Diversity of animal trace assemblages in recent lowland river sediments (Dunajec River, SE Poland)

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In the course of evolution, fauna inhabiting river banks has developed adaptations helping it to colonize and survive in this dynamic environment. One of them is a specific distribution of animals in the vertical profile of bank deposits, that reflects their susceptibility for disturbances. The studied fauna inhabits sandy to muddy, overbank deposits of a well-drained, non-vegetated or partly vegetated and rarely flooded alluvial plain of the Dunajec River (Sandomierz Basin, southern Poland). The most frequently observed animals in the alluvium include four species of ground beetles (*Carabidae*), European mole (*Talpa europaea*), common earthworm (*Lumbricus terrestris*), and solitary bees (*Ammophila*).

The abundance and distribution of the studied burrows within the overbank deposits of the Dunajec River reflect sensitivity of particular animals to disturbances and the position of ground water table. The frequency of *Bembidion quadrimaculatum* burrows ranges from 5 to 100 per m^2. *B. stephensii* burrows occurred less frequently (up to 5 per m^2) and were observed farther from the contemporary river bank. The burrows of *Harpalus rufipes* and *Melolontha melolontha* were most scarce (less than 1 per m^2) and occurred highest above water table.

The *Melolontha melolontha* burrows occur in the most distal places and are limited to the elevated Pleistocene terrace. As this is a breeding chamber, larvae need to burrow deeply during all phases of ontogenetic development, also during winter, when the ground can be frozen down to 1 m depth. Moreover, in this part of the alluvial plain, soils are more mature, with more variable vegetation and hence food availability related to roots (Hembree & Nadon, 2011). The burrows of *Harpalus rufipes* occupy an intermediate position. This fits well with the herbivorous activity of the tracemaker, as vegetation is better developed at some distance from the river channel. The bembidionid burrows are present on the contemporary floodplain, but the burrows of *Bembidion stephensii* occupy more distal position, while those of *Bembidion quadrimaculatum* are located closer to the river. As very mobile carnivores, bembidionids are better adapted to stress conditions, which increase towards the river channel.

Water-level fluctuations are the main factor disturbing river-bank burrowing biota and controlling their diversity and abundance (Buatois & Mángano, 2004). Changes in the river bank ecosystem of the Dunajec, caused by summer and winter floods, were examined during the last three years. The highest diversity of the river bank fauna,

especially beetles, occurs under a moderate level of disturbances. With a low intensity of disturbances, large, long-living species dominate, whereas with high-intensity disturbances, small, short-living forms prevail (Fernandes *et al.*, 2002). A large majority of the small organisms inhabiting the alluvial deposits are not adapted to survive floods. On the contrary, European mole and bank swallow (*Riparia riparia*) build their burrows beyond the range of flood waters. Burrows of the latter are long enough to enable nesting during the progressive erosion of the banks. However, a major flood can completely modify river banks, making them unsuitable for quick re-colonisation until the next year.

Earthworms and solitary bees occur in the whole profile of the overbank deposits, but they are the most susceptible to flooding, so their populations can be almost completely destroyed in the case of a major flood. On the other hand, they have the greatest re-colonisation potential among the Dunajec River bank animals. This adaptation allows them to colonize the parts of the alluvial plain nearest to the river channel and be the first animals colonizing sediment after flooding.

Most of the organisms inhabiting river banks are well equipped to survive unfavourable environmental impact. Rapid changes in alluvial environment increase interspecies competition and stimulate growth of biodiversity. Major flooding can completely destroy most of the river animal assemblies but after this event, species richness increasing in freshly deposited sediment more rapidly than before the flood.

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