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Identification of runoff formation with two dyes in a mid-latitude mountain headwater

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There have been numerous studies on subsurface flow in peat bog areas, as both water scarcity and floods have led to increased attention to this specific environment and its role within the hydrological cycle. In contrast, this experimental study identifies runoff formation at two opposite hillslopes in a peaty mountain headwater; a slope with organic soils (Peat / Histosol) and shallow groundwater ($\sim$ 0.5 m below surface) complemented by a slope with mineral soils (Podzol) and no detectable groundwater within 2 m below surface. Differences in infiltration, percolation, and preferential flowpaths between both hillslopes could be identified by sprinkling experiments with two dyes – Brilliant Blue FCF and Fluorescein. By excavating dye-stained soil profiles parallel ("lateral") and perpendicular ("frontal") to the slopes' gradients – both within and downstream of the sprinkling plots – dye stained flow patterns in the soil could be clearly identified. The results show that biomat flow occurred at both hillslopes. The dye solutions infiltrated into the soil and continued either as lateral subsurface pipeflow (SSF), in the case of the Peat Bog, or percolated vertically towards the bedrock in the case of the Podzol. The study provides evidence that biomat flow (BMF) – shallow, lateral preferential flowpaths along decomposed tree roots or logs – is a major runoff formation process at the Peat Bog hillslope and in the adjacent riparian zone. This lateral flow through the organic soil hillslope (Peat Bog) towards the stream occurred mainly as shallow subsurface flow in organic layers above the groundwater level (BMF and SSF), but water partly percolates to the shallow groundwater via vertical macropores as well . In contrast, the mineral soil hillslope (Podzol) was mostly dominated by vertical percolation. Lateral flow occurred only on short distances in the organic topsoil as biomat flow (BMF). The sorptive tracer Brilliant Blue FCF successfully stained flowpaths in the soil at both hillslopes, whereas the identification of soil staining patterns by the relatively conservative tracer Fluorescein was limited on organic soil profiles.