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## Footprints of Birds and Sedimentary Structures from the Subalpine Molasse near Flühli (Canton of Luzern).

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### ABSTRACT

Footprints of rail-like birds and shallow-water environment sedimentary structures were found in the "Beichlen-Series" (Chattian) of the sub-alpine molasse. They give evidence for a fluvial deposit by a braided river system, that periodically deposited as a floodsheet on a floodplain with vegetation.

During a short excursion to the Alps, footprints of birds were found in the lower part of the "Beichlen-Series" which outcrops along the road from Schüpfheim to Flühli, 350 metres south of the bridge over the Waldemme brook in the "Lamm-schlucht" (Fig. 1).

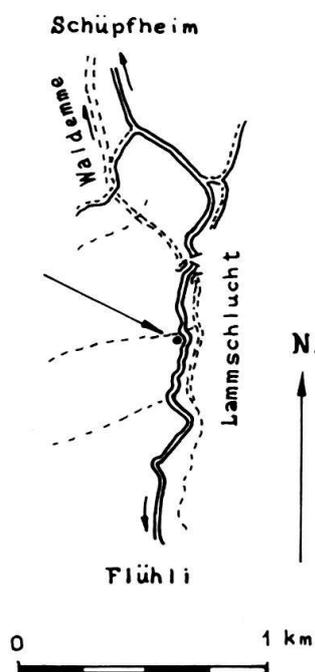


Fig. 1. Schematic map of the area; the arrow indicates the locality where the footprints were found.

The "Beichlen-Series" at this locality consists of a cyclic succession. Each cycle is on the average 15 metres thick. It begins with polymict conglomerates, which gradu-

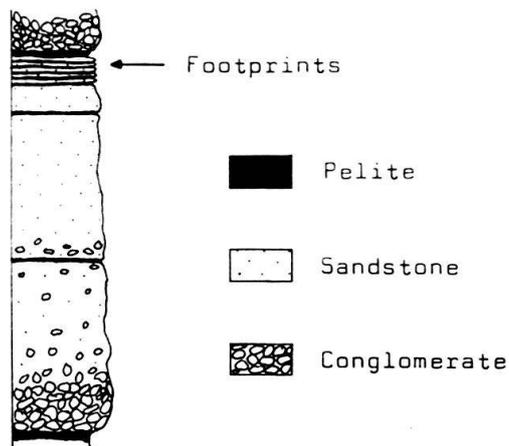


Fig. 2. Schematic column of the cycle discussed. Total thickness approx. 10 m.

ally change into fine grained layers (Fig. 2). In the literature they have been described as fluvio- or limno-terrestrial Stampian (HOLLIGER, 1955; GASSER, 1968).

The age of the "Series" is Chattian (Upper Oligocene). This age has been determined by means of landsnails. The continental character is among others clear from the facies-fossils: landsnails, freshwater-molluscs (*Unio*) and remains of mammals which are found near Bumbach (STEHLIN, 1922). In other localities comparable cyclic deposits with freshwater-limestones and coal layers (Molasse à charbon, Blättermolasse) of the same age have been found.

The cycle in which the footprints have been found (Fig. 2) starts with a conglomerate changing gradually into a sandstone, still containing some pebbles, which in turn passes into a sequence of alternating sandstones and pelites (Fig. 2-3). The thickness of this cycle is approximately 10 metres.

The footprints of the birds (Fig. 4-5) occur at the base of the sandstone in the upper part of the cycle. Therefore they are not the original prints, but natural moulds formed by the sand.

Prof. Dr. K. H. VOOUS of the Zoological Museum of the Amsterdam University made a close examination of the prints and concluded that the prints most probably were made by some species of rail (Rallidae) rather than by a kind of wader (Limicolae). He based his assumption (1) on the long first toe (hind toe) which seems almost in level with the front toes, and (2) on the long and pointed shape of the claws.

