Studi Trent. Sci. Nat., *Acta Geol.*, 83 (2008): 253-257 ISSN 0392-0534

First record of the fish trace fossil *Undichna* from the Middle Triassic of Italy

Rossana TODESCO[1,2] & Marco AVANZINI[2*]

[1]Dipartimento di Scienze della Terra, Università di Modena, Via S. Eufemia, 41100 Modena, Italy
[2]Museo Tridentino di Scienze Naturali, Via Calepina 14, 38100 Trento, Italy
[*]Corresponding author e-mail: *avanzini@mtsn.tn.it*

SUMMARY - *First record of the fish trace fossil* Undichna *from the Middle Triassic of Italy* - The ichnogenus *Undichna* is reported for the first time from the Anisian "Voltago Conglomerate" of Northern Italy. It consists of three unpaired intertwined waves and is attributed to *Undichna gosiutensis* Gibert 2001. The ichnogenus *Undichna* was interpreted as impressions of fish fins when swimming close to bottom surface. The Italian *Undichna* is referred to a transitional fluvial to marine environment.

RIASSUNTO - *Prima segnalazione della traccia fossile* Undichna *nel Triassico medio italiano* - L'icnogenere *Undichna* è segnalato per la prima volta nel Conglomerato di Voltago (Anisico) affiorante in Italia settentrionale. L'esemplare descritto è costituito da tre solchi sinusoidali fuori fase ed è attribuito a *Undichna gosiutensis* De Gibert 2001. L'icnogenere *Undichna* è tradizionalmente interpretato come la traccia lasciata dalle pinne di un pesce durante il movimento prossimo al fondale. L'esemplare in oggetto è riferito ad un ambiente di transizione tra il fluviale e il marino marginale.

Key words: Anisian, ichnology, *Undichna*, fish trace, Northern Italy
Parole chiave: Anisico, icnologia, *Undichna*, traccia di pesce, Italia settentrionale

1. INTRODUCTION

The fish trace fossil *Undichna* includes several ichnospecies consisting in one to several sinusoidal grooves that were left by the body of the tracemaker during swim (Seilacher 2007). After the first description by Anderson (1976) on the basis of material form the Lower Permian of South Africa, the ichnogenus *Undichna* has been recorded from Palaeozoic strata in several regions of the world (Higgs 1988) with nine well known ichnospecies (*U. simplicitas* Anderson 1976, *U. bina* Anderson 1976, *U. insolentia* Anderson 1976, *U. britannica* Higgs 1988, *U. consulca* Higgs 1988, *U. radicensis* Turek 1989; *U. quina* Trewin 2000, *U. trisulcata* Morrissey *et al.* 2004; *U. septemsulcata* Wisshak *et al.* 2004). For long time, the ichnogenus was considered restricted to Paleozoic assemblages and mainly related to lacustrine-continental settings. The first fully described record of *Undichna* in post-Paleozoic strata was reported by Gibert *et al.* 1999 for the Cretaceous of Spain (*U. unisulca* Gibert *et al.* 1999 and *U. britannica*). Melchor & Cardonatto (1998) reported two additional Mesozoic occurrences of *Undichna* in the Triassic and Cretaceous of Argentina, the second one being the first record in clearly marine sediments. A total of five additional ichnospecies have now been formally named for the Mesozoic (*U. tricosta* Lu & Chen 1998; *U. unisulca* Gibert *et al.* 1999; *U. gosiutensis* Gibert 2001; *U. prava* Lu *et al.* 2004; *U. westerbergensis* Schweigert 2001), but many more are known (Morrissey et al. 2004; Minter & Braddy 2006).

In Triassic sediments *Undichna* is rarely observed. Lu & Chen (1998), Melchor and Cardonatto (1998) and Lu *et al.* (2004) described some specimens from the Upper Triassic of China and Argentina, while only one unnamed trail is described from the Middle Triassic Muschelkalk of Germany (Diedrich 2000).

In a recent work, Minter & Braddy (2006) suggested that some of the *Undichna* ichnospecies could represent a subset of the morphology of others *Undichna*. This is due to the fact that many ichnotaxa are probably minor behavioural or preservational variants of others. For this reason they proposed an ichnotaxonomic revision to reduce the number of *Undichna* ichnospecies from 14 (excluded *U. westerbegensis* Schweigert 2001) to 9.

