The Late Jurassic continental record of Northern Switzerland – evidence and implications

Article · January 1996

CITATIONS
11

READS
80

2 authors:

Christian A. Meyer
University of Basel
231 PUBLICATIONS **4,520** CITATIONS
SEE PROFILE

Martin Lockley
University of Colorado
489 PUBLICATIONS **15,076** CITATIONS
SEE PROFILE

From: *The Continental Jurassic,* Michael Morales, ed., 1996. Museum of Northern Arizona Bulletin 60.

THE LATE JURASSIC CONTINENTAL FOSSIL RECORD OF NORTHERN SWITZERLAND: EVIDENCE AND IMPLICATIONS

Christian A. Meyer and Martin G. Lockley

ABSTRACT: The Late Jurassic record of plants and vertebrates from Northern Switzerland is reviewed. Evidence from the steady stream of new discoveries, including remains of theropods, land plants and dinosaur tracks, suggests prolonged emergent areas or smaller landmasses connecting the London - Brabant Massif with parts of the Massif Central. The recognition of the first megatracksite in the Late Kimmeridgian as well as a growing number of tracksites in six stratigraphically distinct levels (Lower Kimmeridgian to Lower Portlandian) supports this hypothesis. The presence of large sauropods as well as theropods points to larger vegetated areas for food supply.

INTRODUCTION

The record of terrestrial vertebrates and plants from Northern Switzerland is only poorly known. The first account of Late Jurassic vertebrates dates back to the last century when Hugi (1825) announced the presence of pterodactyl bones from the Solothurn Turtle Limestones (Late Kimmeridgian); Gressly (1857), Lang (1853) and Hugi believed these creatures to be birds. Greppin (1870) figured bones and teeth of dinosaurs under the name of *Megalosaurus meriani* from Moutier. In 1922 Huene described this specimen as *Ornithopsis greppini* and assigned it to the sauropod familiy Diplodocidae; one single tooth to *Labriosaurus meriani.* In his paper on the fauna of the Solothurn Turtle Limestone (1925), Huene figured additional but smaller teeth of theropods and two enigmatic bones, one assigned either to a crocodilian or a small theropod, the other to a fibula of a small ornithischian dinosaur.

Heer (1877) figured four different species of the bennettitalean leaf genus *Zamites* from the Late Oxfordian Villigen Formation. One specimen comes from the Geissberg Member near Aarburg and two others have been collected in the Crenularis Member near Olten/Trimbach and Däniken. Another specimen came from the Terrain-à-chailles Member (Bärschwil Formation) of St. Sulpice and additional specimens came from Kimmeridgian sediments of Mount Risoux (Vallée de Joux) and Vuargny. The Effingen Member of the Wildegg Formation has yielded a well preserved specimen of the conifer *Pachyphyllum* near Bubendorf (BL). Reichel (1928) described a reasonably well preserved specimen of *Pagiophyllum* from the Couches à ciment (Oxfordian) of St. Sulpice and Pümpin (1965) figures an imprint of a bennettitalean leaf from the chalky limestones of the St. Ursanne Formation. Furthermore Greppin (1870) mentioned the presence of terrestrial snails in the uppermost part of the 'Calcaires portlandiens' known today as 'Twannbach Formation' (Fig. 1).

GEOLOGICAL OVERVIEW

The Sedimentological Record

Oxfordian: Indication of emergent facies has long been recognized in the adjacent French Oxfordian sediments (Enay, 1980). The partial skeleton of the sauropod genus *Bothriospondylus* as well as teeth of carnosaurs from the Oxfordian of Damparis (Lapparent 1943; Dép. Jura) have been interpreted as *in situ* remains of terrestrial animals (Buffetaut, 1988). De Broin *et al.* (1991) point to numerous emergent areas during the Oxfordian and Kimmerdigian of the French Jura mountains. The presence of characeans and ostracods lead to he recognition of freshwater tables in the Oxfordian and the Portlandian of the adjacent French Jura mountains (Oertli & Ziegler, 1965). Ziegler (1962) interpreted the widespread occurence of characeans in the Oxfordian of Switzerland as an indication of a vast backreef environment with strong freshwater influence resulting from confined uplifted tectonic blocks on the southern margin of the Vosges mountains. Coeval strata like those of the Vellerat Formation (Natica Member) contain biogenic and sedimentary structures like stromatolites, black pebbles and mud cracks deposited in the uppermost inter- to supratidal part of an ancient tidal flat. The terrestrial