Besides the footprints of the birds there are certain sedimentary structures, that point to a shallow-water environment. In one of the sandstones plant-stems were found perpendicular upon the stratification and thus evidently in growth position. This is corroborated by the observation that around the plant-stems a current has formed a pattern of erosion which corresponds quite well with the "Fleur-de-lys" pattern described by DZULYNSKI & WALTON (1965, p. 60, 61, Fig. 44D) (Fig. 6A). Furthermore longitudinal furrows and ridges (Fig. 6C) and a scaly pattern of imbricating flute-like moulds are clearly visible (DZULYNSKI & WALTON, 1965, Fig. 44C) (Fig. 6E).



Fig. 3. Photograph of the upper part of the cycle. At the upper left the basal conglomerate of the succeeding cycle is visible. The footprints of the birds were found in the layer above the ruler (see arrow) which is one metre long.

Around the plant-stems the current has eroded depressions which were filled out by the sand (Fig. 6–7). Further the sandstones contain small-scale cross-laminations, ripple-marks, some load-structures as well as U-shaped burrows. Some of the sandstones are graded.

Our conclusion is, that the upper part of the cycle has been deposited as a flood-sheet on a floodplain with vegetation. The water was fresh or brackish. The floodplains were periodically inundated by the fast flowing, suspension-loaded floodwaters which were strong enough to erode around the stems of the plants; and which afterwards deposited the sandstone.

