Ichnofabrics in Quaternary inland dunes of SE Poland

Alfred Uchman

Jagiellonian University, Faculty of Geography and Geology, Gronostajowa 3a; 30-087 Kraków, Poland

alfred.uchman@uj.edu.pl

Abstract:

Inland sand dunes were deposited on a large area of western-middle Europe in the so-called European Sand Belt during post-glacial times of Late Pleistocene – early Holocene. During the Late Pleistocene, the southern margin of the ice cap went through southern Scandinavia. The dunes were stabilized during the Holocene and rarely re-mobilized. Recently, they are usually forested or covered by pasture vegetation. The dunes were partly influenced by human activity. They are intensively bioturbated below the recent soil or below buried soils, but usually this fact is overlooked in investigations. The presented investigations concern the southern margin of the European Sand Belt in the Sandomierz Basin, SE Poland (50°–51° N), where the morphology of dunes is still well preserved and their internal structure available in sand pits. The dunes were deposited by generally westerly winds.

The bioturbated zone in the dunes is 1.5–2.2 m thick. Its upper portion (about 0.3–0.9 m thick) is totally bioturbated. The primary sedimentary structures are completely altered. In recent times, various bioturbating animals can be encountered in this zone, mostly insects, e.g. hymenopteran solitary bees and wasps, ants, antlion (*Myrmeleon*) larvae, beetles (e.g. tiger beetles of the subfamily Cicindelinae). Moreover, oligochaetes (earth worms) and mammals (e.g. the European mole *Talpa europaea* in more organic-rich places, and the red fox *Vulpes vulpes* on the slopes) are present. Earth worm burrows (usually 2–4 mm wide) are associated with burrows of the European mole (branched, 40–60 mm wide). Usually, they are well visible in the subsoil below thicker organic rich soils, mostly in the lower dune slopes and in the interdune areas. The sand is also disturbed by roots of trees and other vascular plants.

The totally bioturbated zone passes downward through a partly bioturbated zone (0.8-1.3 m thick) and to a non-bioturbated zone with well visible lamination. In the partly bioturbated zone, primary lamination is cross cut by mostly vertical/subvertical meniscate burrows, which can be ascribed to *Taenidium*, *Entradaichnus* or *Naktodemasis* (irrespective of their ichnotaxonomic problems). They are 5–20 mm thick and can be traced at a distance of several tens of centimetres. Their menisci, usually poorly visible, are usually concave down. The burrows can be concentrated in wedge zones which have been formed after decomposition of thick tree roots ("ghosts of roots"), or they can follow thinner roots. Recent pine roots (*Pinus*) may extend a few metres down the surface. They can follow disturbances after old frost wedges. The lower boundary of the totally bioturbated zone is uneven. Commonly, it deflects down around thicker ghosts of roots.

The meniscate burrows are produced by insects and their larvae or nymphs. They fed on organic matter, mostly on dead or living roots. In the totally bioturbated zone, the burrows are differently oriented. In the deeper zone, they are vertical or steeply oblique. The latter are interpreted as burrows of insects which overwinter below the level of frost (usually 1 m) and migrate into the ground mostly along thin roots. The concavity of the menisci shows that they returned to surface or subsurface along the same path. Probably, the way up was easier along the already used burrow. Stabilized sand dunes seem to be a good place to overwinter for insects, because they are well drained, with very low probability of flooding, well aerated, and with deep roots, which are the basis of the trophic chain.

In non-ploughed areas, the transition between topsoil and the burrowed subsoil is gradual. In the ploughed fields, even if the field was abandoned by tens of years, contact between the topsoil and the subsoil is sharp. In both cases, burrows filled with the topsoil dark particles are well contrasted with the lighter subsoil sediments. In some burrows, sediment from the subsoil is introduced into the topsoil. Visibility of burrows in the totally bioturbated zone can be low, so that the sand seems to be massive. Their visibility depends on moisture and light. Usually, the ichnofabric is less visible in dry sand. In some places, the visibility of burrows is enhanced by mineralization, mainly ferruginization. Locally, ferricretes are present. Shallowly buried soils can be re-burrowed from recent soils and ichnofabrics formed during different times can overlap.

Investigations in old sand pits, which are vegetated and abandoned since a few tens of years, show much thinner and less developed ichnofabrics below the exploitation surface. The laminated sand occurs very shallowly below the soil developing on such surface. This shows that the thick ichnofabrics observed below natural surfaces/soils developedduring at least hundreds of years.

Keywords: aeolian environment, soil, meniscate burrows, Late Pleistocene, Holocene, Central Europe

The research is financed by the National Science Centre, Poland, from the programme Daina 1, grant agreement No 2017/27/L/ST10/03370.