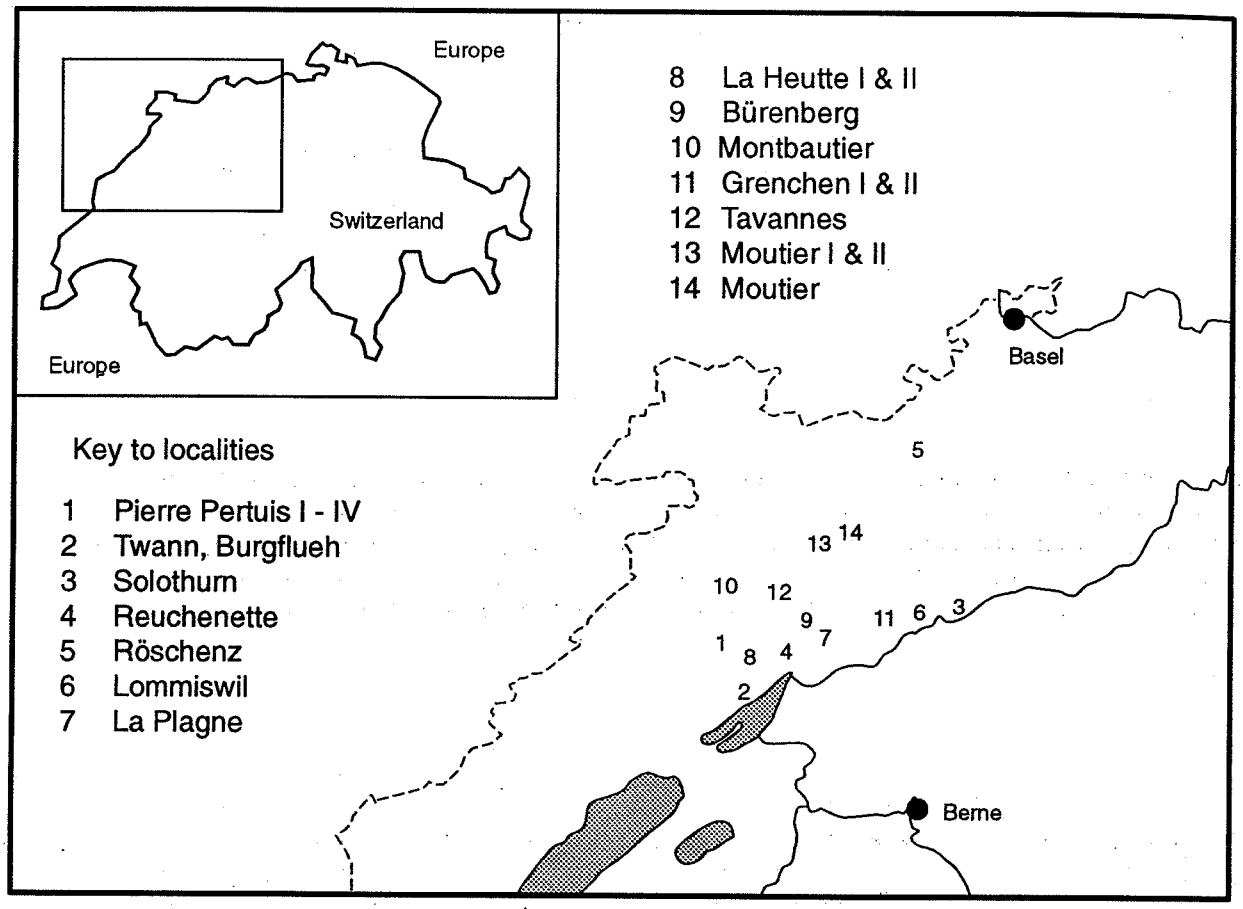

FIGURE 1. Location of study area with main vertebrate and plant localities in Northern Switzerland.

plant remains from Péry-Reuchenette (van Konijnenburg-van Cittert & Meyer, in press; Fig. 1: 4) and coeval coal beds from Moutier (Laubscher & Pfirter 1984; Gygi & Persoz 1986; Fig.1:13) as well as fresh water characeans demonstrate that during the Late Oxfordian some parts of the Swiss Jura have been emergent areas.

