen succession" starts with lake. During the succession increases an amount of organic mass which is the cause of water level reducing. The succession is heading towards the terrestrial biotopes. The succession in mine subsidence starts with the water plane. The overburden consequently affects an inception of the subsidence. The subsidence is filled with rain- and underground water. The stage in the "fen succession" and the succession in mine subsidence could offer very similar conditions.

The succession in mine subsidence is often rapid and unpredictable process that is often related with degradation of biotope (loss of water, loss of littoral zone). How could organisms survive in such unstable environment?

The possible explanation could be the metapopulation theory. Since 2003 has started an intensive monitoring of *Leucorrhinia pectoralis* populations (Dolný & Harabiš, 2004). The dragonfly is protected according to the direction No. 92/43/EEC (under the Natura 2000) in the whole EU. The survey suggests that populations in particular irrigated mine subsidence are connected with migration of adults. That is why the whole area could be taken as one, or the couple of metapopulations (the population of populations). The populations inside the metapopulation could be sink (in the borders of area) which are supplied with migration of adults from source populations. The existence of the whole metapopulation is very effective way how to survive in the unstable environment (it creates stability in an instability).

The survival of the metapopulation depends on sufficiency of the source populations (each population could be the key). The much of populations become inhospitable through the very dynamic succession development. Many irrigated mine subsidence are endangered by planned recultivation of the landscape. The future of these populations could be very insecure.

Conclusion

The results of our study indicate that intensely anthropologic affected biotopes like irrigated mine subsidence could offer suitable conditions for many endangered species of organisms (especially dragonflies). We have found there 45 dragonfly species in relative small area. Several of these species are all European endangered species like *Leucorrhinia pectoralis*. Our explanation of this phenomenon is that the succession on mine subsidence runs reversely to the succession on the typical fen biotope. Both succession processes are going to the similar stage which offers suitable conditions. This hypothesis is supported with finding of several typical fen bryophyte species in the mine subsidence area. The succession on mine subsidence often runs markedly dynamically. The organisms have a lot of strategies how to survive in such unstable environment. One of these strategies could be explained with metapopulation theory, which could be the key for management.

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Appendix

Tab. 1. Dragonfly species recorded in irrigated mine subsidence	
Zygoptera	
Calopteryx virgo (Linné, 1758)	
Calopteryx splendens (Harris, 1782)	
Lestes viridis (Vander Linden, 1825)	
Lestes barbarus (Fabricius, 1798)	
Lestes virens vestalis (Rambur, 1842)	EN
Lestes sponsa (Hansemann, 1823)	
Lestes dryas Kirby, 1890	VU
Sympecma fusca (Vander Linden, 1820)	VU
Platycnemis pennipes (Pallas, 1771)	
Pyrrhosoma nymphula (Sulzer, 1776)	
Erythromma najas (Hansemann, 1823)	
Erythromma viridulum (Charpentier, 1840)	VU
Coenagrion puella(Linné, 1758)	
Enallagma cyathigerum (Charpentier, 1840)	
Ischnura pumilio (Charpentier, 1825)	VU
Ischnura elegans (Vander Linden, 1820)	
Anisoptera	
Aeshna juncea (Linné, 1758)	EN
Aeshna mixta Latreille, 1805	
Aeshna affinis Vander Linden 1820	VU
Aeshna cyanea (O. F.Müller, 1764)	
Aeshna grandis (Linné, 1758)	
Anaciaeschna isosceles (O. F.Müller, 1767)	VU
Anax imperator Leach, 1815	
Anax parthenope (Sélys, 1839)	VU
Brachytron pratense (O. F.Müller, 1764)	EN
Cordulia aenea (Linné, 1758	
Somatochlora metallica (Vander Linden, 1825),	
Somatochlora flavomaculata (Vander Linden, 1825)	VU
Libellula quadrimaculata Linné, 1758	
Libellula fulva O. F.Müller, 1764	
Libellula depressa Linné, 1758	
Orthetrum cancellatum (Linné,1758)	
Orthetrum albistylum (Sélys, 1848)	EN
Orthetrum coerulescens (Fabricius, 1798)	VU
Crocothemis erythraea (Brullé, 1832)	EN
Sympetrum striolatum (Charpentier, 1840)	
Sympetrum vulgatum (Linné, 1758)	
Sympetrum meridionale (Sélys, 1841)	
Sympetrum fonscolombii (Sélys, 1840)	VU
Sympetrum flaveolum (Linné, 1758)	
Sympetrum sanguineum (O. F.Müller, 1764)	
Sympetrum depressiusculum (Sélys, 1841)	VU
Sympetrum danae (Sulzer, 1776)	EN
Leucorrhinia rubicunda (Linné, 1758)	VU
Leucorrhinia pectoralis (Charpentier, 1825)	VU

Key: EN - endangered VU – vulnerable in Czech Republic