
ATTI ACCADEMIA NAZIONALE DEI LINCEI
CLASSE SCIENZE FISICHE MATEMATICHE NATURALI
RENDICONTI

PIERO LEONARDI, MARIA ALESSANDRA CONTI,
GIUSEPPE LEONARDI, NINO MARIOTTI, UMBERTO
NICOSIA

**Pachypes dolomiticus n. gen. n. sp.; Pareiasaur
footprint from the "Val Gardena Sandstone" (Middle
Permian) in the western Dolomites (N. Italy)**

*Atti della Accademia Nazionale dei Lincei. Classe di Scienze Fisiche,
Matematiche e Naturali. Rendiconti, Serie 8, Vol. 57 (1974), n.3-4, p.
221-232.*

Accademia Nazionale dei Lincei

http://www.bdim.eu/item?id=RLINA_1974_8_57_3-4_221_0

L'utilizzo e la stampa di questo documento digitale è consentito liberamente per motivi di ricerca e studio. Non è consentito l'utilizzo dello stesso per motivi commerciali. Tutte le copie di questo documento devono riportare questo avvertimento.

*Articolo digitalizzato nel quadro del programma
bdim (Biblioteca Digitale Italiana di Matematica)
SIMAI & UMI*

<http://www.bdim.eu/>

Paleontologia. — *Pachypes dolomiticus* n. gen. n. sp.; *Pareiasaur footprint* from the "Val Gardena Sandstone" (Middle Permian) in the western Dolomites (N. Italy). Nota di PIERO LEONARDI, MARIA ALESSANDRA CONTI, GIUSEPPE LEONARDI, NINO MARIOTTI e UMBERTO NICOSIA, presentata (*) dal Socio P. LEONARDI.

RIASSUNTO. — Viene descritta un'impronta di rilevanti dimensioni, rinvenuta nelle « Arenarie di Val Gardena » (Permiano Medio) affioranti nella gola del Bletterbach nei pressi di Redagno (Radein) (Bolzano).

Non essendo stato possibile confrontarla con altre impronte data l'assoluta novità, essa è stata paragonata a strutture ossee ed attribuita all'ordine COTYLOSAURIA, famiglia PAREIASAURIDAE. Essendo la prima impronta segnalata di animali di questa famiglia, è stata istituita una nuova icnospecie, *Pachypes dolomiticus* n. gen. n. sp., pur trattandosi di una impronta isolata.

During the summer of 1973 the writers carried out a series of paleontological studies in the gorge of Butterloch-Bletterbach, near Redagno (Radein) on the south-western edge of the Dolomites. Besides an appreciable fauna of cephalopods, 33 specimens of Palaeoniscoids and numerous tetrapod footprints mentioned in a previous work (Conti *et al.*, 1974), a footprint was found in the form of a reverse mould, which, on account of its large dimensions and very original characteristics, seems to call for particular study. This footprint, like all the other material, is preserved in the collections of the Geological Institute of Ferrara University.

As has been stated on other occasions, the Rio delle Foglie, is coming down from the Corno Bianco (Weisshorn), hollowed out a long canyon-like gorge in various formations, dated from Lower Permian to Middle Trias. In the upper part of its course it is known as the Butterloch, in the middle part the Bletterbach, in the lower part the Vallacce. So far the greatest number of footprints have been found in the Butterloch, but during the research campaign of August 1973 many footprints were also found in the Bletterbach.

This last gorge starts from the waterfall that divides it from the Butterloch; it is hollowed out first in the lower part of the "Val Gardena Sandstone" and then further down the valley in "Quartz Porphyry".

The footprint in question was found in the lowest detritus, a few metres below the waterfall. It almost certainly comes from the walls of the Bletterbach and not from the Butterloch, since, if it had been worn smooth and had fallen from the high walls of the waterfall, it would not have such a perfectly preserved appearance. It is more likely that it slid along the first alluvial conoid that can be seen on the left bank of the stream just below the waterfall (fig. 1).

(*) Nella seduta del 9 febbraio 1974.