Kimmeridgian: The Reuchenette Formation (Kimmeridgian) can be subdivied into four shallowing upward cycles ending with stromatolitic intervals; these cycles can be correlated with major discontinuities in Europe (Mouchet 1995; Meyer & Pittmann 1994). The lower part of the formation shows another freshwater influx (characeans) and the presence of mud-cracked intervals and thin layers of stromatolites. Furthermore, black pebbles, mud cracks and intertidal keystone vugs and the presence of two levels with sauropod tracks indicates a general shallowing upward trend.

Stratigraphic Controls

The Late Jurassic shallow water marine limestones and platform carbonates of Northern Switzerland have yielded only two ammonites that give us biostratigrapahical control. According to Gygi (1995) and Meyer & Pittman (1994) the boundary between the Reuchenette Formation and the overlying Twannbach Formation has to be placed into the *autissiodorensis* zone of the Late Kimmeridigian (*sensu* gallico).

The base of the Twannbach Formation contains marker ostracods suggesting a Tithonian age (Portlandian *sensu* gallico) for these layers (Häfeli 1966); the occurence of ammonites in the lower part of this formation (*Gravesia*; Thalmann 1966, Meyer & Pittmann 1994) confirms these observations. Further evidence is provided by the presence of charophytes (*Echiochara pecki*) in the lower part of the Reuchenette Formation (Mouchet 1995).

The Record of Continental Faunas

Terrestrial Vertebrates: The revision of the Solothurn Turtle Limestone fauna as well as extensive field work in Late Jurassic sediments of Northern Switzerland has brought new and additional data concerning the record of continental vertebrate fossils (Meyer 1994a, 1994b, Meyer & Hauser 1994, Meyer & Pittman 1994). A taxonomic revision of the diplodocid skeleton and all other mentioned specimens above is currently beeing undertaken. One bone, originally reported as that of a small ornithischian dinosaur (Huene 1925) is most probably the phalanx of a giant pterosaur ((Hunt & Meyer, in prep.). Muller (1995) who investigated the fish fauna of the same stratigraphic unit (Solothurn Turtle

Limestone member) figured isolated teeth that might belong to the same group. Weishampel *et al.* (1990; p.350) erroneously reported the skeleton of *Cetiosauriscus greppini* being from the Virgula beds (Tithonian) of Moutier; the correct assignment would be Lower part of the Reuchenette Formation (Lower Kimmerdigian *sensu* gallico). In addition to that we have to emphasize that these skeletal remains have not been revised since Huene's description in 1922. Since the circumstances of discovery are still unclear and the taxonomic status of the specimen is still under debate, the comment by Weishampel *et al.* (1990; p.350) that "at least 4 partial skeletons without skulls" have been found has to be regarded with caution

Track Assemblages: Since the report of the first European megatracksite from the Late Kimmerdigian in the Northern Jura mountains (Meyer 1990) many new sites have been discovered (Meyer & Hauser 1994). The megatracksite has been asigned to the *Brontopodus* Ichnofacies (*sensu* Lockley, Hunt & Meyer 1994) and covers approximately 400 km^2. In 1995 the first tracksites in the Twannbach Formation (Portlandian) have been found and up to now four distinct tracklevels have been recognized in this Late Jurassic marginally marine deposit (Fig.3). The sites from the Portlandian contain sauropod tracks only so far. Also in 1995 another large sauropod tracksite was found in the lowermost part of the Reuchenette Formation (Fig.4). This site shows more than 800 individual sauropod prints on a steeply inclined surface of approximately 4000m^2. Some parts of the surface are densly covered by shallow prints that indicate heavy trampling. Others, however, display well preserved individual manus and pes prints up to 40 cm deep. These different preservational styles point to long term exposure, recording the passage of several herds and the drying up of the carbonate sediments. Whereas all the Kimmeridgian sites show wide-gauged animals (*sensu* Farlow 1992), the Portlandian brontosaurs were all narrow-gauged.

