

## First report on a new late Anisian (Illyrian) vertebrate tracksite from the Dolomites (Northern Italy)

Rossana TODESCO<sup>1,2\*</sup>, Michael WACHTLER<sup>3</sup>, Elio DELLANTONIO<sup>4</sup> & Marco AVANZINI<sup>2</sup>

<sup>1</sup>Dipartimento di Scienze della Terra, Università di Modena, l.go S.Eufemia, 41100 Modena, Italy

<sup>2</sup>Museo Tridentino di Scienze Naturali, Via Calepina 14, 38100 Trento, Italy

<sup>3</sup>Rainerstr. 11, 39038 Innichen (BZ), Italy

<sup>4</sup>Museo di Geologia di Predazzo, Piazza SS. Filippo e Giacomo, Predazzo (TN), Italy

\*Corresponding author e-mail: rossanatod@email.it

---

**SUMMARY** - *First report on a new late Anisian (Illyrian) vertebrate tracksite from the Dolomites (Northern Italy)* - A new Middle Triassic ichnosite from the central Dolomites is described. The tracks occur in mixed carbonate siliciclastic basal levels of the Illyrian Calcare di Morbiac Fm. The tracks represent a typical Anisian Alpine ichnoassociation in which have been identified *Rhynchosauroides tirolicus*, *Chirotherium barthii*, *Isochirotherium delicatum*, *Brachychirotherium* isp.

**RIASSUNTO** - *Un nuovo icnosito a vertebrati dell'Anisico superiore (Illirico) delle Dolomiti (Italia settentrionale)* - Viene descritto un nuovo icnosito identificato nelle Dolomiti Centrali. Le tracce fossili sono conservate all'interno di alcuni livelli silicoclastici alla base del Calcare di Morbiac (Illirico). Le tracce corrispondono ad una tipica icnoassociazione dell'Anisico delle Alpi nella quale sono stati riconosciuti *Rhynchosauroides tirolicus*, *Chirotherium barthii*, *Isochirotherium delicatum*, *Brachychirotherium* isp.

*Key words:* Illyrian, Dolomites, ichnosite, *Rhynchosauroides*, *Chirotheriidae*

*Parole chiave:* Illirico, Dolomiti, icnosito, *Rhynchosauroides*, *Chirotheriidae*

---

### 1. INTRODUCTION

In the Southern Italian Alps, Early and Middle Triassic tetrapod footprints are known since the first decade of the '900 (Abel 1926), but extensive researches were led only in the last 30 years with the discovery of vertebrate tracks at many sites of the Dolomite region and surrounding areas of Northern Italy (Avanzini *et al.* 2001). The main ichnoassociations are preserved in terrigenous and carbonate sediments of Anisian age, deposited in marine marginal environments. They consist of complex Lepidosauria - Archosauria associations. In the Southern Alps, continental layers rich of vertebrate traces are interbedded with marine and volcanic levels, both datable; this mixed succession has allowed the dating and the correlation of the levels containing ichnoassociations (Avanzini *et al.* 2001).

The tetrapod ichnofauna of the Southern Alps are important for paleoenvironmental and paleogeographic reconstructions and for paleobiological considerations as well.

### 2. GEOLOGICAL SETTING

The new ichnosite occurs in the Calcare di Morbiac Formation (Illyrian) (Delfrati & Farabegoli 2000) in Val Duron near Campitello (Fassa Valley, Trento) (Fig. 1). Here, the

formation prevalently consists of decimetric-thick grey silty and silty-limestone layers becoming towards the top wackstones and packstones with foraminifers and ostracods (Fig. 2). Several stromatolite bindstones and thin grey or green siltstones layers are present. Plant debris is common.

In the lower portion of the unit, three main layers of laminated silty-limestones are trampled by vertebrates. In the lowermost and uppermost layers small tracks, mainly pertaining to lizard-like reptiles are largely represented, whereas larger reptile footprints are found in the middle layer.