2. GEOLOGICAL SETTING

The fish trail was found in the Anisian Voltago Conglomerate cropping out at Bad Gfrill near Tisens (Bozen), along the Adige Valley in the Southern Alps (Fig. 1). Here, the formation is about 130 m thick and is composed by dark red sandstone and siltstone with conglomerate beds and silty-limestone with interbedded evaporitic dolomites . The Voltago Conglomerate is Pelsonian in age (Avanzini & Tomasoni 2004).

The described fossil traces occur in an alternation of red fine-sandstones with ripple marks and thinly mud cracked parallel laminated siltstones. On the same surfaces a

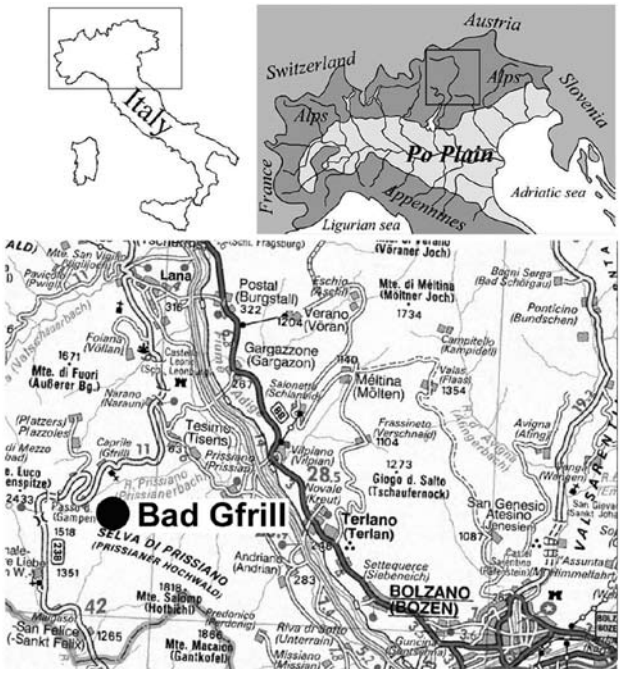

Fig. 1 - Locality map showing the Bad Gfrill tracksite
Fig. 1 - Localizzazione dell'icnosito di Bad Gfrill.

rich ichnofauna consisting of *Rhynchosauroides*, *Chirotherium*, *Rotodactylus* and *Procolophonichnium* footprints were found. The palaeoenvironment is referable to a transition from fluvial to marine environment, with periodical emersion of delta sand bars and tidal mudflats (Avanzini & Tomasoni 2004) (Fig. 2).

3. SYSTEMATIC ICHNOLOGY

Ichnogenus UNDICHNA Anderson 1976
Undichna gosiutensis Gibert 2001

3.1. Material

Three fragments of the same slabs of fine-sandstone. Two of them represent the convex and concave hyporelief of the same trail. Those are stored at Museo Tridentino Scienze Naturali, Trento (catalogue marks BG E 126 – 18; BG E 126 – 19a; BG E 126 – 19b; Fig. 3).

3.2. Description

Set of three unpaired, intertwined, sinusoidal waves. Two of them have small difference of phase and amplitude, while the third has a larger amplitude and a greater difference of phase than the other two. The preserved trail shows two interruptions.

The waves are marked by A, B and C respecting their temporal order of imprint: B cuts A and C cuts B. Waves A and B have similar wave length (λ = 90 mm). The difference of phase between A and B is less than 9 mm. The amplitudes are about 7 mm (A) and 11 mm (B). C has a wave-length of 120 mm and the difference of phase between the first two and C is about 17 mm. The amplitude of C is about 30 mm. The total trail length is 210 mm.

Short additional trails (D and E) might be related to the three main waves, but they are not so clear to be analyzed.

The slabs surface shows some sedimentary structures like some small tools transversally oriented and cut by the fish trail. On the same surface digits and scratch marks of the reptilian ichnogenus *Rhynchosauroides* are impressed.

3.3. Discussion

All the observed features are coherent to the morphology of *Undichna gosiutensis* Gibert 2001.

Minter & Braddy (2006) suggested that *U. gosiutensis* was not a valid ichnospecies as it was described based on a single specimen. They thought it might represent a partial preservation of *U. quina* Trewin, 2000. *U. quina* consists of two pairs of outer, parallel, intertwined waves of similar wavelength, and an inner, unpaired wave of greater amplitude. Each pairs are in-phase and one side of this trail is strictly similar to *U. gosiutensis*.