The Record of Landplants: The Natica Member of the Vellerat Formation (Late Oxfordian) has produced a small flora in the quarry La Charuque (Péry-Reuchenette) in the Swiss Jura mountains. Four taxa have been found: the bennettitalean leaf *Zamites* cf.

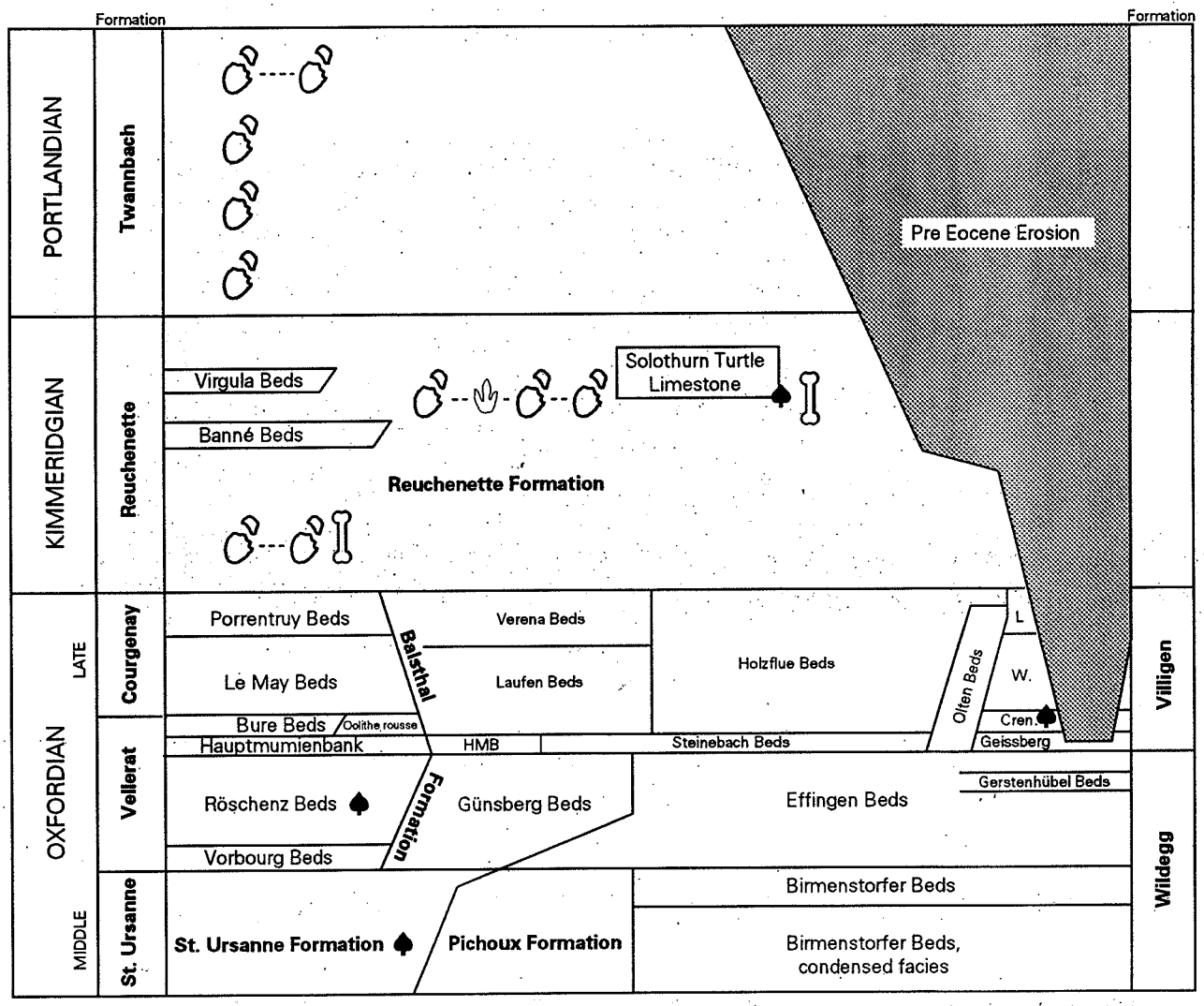

FIGURE 2. Stratigraphic chart showing the position of continental fauna and flora.