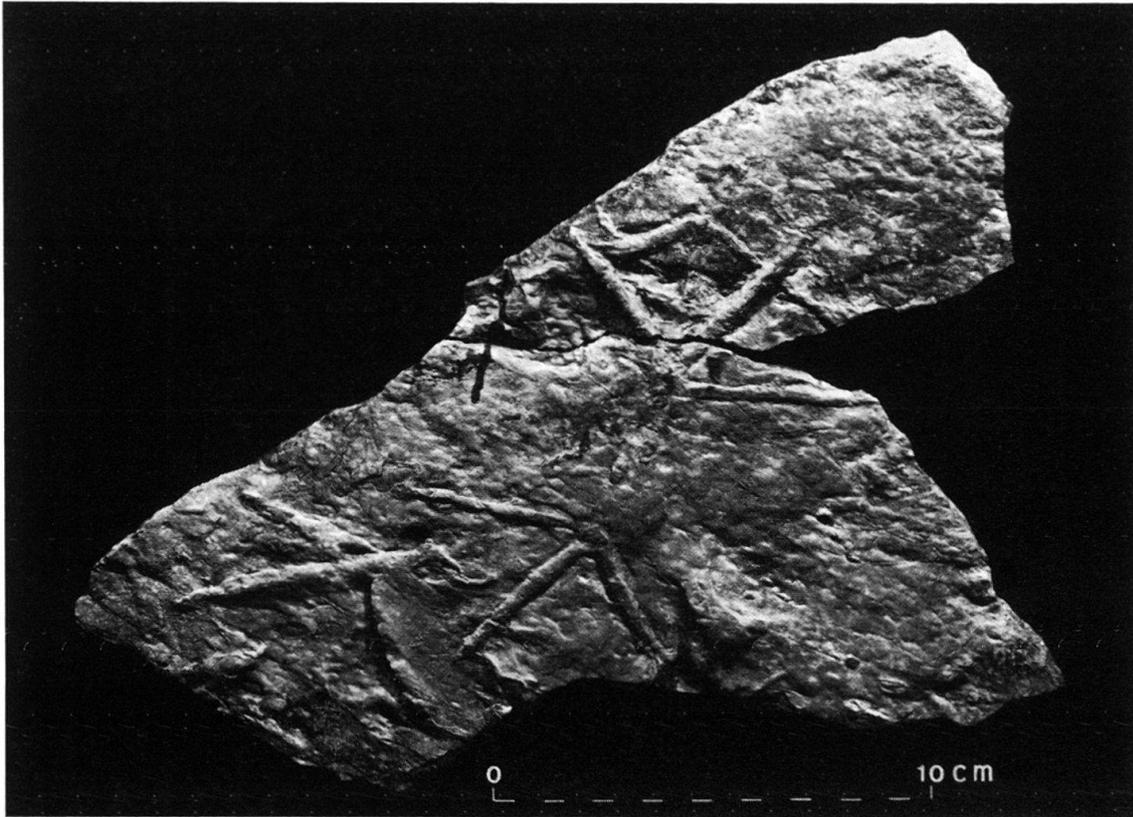


Fig. 4. Moulds of the footprints of the birds at the base of sandstone.

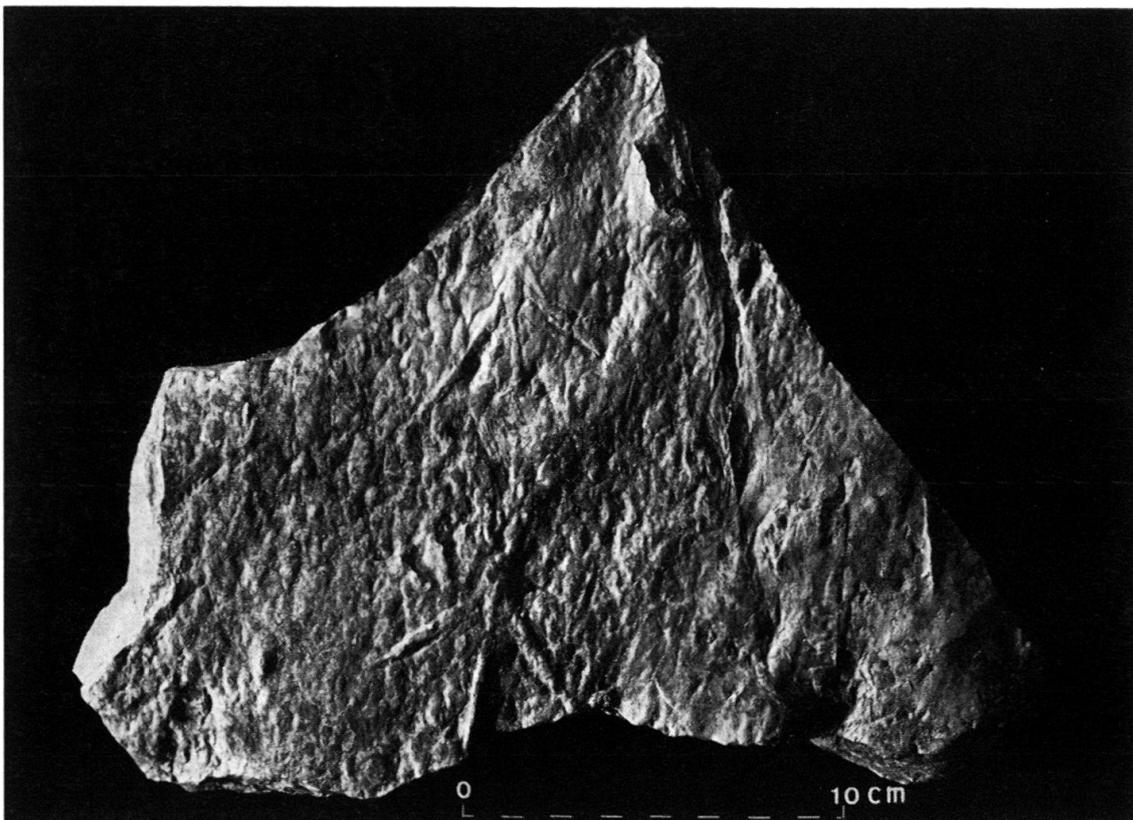


Fig. 5. Moulds of the footprints of the birds at the base of sandstone.