In the described specimen no irregularity or change of trail parameters are recognisable. The geometry of the stratification shows that the original seabed was perfectly horizontal and that the fish swam on plane bottom surface. So the hypothesis that the trace could represent only a side of a more complex trail (i.e. one side of *U. quina*) seems improbable.

3.4. Tracemaker

When fishes swim close to the soft sediment leave trails that depend on relation between the position of its body parts (especially fins) and the forward movement.

The paired fins (pectoral and pelvic) are symmetrically located on either side of the longitudinal axis, so they will leave two parallel waved trails, as in *U. bina* Anderson 1976. On the other side, unpaired fins produce unpaired waves that are out of phase and have different amplitude. The caudal fin that is positioned behind will produce a wave trail that cuts through other waves and of a greater amplitude than others.

The Italian *Undichna gosiutensis* is composed of three unpaired cross-cutting and out-of-phase waves that were probably left by three different unpaired elements: wave C by caudal fin and waves A and B probably by two anal fins or a bilobate anal fin (Gibert 2001).

To calculate the fish size is not so easy. Different equations have been proposed by several authors (Bainbridge 1958; Videler 1993; Wardle *et al*. 1995) that correlate the fish length with the amplitude and wavelength of the caudal fin and that also depend on some parameters as for example swimming speed. According to this equations the estimated trackmaker length of the Italian *U. gosiutensis* is approximately comprised between 120 mm to 190 mm.