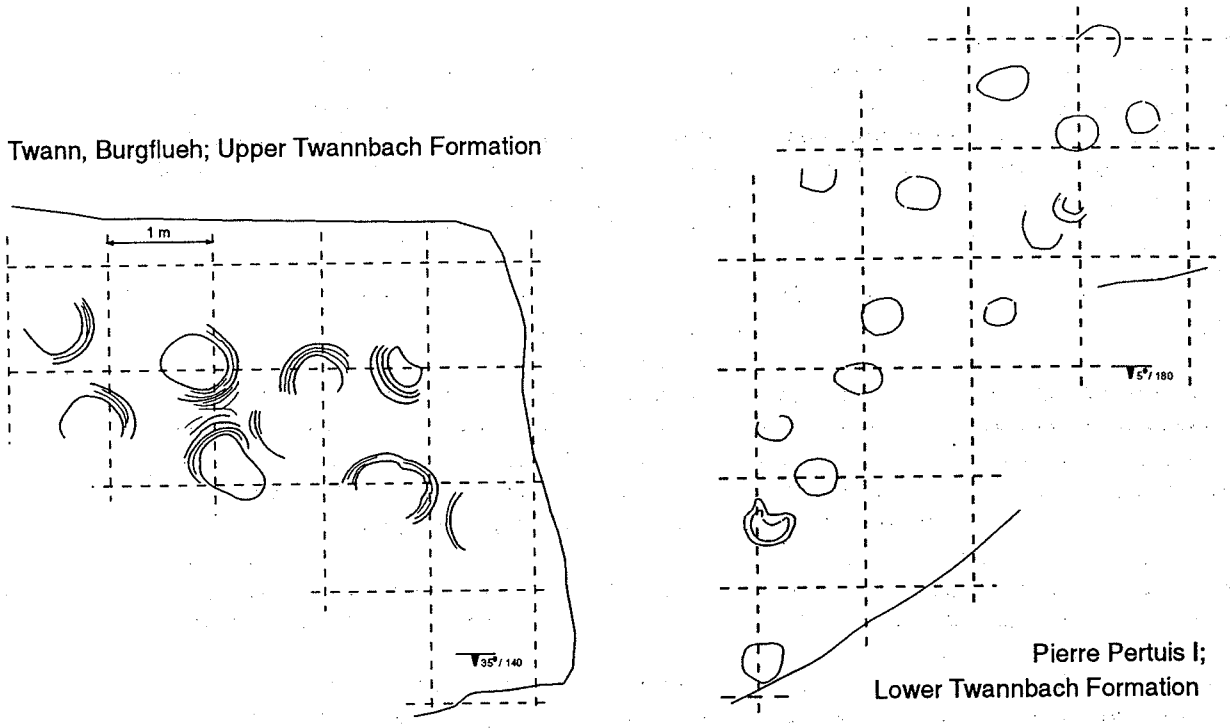

FIGURE 3. Left: Sauropod tracks, Lower Twannbach Formation (Portlandian) locality Twannberg (note: shallow undertracks with wrinkle marks from the supratidal). Right: Sauropod tracks; Upper Twannbach Formation (Portlandian) locality Pierre Pertuis I.