For all the three layers, the depositional environment is referable to a marine marginal setting as a terrigenous tidal flat.

### 3. SYSTEMATIC ICHNOLOGY

Twelve silty-limestone slabs with one or more preserved footprints were recovered from the studied section. Most of the tracks belong to the ichnogenus *Rhynchosauroides*, the remaining pertain to probable chirotheriids. The slabs are currently stored at the Museo Tridentino di Scienze Naturali, Trento and at the Museo di Geologia di Predazzo (provisory catalogue marks progressive number from VD1 to VD12).



Fig. 1 - Location of the Val Duron ichnosite.  
Fig. 1 - Localizzazione del sito della Val Duron.

Ichnogenus *Rhynchosauroides* Maidwell 1911

*Rhynchosauroides tirolicus* Abel 1926

*Material*

Many footprints on 4 slabs; not all well preserved. Slab VD12 shows the best manus-pes set. Referred material VD 8, VD 9, VD 11, VD 12.

*Description*

*Manus*. Pentadactyl, semiplantigrade and asymmetric. Digit IV is the longest but III is nearly as long as it. Digit V is placed behind digit IV and rotated outward with respect to the digits I-IV.

*Pes*. Similar to the *manus*, but rather larger and digi-tigrade. Length varies between 30 to 50 mm. Digits II, III and IV are the better impressed. Digit V is never impressed. The angle of divergence between digits I-IV varies from 21° to 70°.

*Manus-pes* set. Pedal print overlaps the manual print. Pes rotation is of 16° with respect to the manus. Manus-pes distance is about 41 mm.

*Discussion*

The form here described belongs to a medium-sized lizard-like trackmaker, and correspond to the well known ichnospecies *Rhynchosauroides tirolicus* Abel 1926, the most common track of the Anisian of Southern Alps (Abel 1926; Brandner 1973; Avanzini 1999; Avanzini & Renesto 2002).