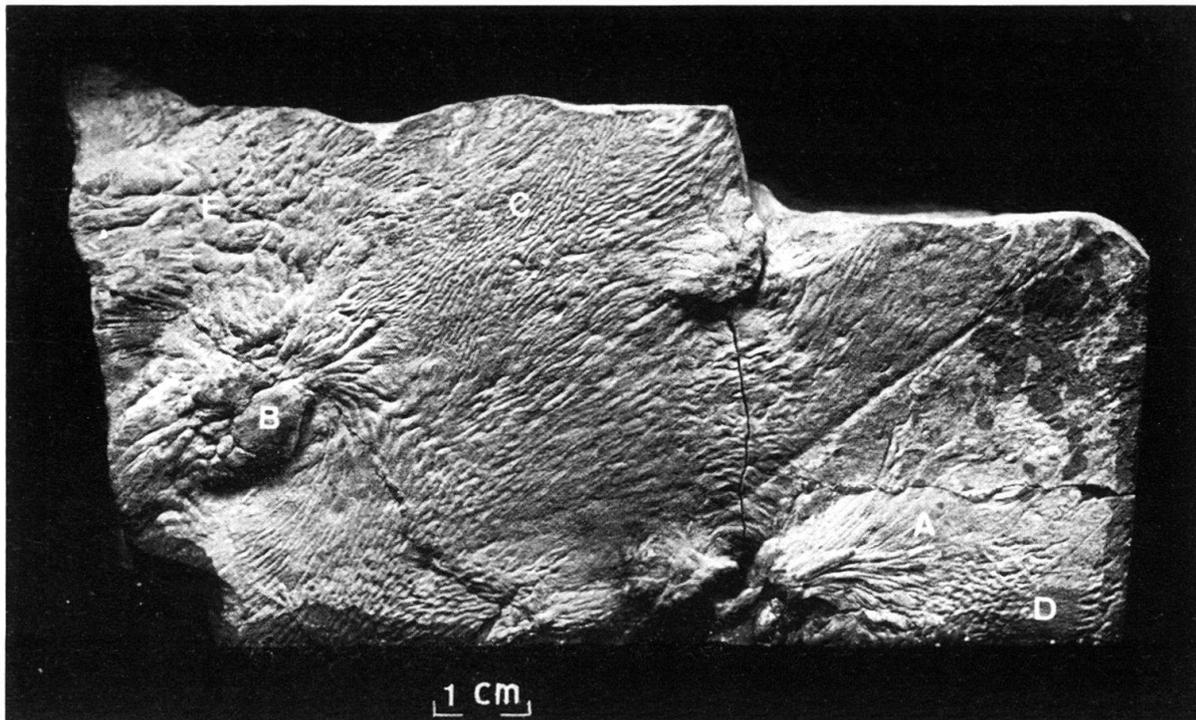


Fig. 6. Base of fine-grained sandstone with sole-markings. Natural size.

- A. "Fleur-de-lys" like pattern.
- B. Moulds of depressions around plant-stems.
- C. Longitudinal ridges and furrows.
- D. Non-directional structures.
- E. Scaly pattern of imbricated flute-like moulds.

Current direction is towards the lower left.

We cannot state for certain, that the area ever fell dry, since in the short time available we did not find any desiccation structures such as mud-cracks.

The inundations could be the result of flooding of rivers. The cycle as a whole is a distinct fining-upwards sequence and thus most possibly represents a fluvial deposit. The conglomeratic base is a typical channel-fill; the presence of intercalated silt-layers in the polymict conglomerates and channeling within the conglomeratic layer itself could be taken to indicate a braided-river deposit.

The alternation of sandstones and pelites would then represent the overbank-deposits (sheet-floods) of the flood-basin and the cyclicity of the formation as a whole could be explained by migration of the channel in time.