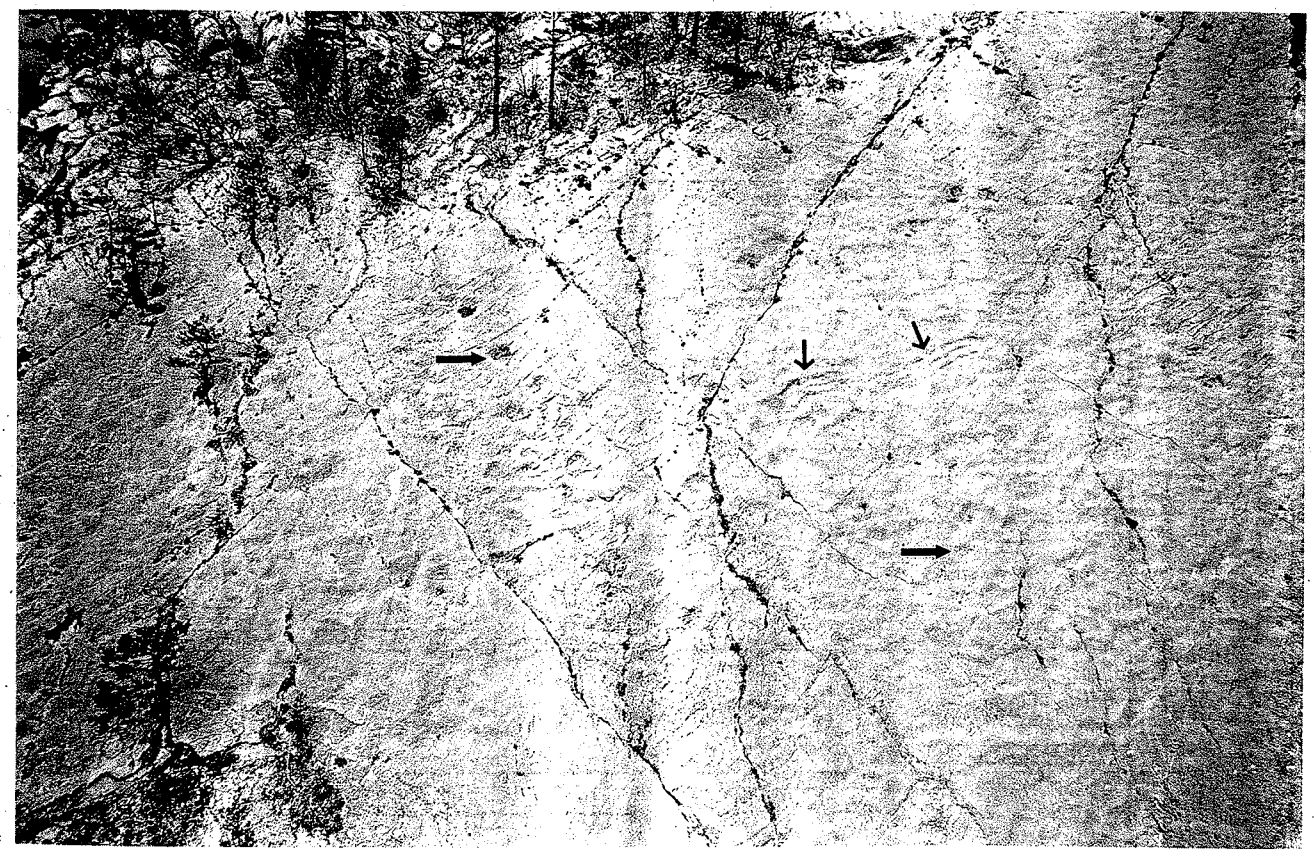

FIGURE 4. Sauropod tracks, Lower Reuchenette Formation, locality Moutier II. Trampled surface recording long-time presence of dinosaurs (note deep tracks and slightly folded algal mats: arrows).

feneonis, the araucariaceous conifer *Brachyphyllum* cf. *thuioides* and the cone-scale *Araucarites* cf.*moreauana* and the cheirolepidiacean conifer *Pagiophyllum araucarinum* as well as male cones of the genus Masculostrobus that are thought to belong to the latter species. The size of the plant remains and the association with seeds and cones points to a parauthochtonous assemblage. The palynological analysis indicates a small plant community growing near the coast (van Konijnenburg - van Cittert & Meyer, in press). Phillippe (1995) reported the conifer *Agathoxylon* from the Solothurn Turtle Limestone (Kimmeridgian; Reuchenette Formation) near Solothurn and Meyer (1994a) mentioned badly preserved imprints of Equisetales (Fig.1, 2).