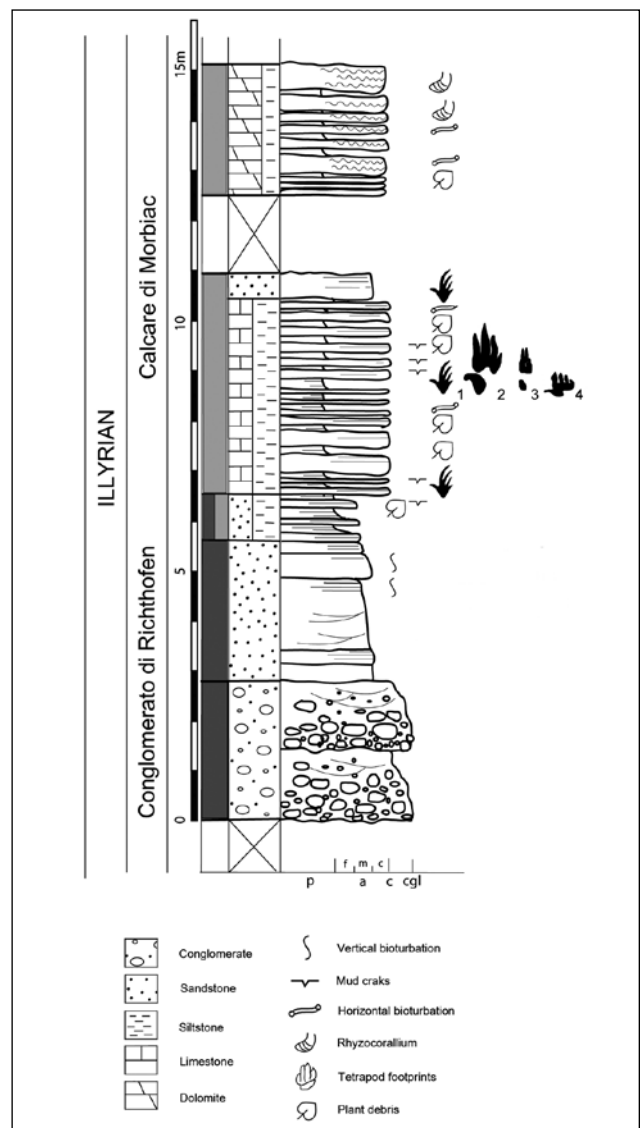


Fig. 2 - Simplified stratigraphical scheme of the trampled layers. 1. *Rhynchosauroides*; 2. *Chirotherium barthii*; 3. *Isochirotherium delicatum*; 4. *Brachychirotherium* isp.

Fig. 2 - Schema stratigrafico dei livelli con orme. 1. *Rhynchosauroides*; 2. *Chirotherium barthii*; 3. *Isochirotherium delicatum*; 4. *Brachychirotherium* isp.

*Rhynchosauroides* isp

*Material*

The best specimen is shown in slab VD 10 (Fig. 3) with manus-pes set. Other are poorly preserved. Referred material VD 8, VD 9, VD 10, VD 11.

*Description*

*Manus*. Pentadactyl, semiplantigrade and asymmetric, smaller than the pes. Digit lengths increase from I to IV. Digit V is placed in a rear position, and rotated outwards with re-



Fig. 3 - Footprints of Val Duron ichnosite. *Rhynchosauroides* isp. VD 10 manus-pes set, hyporelief, scale bar= 20 mm.  
 Fig. 3 - Orme della Val Duron. *Rhynchosauroides* isp. VD 10 manus-pes, iporilievo, scala = 20 mm.

spect to the digit IV (IV-V=46°). The digits are nearly straight. The manus is 36 mm long and the 16 mm wide. The low angle value I-IV (between 9° and 15°) denotes a narrow shape.

*Pes.* It is almost always represented by the distal ends of the digits I, II, III, IV only.

*Discussion*

The general pattern of characters exhibited by these footprints is comparable to that of the ichnogenus *Rhynchosauroides* Maidwell 1911.

The most similar ichnotaxa to these are *R. tirolicus* Abel 1926. The manus of *R. tirolicus* displays some differences allowing for excluding the described specimen from it, namely, less length-width ratio (about 1,3), more spread digits I-IV (21° to 70°), digits III and IV of the same length; digits I and V outwardly aligned.

An intraspecific (i.e. sexual dimorphism) or a preservational variant of *R. tirolicus* seems very probable.

*Ichnogenus Chirotherium* Kaup 1835

*Chirotherium barthii* Kaup 1835

*Material*

A manus-pes set on slab VD 7, fairly well preserved (Fig. 4).

*Description*

*Manus.* Digits I-IV are well impressed digit V slightly impressed. The manus is 112 mm long and 97 mm wide. Digit I is the shortest (32 mm), digits II and III are nearly equal 42-44 mm. Digits I-IV angulation is of 72°.

*Pes.* Much more complete and clearly impressed than the manus. Size: length 230 mm, width 196 mm. The length

to width ratio is about 1.18 and indicates an enlarged print. Digits about 43 mm wide. Digit III is the longest (110 mm), I, II and IV are rather equal (90, 92, 86 mm). Digit V is placed behind digits I-IV. It displays a large sub-ovoidal impression of the metatarsal pad; 54 mm in width, and an elongate impression of the distal portion of the digit, rotated outwards and relatively perpendicular to the digit-axis. Its total length is 120 mm, and it is rotated of 16° with respect to digit IV. Divergence between digits I-IV is 72°. Cross axis is 84°. Claws are well impressed and are about 15 mm in length.

*Manus-pes set.* The manus-pes distance is 204 mm. The manus is placed in front of the pes, and rotated 5° with respect to it.