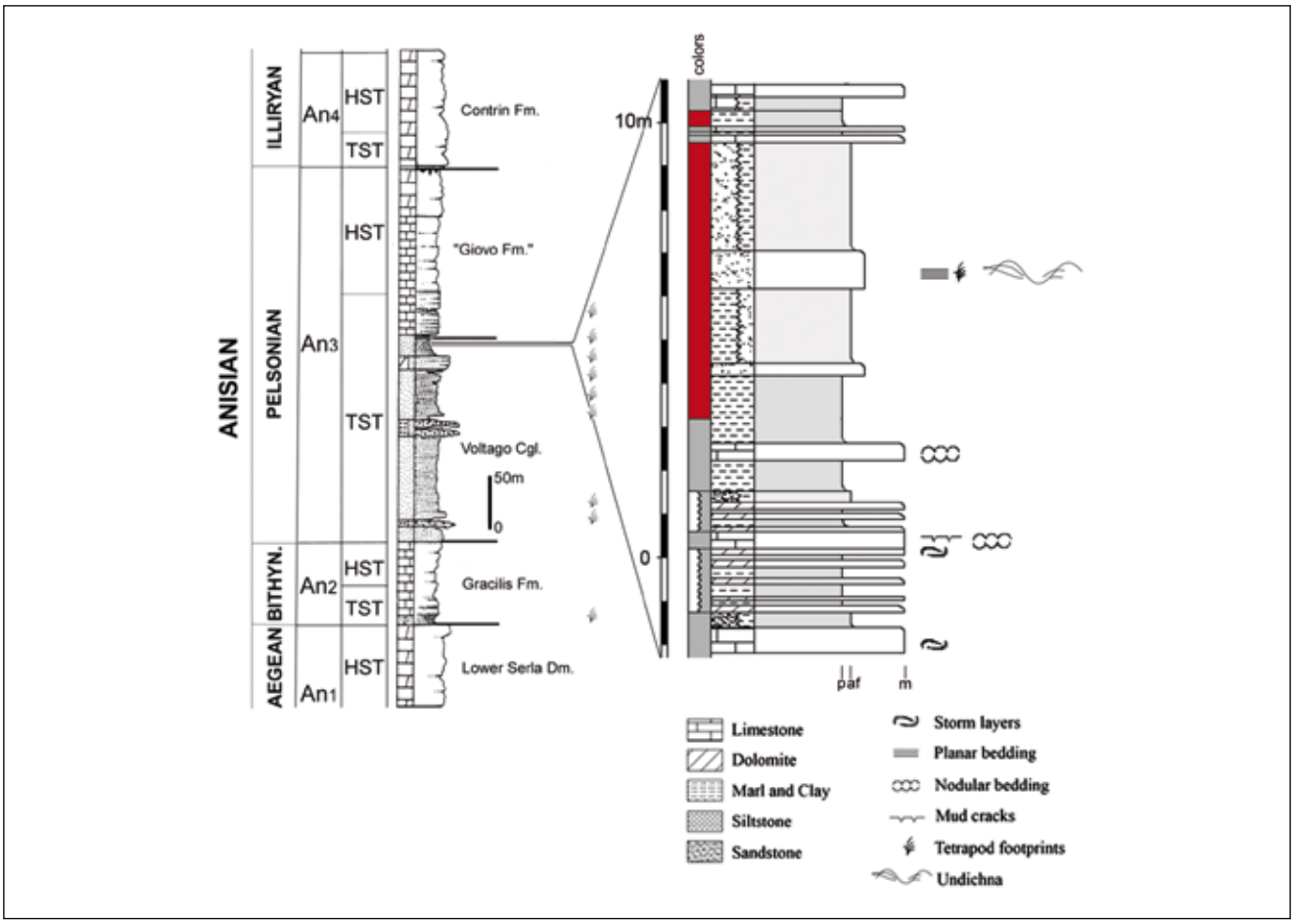

Fig. 2 - Lithostratigrafic scheme of the Anisian sedimentary succession of Bad Gfrill with the position of the *Undichna* -bearing layer. (m:mudstone, p: siltstone, af: fine sandstone).

Fig. 2 - Schema litostratigrafico della successione sedimentaria anisica di Bad Gfrill con la posizione del livello con Undichna *(m= mudstone, p= siltiti, af= arenare fini).*

In the Pelsonian basinal Dont Formation of Dolomites a fish fauna (Tintori *et al.* 2001) has been recently found and it was composed of marine fishes such as coelacaths, *Saurichthys*, *Bobasatrania*, *Peltopleurus* and fresh water or brackish water dwellers such as *Dipteronotus* and "*Gyrolepis*". None of these taxa show morphological elements coherent with the trace (Tintori pers. comm.), therefore the trackmaker is still unknown.

4. TAPHONOMY AND PALEOENVIRONMENT

The fish fossils trails more often occur in sediments referred to fresh-water or brackish marine environments. The distribution and the preservation of these delicate structures were a consequence of many taphonomical constrains (Buatois & Mangano 1994; Gibert *et al.* 1999; Simon *et al.* 2003): 1) absence or scarcity of infaunal burrowers; 2) very finedgrained sediment; 3) low-energy conditions; 4) relatively rapid burial without erosion.

The here described deposits that preserved *Undichnia* trail were formed in an intertidal mudflats with periodical expansion of the body of water due to fluvial floods as suggested by the sedimentological features. The finding in the same layer of fish swimming trails and walking tetrapod footprints is indicative of a surface that has been submerged and then exposed, which seems to be consistent with present inorganic structures. During submersion the depth of water was probably very small, which could have forced the fish to swim touching the bottom and consequently favouring the formation of the trace. Some of the occurrences of *Undichna* in flood plain deposits may have a similar explanation, with a rapid burial as the main factor of preservation (Soler-Gijon & Moratalla 2001; Gibert *et al.* 2000).

5. CONCLUSIONS

The Italian *Undichna gosiutensis* is the first reported Mesozoic occurrence of the fish trace fossil Undichna in Italy and one of the rare in Middle Triassic deposits.