SUMMARY AND PROSPECTUS

The Late Jurassic continental record of Northern Switzerland indicates the presence of large herbivore and carnivore dinosaurs as well as pterosaurs. The skeletal record alone indicates little evidence of dinosaurs, it is the well documented track record that suggests the long term presence of dinosaurs. Small islands would not provide enough food resources for the herbivores therefore recurrent emergent areas must have been present that connected the southern part of the London-Brabant mass with the northeastern part of the Massif Central.

Furthermore it has to be stressed that all of the tracksites occur at sequence boundaries or on a smaller scale at third order boundaries. This evidence has provided a "search image" that has lead to recent discoveries of four new tracklevels in the Twannbach Formation. The marginal marine, tidal flat and sabhka deposits of the Late Jurassic cannot be correlated with index fossils, but the recognition of these tracksites will further help to integrate these deposits into a more comprehensive stratigraphic framework. The present state of knowledge allows us to predict important discoveries in the future. The presence of arboreal gastropods and characeans in marly intercalations of the upper part of the Twannbach Formation (Greppin, 1870) suggest the potential to prospect for Mesozoic mammals and small reptiles.

ACKNOWLEDGEMENTS

We would like to thank Kaspar Graf (Biel) for field assistance and Michel Monbaron (Fribourg) for information on the Twannberg site. Financial support came from the Comittee of "Arbeitsgruppe Zusammenarbeit mit den Hochschulen" of the Canton Solothurn. This is paper No 1 of the Swiss Dino Project.

Christian A. Meyer: Naturmuseum Solothurn, Klosterplatz 2, CH-4500 Solothurn, Switzerland. Telephone: (0041) 65 22 70 21, Fax: (0041) 65 22 70 52.

Martin. G. Lockley: University of Colorado at Denver, Departement of Geology, Campus Box 172. P.O. Box 173364, Denver, Co 80217-3364, USA

REFERENCES

De Broin, F. de, S. Barta-Calmus, L. Beauvais, G. Camoin, J. Dejax, M. Gayet, J-G. Michard, Th. Olivaux, J. Roman, D. Sigogneau-Rusell, Ph. Taquet and S.Wenz, 1991. Paléobiogéographie de la Téthys: apports de la paléontologie à la localisation des rivages des aires émergées et des plates-formes au Jurassique et au Crétacé. Bullétin Société géologique de France t. 162: 13-26.

Buffetaut, E., 1988. Les restes de dinosauriens de l'Oxfordien supérieur de Damparis (Jura): preuves d'émersion sur place. Révue de Paléobiologie 7/2: 301-306.

Enay, R., 1980. Indice d'émersion et d'influences continentales dans l'Oxfordien supérieur - Kimméridgien inférieur en France. Interprétation paléogéographique et conséquences paléobiogéographiques. Bullétin Société géologique de France (7) 22/4, 581-590.

Gressly, A, 1838-41. Observations géologiques sur le Jura soleurois.- Neue Denkschriften schweizerische naturforschende Gesellschaft 2-5.

Greppin, J.B, 1870. Description geologique du Jura bernois et de quelques districts adjacentes - Matériaux Carte géologique de la Suisse 39/40.

Gygi, R.A., 1986. Eustatic sea level changes of the Oxfordian (Late Jurassic) and their effect documented in sediments and fossil assemblages of an epicontintal sea. Eclogae geologicae Helvetiae 79/2, 455-491.

Gygi, R.A., 1995. Datierung von Seichtwassersedimenten des späten Jura in der Nordwestschweiz mit Ammoniten. Eclogae geologicae Helvetiae. 88/1, 1-58.

Heer, O., 1877. Flora fossilis Helvetiae. Die vorweltliche Flora der Schweiz. Wurster edit., Zürich. 182 pp.

Hugi, F.J., 1825. Ueber die Vertheilung der Petrefakten in den Solothurner Steinbrüchen. Jahresbericht kantonale historische Gesellschaft Solothurn.