The footprint occupies the whole lower surface of a roughly circular block measuring about 33×31 cm, becoming thinner towards the edges. The upper surface of the block is slightly concave, whereas the lower surface is decidedly convex. The block consists of rough sandstone with light brown siliceous cement with siltitic layers and lenses. No laminations are to be

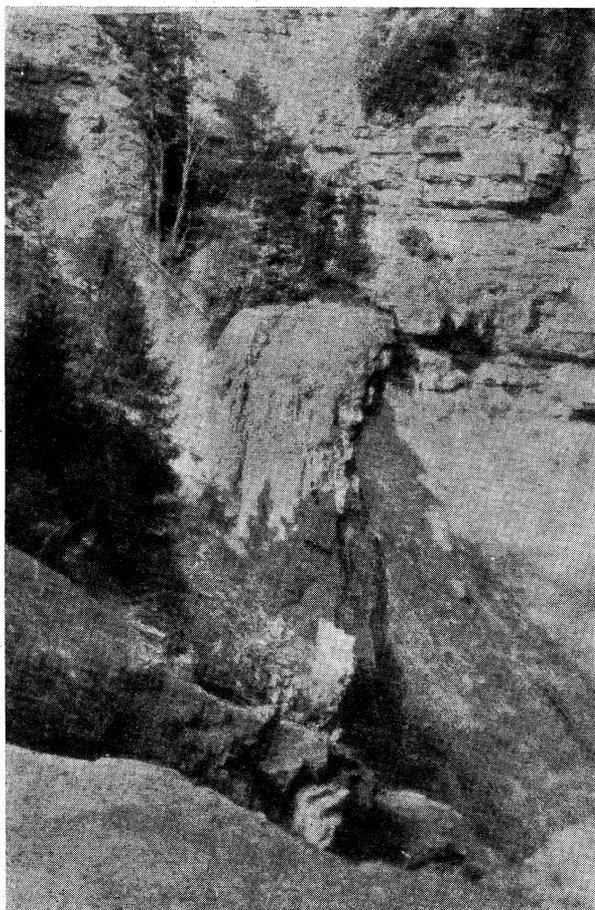


Fig. 1. - The head of the Bletterbach seen from the foot of the waterfall. To the right of the obvious volcanic chimney may be seen the layers from which the footprint presumably comes, and the underlying conoid. (Photo: P. Leonardi).

observed. The mass and the surface are very rich in burrows crossing in all directions. A few small cavities are covered by small gypsum crystals, probably secondary.

The unusual form and the dimensions, much larger than those of the footprints previously found in the "Val Gardena Sandstone", might suggest the idea that it is not so much a footprint as a sedimentary structure: for example, a slumping, a flutecast system or a load-cast. But it seems that

this idea should be excluded ⁽¹⁾. In actual fact, a slumping would preserve laminations parallel to the outer surface of the structure, and these are entirely absent here; quite apart from the fact that a slumping with five "digits" would be somewhat unusual. Moreover, the five elongated convex forms that converge into the large semicircular convexity should be parallel to one another, if they were flute-casts, whereas here they are fairly clearly convergent. As for the third possibility, it need hardly be remarked that also the reverse print of an animal on soft soil constitutes, though improperly, a load-cast; but it seems that the idea that it is a load-cast in the strict sense can be excluded, both because, as stated earlier, the lamination that is present in load-casts is not present here, and because the sandstone of the upper layer in which the footprint is preserved is no more coarse-grained than that of the lower layer, a little of which remains between the digits.

Moreover, to an experienced eye, it appears obvious that it is really the reverse-print of a large footprint. In any case, if it were not so, it would be impossible to explain the traces of slipping and sinking in the mud that are to be seen very clearly in front of the first four digits.

DESCRIPTION OF THE FOOTPRINT

It is a plantigrade pentadactyl footprint (figs. 2-3-4), with a rounded outline and slightly divergent digits. The sole is very big in comparison with the surface occupied by the digits. Its breadth is slightly greater than its length and it is divided by an elongated depression, more or less normal to the axis of the foot, situated slightly in front of the transversal centre line of the footprint. This depression, which curves forward at the lateral edge and backward at the medial edge, has a width that reaches a maximum of 4 cm in the centre and decreases towards the edges. It is occupied by the impression of numerous fine folds of skin, parallel to one another and to the direction of the depression. In front of it, in the area of attachment of the first four digits, four small pads may be noted, varying in shape from oval to sub-round. These probably correspond to the point of juncture between the metacarpals and the first phalanges of the digits, assuming, as will be said later, that the print is of a *manus*. In front of the pads corresponding to digits II, III, IV, transverse depressions may be noted, showing the traces of various other small parallel folds of skin. The portion of the sole behind the transverse depression is further subdivided by a sigmoid-like depression lying diagonally across the axis of the foot, from the middle of the proximal edge of the sole to the phalangeal-metacarpal pad of the digit. Also in this depression, which has a maximum width of about 3 cm and a length of