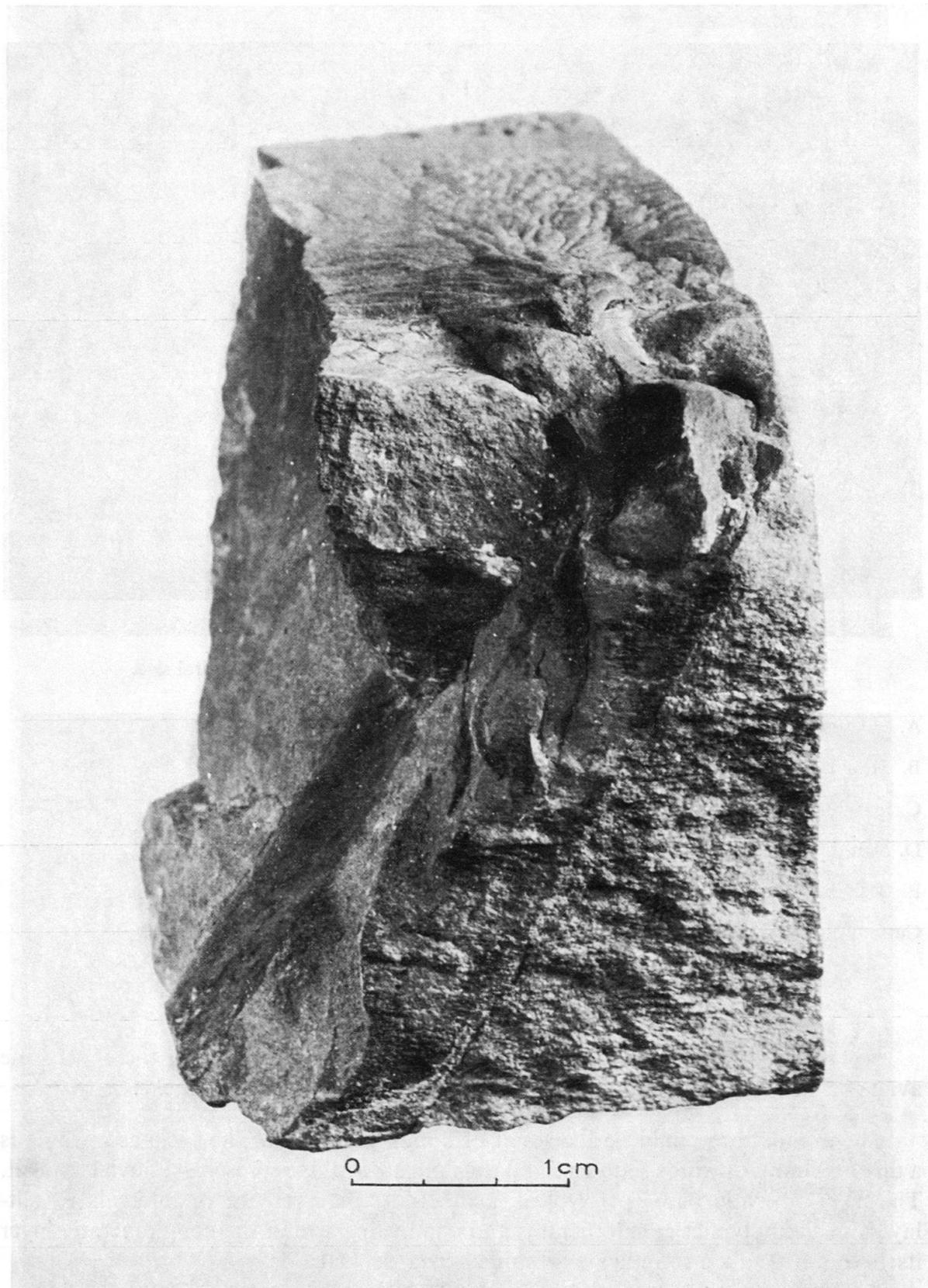


Fig. 7. Imprint of plant-stem in sandstone showing clearly that the plant was not washed away by current which made a depression around the stem and then deposited the sand layer. Natural size.

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