*Discussion*

These footprints based on their general morphology: for instance the longest digit III and divergence of digit V are referable to the ichnogenus *Chirotherium* Kaup 1835. The *Chirotheriidae* are well known in Lower-Middle Triassic layers all over Europe, featuring numerous ichnospecies. The most representative ichnotaxon is *C. barthii* Kaup 1835 (Haubold 1971a, 1971b, 1984; Demathieu 1970; Gand 1978) which shows similarities with the described specimen.

The specimen here described has to be compared with other *C. barthii* from Pelsonian strata of the Southern Alps in which two complex ichnofaunae were found (Valdiserri & Avanzini 2007; Todesco 2007).

*Ichnogenus Isochirotherium* Haubold 1971

*Isochirotherium delicatum* Courel & Demathieu 1976

*Material*

Four prints in two slabs: VD 1 two footprints that overlapping each others (Fig. 5), and VD 2 manu-pes set.

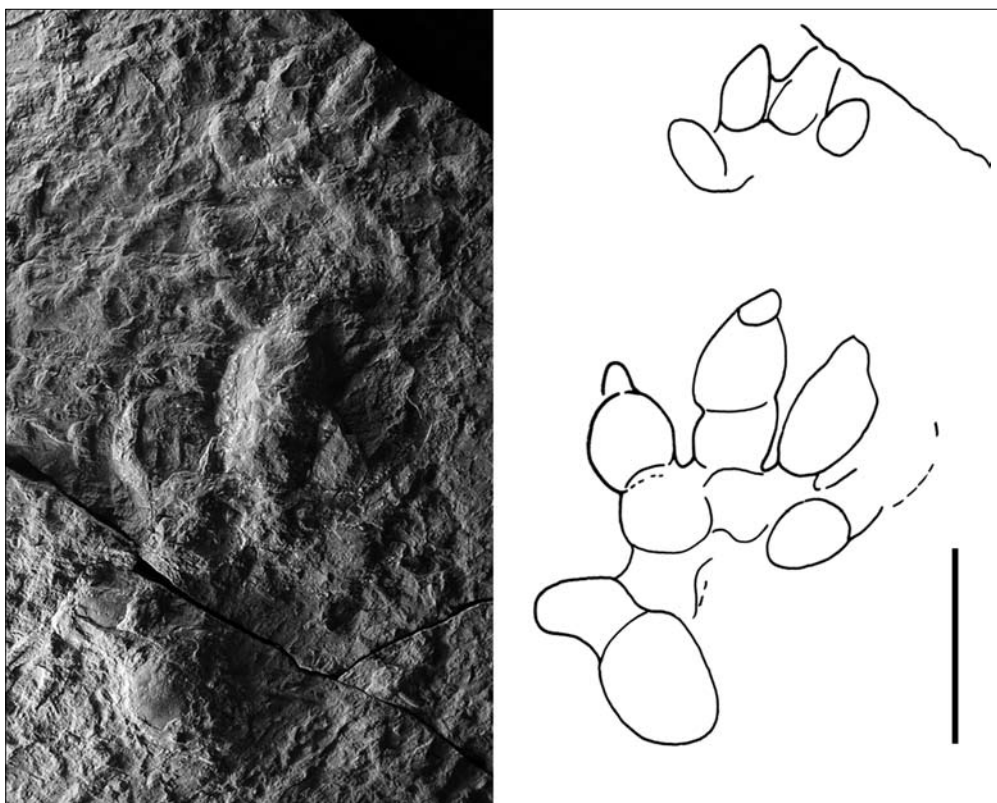


Fig. 4 - *Chirotherium barthii* VD 7 manus-pes set, hyporelief, scale bar= 100mm.  
 Fig. 4 - *Chirotherium barthii* VD 7 manus-pes set, iporilievo, scala= 100mm.