(1) Also in the opinion of Prof. A. Bosellini (Prof. of Sedimentology at Ferrara University), to whom we are grateful for his oral communication of 1st October 1973.

about 20 cm, there are impressions of fine parallel folds, divided into two marginal bands about 1 cm apart in the centre and joined at the ends. On the posterior and medial side of this depression there is an elongated pad (15 × 5 cm) parallel to the edge of the print; on the anterior and lateral side of it there is a sub-trapezoidal surface occupied by a smaller pad in the medial corner and by a larger pad, somewhat raised, adjacent to the base of digit V (about 10 × 11 cm), in the lateral part of the sole.

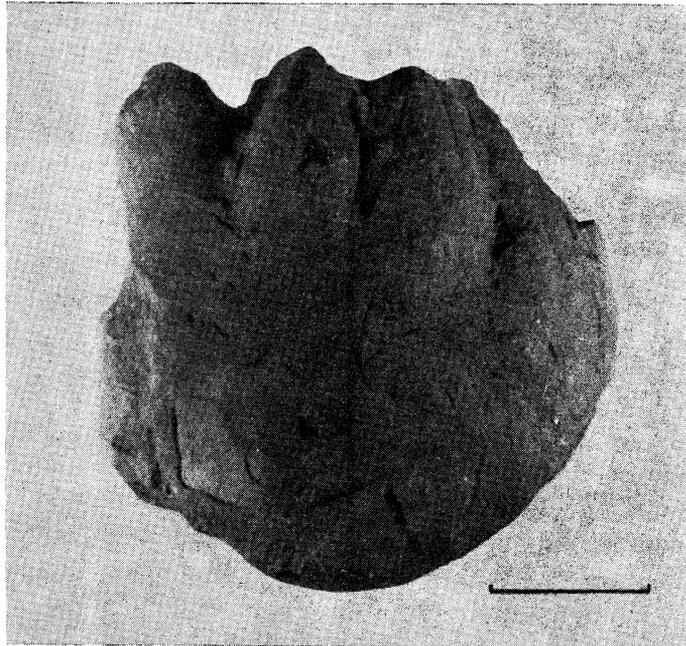


Fig. 2. - Reverse-print of *Pachypes dolomiticus* n. gen. n. sp., taken from the "Val Gardena Sandstone" of the Bletterbach (Bolzano). (Photo: S. Borsetti).

The digits are large and dumpy and diverge slightly in the distal direction. There are no obvious signs of claws and the first four digits carry a single pad, limited caudally, in digits III and IV, by a wrinkled depression. At the base of digit V there is a single very small pad (1 × 2 cm), almost a slight callosity. Thus there is a coalescence of the pads. On the whole, the digits increase gradually and slightly in length and breadth from I to IV, with the exception of III, which is slightly smaller than II and IV. Digit V is sub-parallel to IV; it is rather slender and lacks the distal extremity.

Even if this observation still remains doubtful, the digits were probably connected by the tissues as far as the joint between the first and second phalanges. Hence the measurements of the length of the digits taken in two ways are reported: from the apex of the third phalanx to the mid-point of the line joining the apparent points of conjunction of the digit in question to the two adjacent digits, and from the apex to the mid-point of the pad

below which probably lay the joints between the proximal end of the first phalanges and the metacarpals. As has been said, in front of digits I to IV may be seen clear parallel marks made by these digits sliding in the mud: the sliding that occurred before the foot found a firm support.

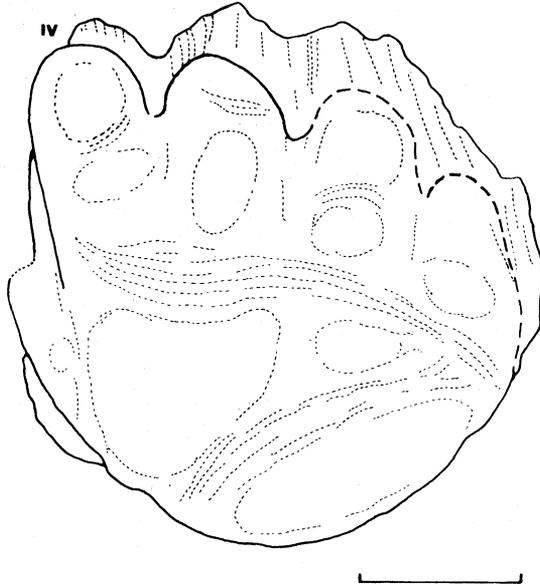


Fig. 3. - Outline of the footprint.