The presence of *Undichna* in a tetrapod ichnoassocia-

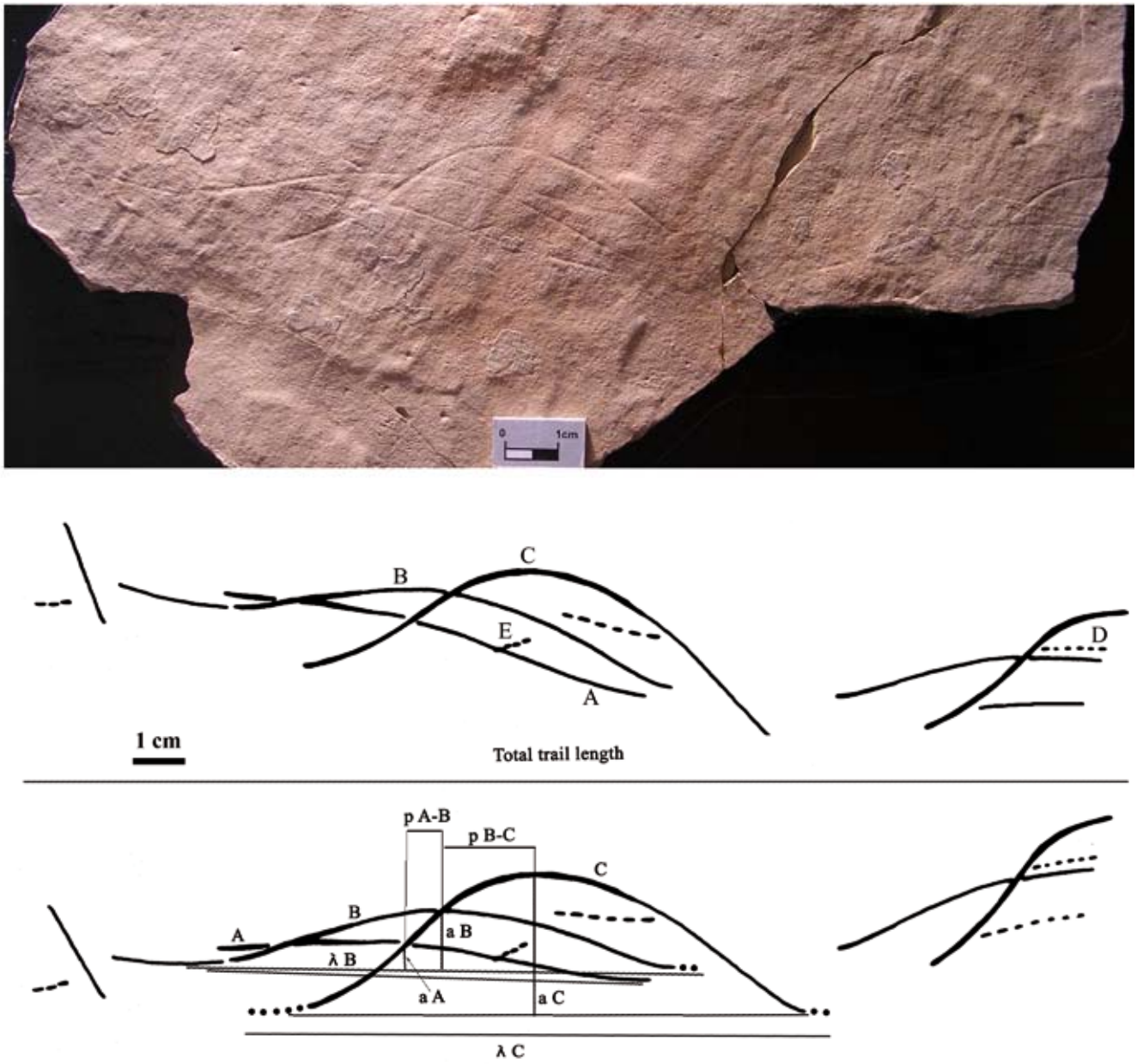

Fig. 3 - *Undichna* specimen BG E 126-9 constituted by a set of three unpaired, intertwined, sinusoidal waves with difference of phase and amplitude.
Fig. 3 - L'esemplare di Undichna *BG E 126-9 è costituito da tre solchi sinusoidali intersecati con differenza di fase ed ampiezza.*

tion enriches its faunal variety and increases its use to paleoenvironment reconstructions.

ACKNOWLEDGEMENTS

We wish to sincerely thank Jordi de Gibert and Max Wisshak for their valuable comments. We thank also the Geological Survey of Bolzano Province for their support. Field survey, carried out with the cooperation of P. Ferretti and R. Tomasoni, was granted by Museo Tridentino di Scienze Naturali (Trento).

REFERENCES

Avanzini M. & Tomasoni R., 2004 - Middle Anisian stratigraphy in the central Southern Alps (Adige Valley, Trentino, Italy). In: Ryan W.B. & Malinverno A. (eds), *The Mediterranean Tethys and the development of the new concepts of top-down tectonics.* 32 Int. Geol. Congr. Florence-Italy, August 20-28, 2004

Anderson A., 1976 - Fish trail from the Early Permian of South Africa. *Palaeontology*, 19, 397- 409.

Bainbridge R., 1958 - The speed of swimming of fish as related to size and to the frequency and amplitude of the tail beat. *Journal of Experimental Biology*, 35: 109-133;

Buatois L.A. & Mangano M.G., 1994 - Pistas de peces en el Car-

bonifero de la Cuenca Paganzo (Argentina): su significado estratigrafico y paleoambiental. *Ameghiniana*, 31, 33-40

Diedrich C., 2000 - New vertebrate tracks from the Lower Muschelkalk (Middle Triassic) of the Osnabrueck Hills and Teutoburg Forest (NW-Germany) and their stratigraphic and palaeogeographic significance in the Germanic Basin. *Neues J. für Geol. und Pal., Abh.*, 217: 369-395.