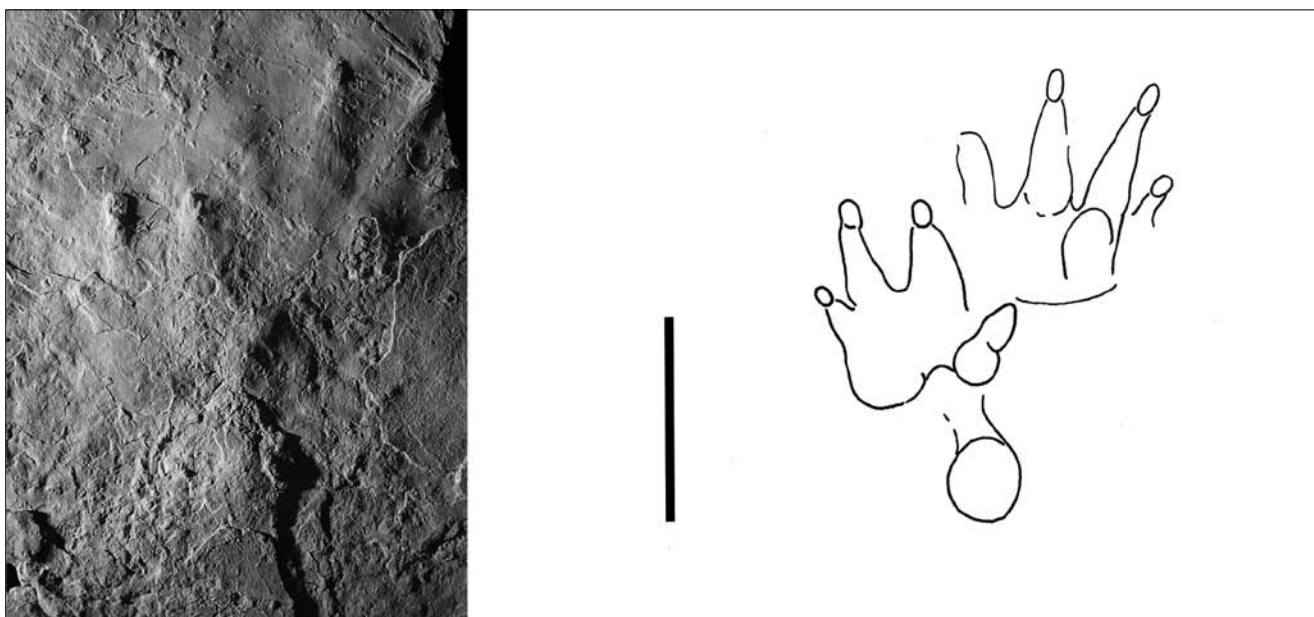


Fig. 5 - *Isochirotherium delicatum* VD 1 the two pedal prints with stout shape, hyporelief, scale bar= 50 mm.  
 Fig. 5 - *Isochirotherium delicatum* VD 1 due orme appartenenti al morfotipo robusto, iporilievo, scala= 50 mm.

*Description*

*Manus.* L= 22 mm (about 1/4 of the pes print length), of a sub-circular shape with digit prints lightly evidenced.

*Pes.* Digit I thin and lightly impressed. Digits II and III are nearly equal, IV is the shortest and separated from the digits I-III. Digit V is placed behind IV and is commonly represented by the sub-circular metatarsal pad imprints.

Digits I-III are subparallel. The length varies from 86-92 mm, the width from 51 to 47 mm.

Two pes preserved on slab VD1 exhibit a more robust morphology (L/W= 1.7) compared to the more slender pes on slab VD 2 (L/W= 1,95). They also differ in the angulation between digits III-IV (41° in VD 1 and 17° in VD 2) and in

the digit V shape, which is sub-circular in VD 1 and in VD 2 it show a long metatarsal pad with the digit distal end rotated outwards.

Manus-pes set. One set on VD 2. The manus-pes distance is about 75 mm (measured from each central prints projecting the segment on pes axis). The manus is placed in front of the pes and more internally with respect to the midline.