Huene, F. von., 1922. Ueber einen Sauropoden aus dem oberen Malm des Berner Jura. Eclogae geologicae Helvetiae 17/1, 80-94.

Huene, F. von., 1925. Die Saurierfauna des Portlandkalkes von Solothurn. Eclogae geologicae Helvetiae 19/3, 584-603.

Van Konijnenburg-van Cittert, J.J. & C.A. Meyer, 1996. Plant remains from the Late Oxfordian Vellerat Formation. Eclogae geologicae Helvetiae 89/3 (in press).

Lapparent, A. de, 1943. Les Dinosauriens jurassiques de Damparis (Jura). Mémoire Société géologique France (N.S.) 47, 1-21.

Lockley, M. G., A. P. Hunt and C.A. Meyer, 1994. Vertebrate Tracks and the Ichnofacies Concept: Implications for Paleoecology and Palichnostratigraphy. In: Donovan, S. (ed), The Palaeobiology of Trace fossils. Belhaven Press, London.

Meyer, C.A., 1990. Sauropod tracks from Upper Jurassic Reuchenette Formation (Kimmeridgian; Lommiswil, Kt. Solothurn). Eclogae geologicae Helvetiae 83/2, 389-397.

Meyer, C.A., 1993. A sauropod dinosaur Megatracksite from the Late Jurassic of Northern Switzerland. Ichnos vol. 3, 2-10.

Meyer, C.A., 1994a. Depositional environment and paleoecology of the Solothurn Turtle Limestone. Géobios Mémoire. Spéciale 16, 227 -236.

Meyer, C.A., 1994b. 145 Millionen Jahre vor unserer Zeit - Das Leben in einer tropischen Meereslagune. 80 pp. Vogt-Schild, Solothurn.

Meyer, C.A., 1995. A new sauropods printsite from the Upper Jurassic of Northern Switzerland ("Kimmeridgian"; Montbautier, Kt. Bern) by Ph. Mouchet - A reply. Révue de Paléobiologie 13/2, 427-428.

Meyer, C. A. and M. Hauser, 1994. Additional theropod and sauropod prints from the Upper Jurassic megatracksite of Northern Switzerland. In: Lockley, M.G., V.F. dos Santos, C.A. Meyer and A.P. Hunt (eds), Aspects of sauropod paleobiology. GAIA Special Vol. 10, 49-56.

Meyer, C.A. & Pittman, J.G., 1994. A comparison between the Brontopodus ichnofacies of Portugal, Switzerland and Texas. In: Lockley, M.G., V.F. dos Santos, C.A. Meyer and A.P. Hunt (eds), Aspects of sauropod paleobiology. GAIA Special Vol. 10, 125-134.

Mouchet, P., 1993. A new sauropods printsite from the Upper Jurassic of Northern Switzerland ("Kimmeridgian"; Montbautier, Kt. Bern). Révue de Paléobiologie Vol. 12/2, 345-349.

Mouchet, P., 1995. Le Kimmérdigien du Jura central - Microfaciès, Minéralogie et interprétation séquentielle. Unpublished Ph. D., Université de Neuchâtel, 204 pp.

Müller, M., 1995. Die Fischfauna der Solothurner Schildkrötenkalke. Unpublished Master Thesis, Universiy of Basel, 112 pp.

Oertli, H.J. & Ziegler, M., 1958. Présence d'un Séquanien lacustre dans la région de Pontarlier (Département du Doubs). Eclogae geologicae Helvetiae 51/2, 385-390.

Phillippe, M., 1995. Bois fossile du Jurassique de Franche-Comté (NE-France). Palaeontographica B, 236 (1-3), 45-103.

Pümpin, V.F., 1965. Riffsedimentologische Untersuchungen im Rauracien von St. Ursanne und Umgebung (Zentraler Schweizer Jura). Eclogae geologicae Helvetiae 58/2, 799-876.

Reichel, M., 1928. Conifère fossile trouvé dans les Couches à ciment (Argovien) de Saint-Sulpice. Bulletin Société neuchâteloise Sciences Naturelles N.S. 1/52, 125-136.