Gibert J.M. de, 2001 - *Undichna gosiutensis*, isp. nov.: A new fish trace fossil from the Jurassic of Utah. *Ichnos*, 8: 15-22.

Gibert J.M. de, Buatois L.A., Fregenal-Martinez M.A., Mangano M.G., Ortega F., Poyato-ariza F.J. & Wenz S., 1999 - The fish trace fossil *Undichna* from the Cretaceous of Spain, *Paleontology*, 42: 409-427.

Gibert J.M. de, Fregenal-Martínez M.A., Buatois L.A. & Mángano M.G., 2000 - Trace fossils and their palaeocological significance in Lower Cretaceous lacustrine conservation deposits, El Montesec, Spain. *Palaeogeogr., Palaeoclimatol., Palaeoecol*., 156: 89-101.

Higgs R., 1988 - Fish trail in the Upper Carboniferous of South-West England. *Palaeontology*, 31: 255- 272.

Lu Z. & Chen B., 1998 - Discovery of Late Triassic fish trails (*Undichna*) in Hengshan Country, Shaaxi, China. *Acta Palaeont. Sinica*, 37: 76-84.

Lu Z., Hou J., Chen B., Hao C. & Li X. 2004 - Genetic interpretation of fish swimming trails and calculation of fish body length in the Late Triassic Hengsham, Shaanxi Provincie, China. *Science in China*, Series D, Earth Sciences, 47: 272-279.

Melchor R.N. & Cardonatto M.C., 1998 - Pistas de peces (Undichna): rango estratigrafico, paleoambientes y mecanismos de propulsion del productor. Tercera Reunión Argentina de Ichnología, Primiera Reunión de Ichnología del Mercosur: 20-21.

Minter N.J. & Braddy S.J., 2006 - The fish and amphibian swimming traces *Undichna* and *Lunichnium*, with examples from the Lower Permian of New Mexico, USA. *Palaeontology*, 49: 1123-1142.

Morrissey L.B., Braddy S.J., Bennett J.P., Marriott S.B. & Tarrant P.R., 2004 - Fish trails from the Lower Old Red Sandstone of Tredomen Quarry, Powys, southeast Wales. *Geol. Journal*, 39: 337-358.

Schweigert G., 2001 - Eine Schwimmspur aus dem Nusplinger Plattenkalk (Oberjura, SW Deutschland). *Neues J. für Geol. und Pal., Monatshefte*: 77-84.

Seilacher A., 2007 - *Trace fossil analysis*. Springer Berlin Heidelberg: 1-19.

Simon T., Hagdorn H., Hagdorn M.K. & Seilacher A., 2003 - Swimming trace of Coelacanth fish from the Lower Keuper of South-West Germany. *Palaeontology*, 46: 911-926.

Soler-Gijon R & Moratalla J.J., 2001 - Fish and tetrapod trace fossils from the Upper Carboniferous of Puertollano, Spain. *Palaeogeogr., Palaeoclimatol., Palaeoecol*., 171: 1-28.

Tintori A., Posenato R., Kustatscher E. & Wachtler M., 2001 - New Triassic fish faunas from paralic environments in the Alps. 3rd International Meeting on Mesozoic Fishes, Serpiano (CH), 26-31 august 2001.

Trewin N.H., 2000 - The ichnogenus *Undichna*, with examples from the Permian of the Falkland Island. *Palaeontology*, 43: 979-997.

Turek V., 1989 - Fish and amphibian trace fossil from Westphalian sediments of Bohemia. *Palaeontology*, 32: 623-643.

Videler J.J., 1993 - Fish swimming. Chapman & Hall, London: 260 pp.

Wardle C.S., Videler J.J. & Altringham J.D. 1995 - Tuning in to fish swimming waves: body form, swimming mode and muscle function. *Journal of Experimental Biology*, 198: 1629-1636.

Wisshak M., Volohonsky E. & Blomeier D. 2004 - Acanthodian fish trace fossils from the Early Devonian of Spitsbergen. *Acta Palaeont. Polonica*, 49: 629-634.