*Discussion*

Characters displayed by these traces, namely the length ratio of digits II and III, the digit IV separated from groups I-III, the metatarsal pad shape and position of digit V, the light impression of digit I, and the much smaller manus, belong to ichnospecies *Isochirotherium delicatum* Courel & Demathieu 1976.

The specimens studied in this paper correspond to the greatest specimens of *I. delicatum* found in Pelsonian strata of Voltago Conglomerate Fm. at Gampenpass (Bozen) and described by Avanzini & Lockley (2002).

*Isochirotherium delicatum* is a characteristic ichnospecies of the French Central Massif, identified by Courel & Demathieu 1976 at the Anisian-Ladinian boundary in the area of Largentière (Ardèche, France). It is reported here for the first time from Illyrian strata of the Southern Alps.

Ichnogenus *Brachychirotherium* Beurlen 1950

*Brachychirotherium* isp.

*Material*

A manus-pes set on slab VD 6. It is slightly impressed and shows well preserved skin impressions on all digits and on the metatarsal pad of pes digit V (Fig. 6).

*Description*

*Manus.* It is smaller than the pes (M:P=1:2,2) and exhibit rounded digits splayed like a fan and rotated outwards. Digit V is placed behind IV and nearly parallel to it.

*Pes.* It is about 112 mm in length and 89 in width. Digit I is the shortest and is placed behind the digits group II-IV. The longest digit is III, 39 mm, but it is quite equal with IV, that is 35 mm long. Digits group I-IV are well impressed (especially II and III), while the V is represented only by a small (27 x 18 mm) elliptic metatarsal pad, placed behind along the IV digit axis, with angulation of 70° to IV. A relatively large gap (about 5-7 mm) separates digits II from III. Digits are short and blunt with robust, rounded pads.

Digits I-IV are sub-parallel, angulation I-IV= 11° and digit group I-IV is slightly wider than longer (L/W= 0,98). Cross-axis is about 65°.

*Set.* Manus-pes distance is about 86 mm (measured from the base of the manus and pes digit III). The manus is placed in front of the pes and more internally with respect to the trackway axis.

Skin impression are recognizable on pedal and manual prints with small rounded scales of different size on different areas of the tracks.

*Discussion*

The stout shape and rounded digits moderately spread are typical features of the ichnogenus *Brachychirotherium* (Beurlen 1950). *Brachychirotherium* is widely distributed in Middle Triassic deposits of Central Europe with several ichnospecies.

The specimen described here is compared with some material of the *B. parvum* (Hitchcock 1889) "group". The features of the studied specimen suggests attribution to *B. aff.*

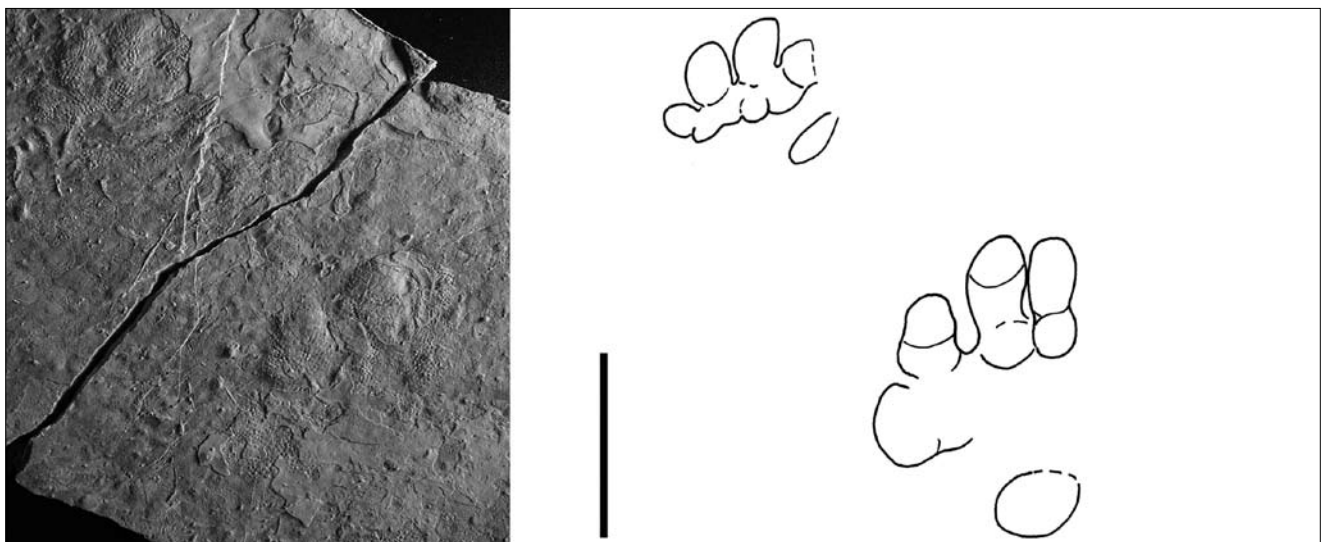


Fig. 6 - *Brachychirotherium* isp. VD 6 manus-pes set, hyporelief, scale bar= 50mm.  
 Fig. 6 - *Brachychirotherium* isp. VD 6 manus-pes, iporilievo, scala= 50mm.

*parvum* Brandner 1973 from the Illyrian strata of Braies Dolomites, and to *B. paraparvum* Demathieu & Oosterink 1983 from Upper Bithynian (Demathieu & Oosterink 1988) strata of Winterswijk (East Netherlands).

The former, *B. aff. parvum*, is nearly equal in size but more slender (L/W group I-IV = 1.2) and exhibits the same manus-pes ratio (M:P= 1:2.2). Digit III is the longest, 65 mm, digits II and IV are equal in length, 55 mm. Divergence I-IV is 20°. *B. paraparvum* is greater in size (L pes= 120 mm), but with the same digits I-IV L/W ratio (0.98). Digits III and IV are the longest and quite equal.

#### 4. CONCLUSIONS

- The trampled layers are referable to a carbonate tidal flat influenced by continental sedimentation, of Illyrian age (Delfrati & Farabegoli 2000).
- *I. delicatum* is here reported for the first time in the late Anisian of the Southern Alps.
- The ichnoassociation described here represents a typical Anisian ichnofauna of the Southern Alps composed prevalently by *Rhynchosauroides* and by chirotheriid tracks.

#### ACKNOWLEDGEMENTS

We wish to sincerely thank Maria Alessandra Conti (Università di Roma "La Sapienza") and Cajus Diedrich (Universität Osnabrück) who provided helpful comments. Field survey was supported by Museo Tridentino di Scienze Naturali (Trento).

#### REFERENCES

- Abel O., 1926 - Der erste Fund einer Tetrapodenfährte in den unteren alpinen Trias. *Palaeontol. Zeitschr.*, 7: 22-24.
- Avanzini M., 1999 - New Anisian vertebrate tracks from the Southern Alps (Val d'Adige and Valle di Non - Italy). *Riv. Mus. Civ. Sci. Nat. "E. Caffi" Bergamo*, 20: 17-21.
- Avanzini M. & Lockley M., 2002 - Middle Triassic archosaur ontogeny and population structure: interpretation based on *Ischirotherium delicatum* fossil footprints (Southern Alps, Italy). *Paleogeogr., Paleoclimatol., Paleoecol.*, 185: 391-402.
- Avanzini M. & Renesto S., 2002 - A review of *Rhynchosauroides tirolicus* Abel 1926 ichnospecies (Middle Triassic: Anisian - Ladinian) and some inference on *Rhynchosauroides* trackmaker. *Riv. It. Pal. Strat.*, 108: 51-66.
- Avanzini M., Ceoloni P., Conti M.A., Leonardi G., Manni R., Mariotti N., Mietto P., Muraro C., Nicosia U., Sacchi E., Santi G., & Spezzamonte M., 2001 - Permian and Triassic tetrapod ichnofaunal units of Northern Italy: Their potential contribution to continental biochronology, Int. Congr. "Natura Bresciana", *Ann. Mus. Civ. St. Nat. Brescia, monografie*, 25: 89-107.
- Beurlen K., 1950 - Neue Fahrtenfunde aus der Frankischen Trias. *N. Jahrb. Geol. Paläont. Monat.*, (1950): 308-320.
- Brandner R., 1973 - Tetrapodenfährten aus der unteren Mitteltrias der Südalpen. *Veröffentlichungen der Universität Innsbruck*, 86: 57-71.
- Courel L. & Demathieu G., 1976 - Une Ichnofaune reptilienne remarquable dans les Grès Triasiques de Largentière (Ardèche, France). *Palaeontographica Abt. A*, 151: 194-216.
- Delfrati L. & Farabegoli E. 2000 - Calcare di Morbiac. In: Delfrati L., Falorni P., Groppelli G. & Pampaloni R.: *Carta Geologica d'Italia - 1:50.000, Catalogo delle Formazioni*. APAT, Dipartimento Difesa del Suolo, Servizio Geologico d'Italia. Quaderni serie III, 7, Fascicolo I: 154-160.
- Demathieu G., 1970 - Les empreintes de pas de vertébrés du Trias de la bordure N-E du Massif Central. *Cahiers de Paléontologie CNRS*: 211 pp.
- Demathieu G.R., Oosterink H.W., 1983 - Die Wirbeltier-Ichnofauna aus dem Unteren Muschelkalk von Winterswijk (Die Reptilfährten aus der Mitteltrias der Niederlande). *Staringia* 7: 1-51.
- Demathieu G. & Oosterink H., 1988 - New discoveries of ichnofossils from the Middle Triassic of Winterswijk (the Netherlands). *Geol. Mijnbouw*, 67: 3-17.
- Gand G., 1978 - Sur le matériel ichnologique récolté dans le Muschelkalk de Culles-les-Roches (Sône-&-Loire). *Bull. Soc. Hist. Nat. du Creusot*, 35: 21-22.
- Haubold H., 1971a - *Ichnia amphibiorum et Reptiliorum fossilium*. In: Kuhn O. (ed.), *Handbuch der Paläoherpetologie*, Teil 18. Gustav-Fischer-Verlag, Stuttgart: 124 pp.
- Haubold H., 1971b - Die Tetrapodenfährten des Buntsandsteins in der DDR und in WD und ihre Äquivalente in der gesamten Trias. *Deutschen Gesellschaft für Geologische Wissenschaften, Paläontologische Abhandlungen*, 3: 397-548.
- Haubold H., 1984 - *Saurierfährten*. "Die Neue Brehm-Bucherei". A. Ziemsen Verlag, Wittenberg Lutherstadt Dresden: 231 pp.
- Hitchcock C.H., 1889 - Recent progress in ichnology. *Proceedings Boston Society of Natural History*, 24: 117-127.
- Kaupp J.J., 1835 - Mitteilung über Tiefahrten bei Hildurghausen. *N. Jahrb. Geol. Paläont.* (1835): 327-328.
- Maidwell F., 1911 - Notes on footprints from the Keuper of Runcorn Hill. *Proc. Liverpool Geol. Soc.*, 11: 140-152.
- Todesco R., 2007 - Studio paleontologico delle orme di rettili triassici (Pelsonico) nel Conglomerato di Voltago (Valle di Prissiano, Trentino-Alto Adige). Tesi di laurea, Università di Modena: 52 pp.
- Valdiserri D. & Avanzini M., 2007 - Tetrapod ichnoassociation from the Middle Triassic (Anisian, Pelsonian) of Northern Italy. *Ichnos*, 14: 105-116.