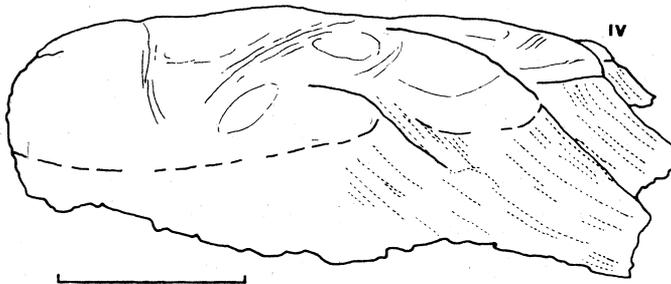


Fig. 4. - Outline of the footprint in medial view. The considerable thickness and the long furrows caused by sinking may be noted. In all three figures, the datum line is 10 cm.

The footprint is slightly ectaxonic or mesaxonic, according as to whether the axis of the foot is considered as passing through digit IV, the longest one, or through digit III, along which the axis of greatest load seems to lie.

From the functional aspect, it would seem that a prevalence (though an indistinct one) may be attributed to the area between digits III and IV and the lateral pad.

This footprint corresponds to a right autopodium, probably of a fore limb (*manus*) for the reasons that will be stated in the paleontological discussion, though in animals with such large and dumpy autopodia it is not always easy to distinguish the *manus* from the *pes* when, as in this case, there are only isolated footprints.

For practical reasons, in the description it is assumed that it is actually a *manus*.

The measurements of the footprint are as follows (in mm):

maximum length (on axis of digit III)	325
maximum breadth (perpendicular to digit III)	305
maximum length of sole	233
maximum breadth of sole	265

Digits ⁽²⁾:

Length of digit I	about 58-60
length of digit II	about 60-83
length of digit III	about 56-75
length of digit IV	78.5-98
length of digit V (part preserved)	64
maximum breadth of digit I	54
maximum breadth of digit II	69
maximum breadth of digit III	66
maximum breadth of digit IV	98
maximum breadth of digit V	31

Divergences (necessarily approximate):

total divergences (Digits I-V)	about 37°
between digits I-II	about 5°
between digits II-III	about 10°
between digits III-IV	about 20°
between digits IV-V	about 2°
between digits II-IV	about 30°

PALEONTOLOGICAL STUDY

Unfortunately, an isolated footprint does not enable us to give much precise information on the gait and size of the animal that left it; certain facts, however, may be obtained.

The animal was a tetrapod of considerable size, because the footprint is one of the largest—if not actually the largest—ever found so far in the Permian; so it was probably a real giant for that time, in which amphibians and reptiles were mostly still small.

(2) Two dimensions of the length of the digits are given as has been explained in the description of the same.

The animal was a plantigrade quadruped of massive build; its limbs were probably short and dumpy and its trunk was about 1.3 m long (3).

The remarkable depth of the impression is evidence of the considerable weight of the animal. Its feet, broad and thick, made contact with the ground over the whole area of the sole, with a slight functional prevalence of the side of the foot. The digits were short, probably indicating a reduction in the number or the length of the phalanges, which were large, barely divergent and increased slightly from I to IV, with the apex rounded; the free part was also shorter. Digit V was slender and sub-parallel to IV.

The claws were little developed and did not project appreciably from the soft tissues of the large distal pads.

The sole of the foot showed folds and pads, as already remarked earlier.

We feel it possible to exclude the idea that a foot of this type and a body of such a size might belong to an amphibian, since such developed amphibians have so far not been reported in the Permian.

Among the reptiles of the Permian known up to now, it is possible to exclude immediately the order MESOSAURIA (Baur, 1889), for obvious reasons, and also the orders EOSUCHIA (Broom, 1914) and ARAEOSCELIDIA (Williston, 1913), which nearly always have a lacertoid-type foot and are small or medium-sized. The Pelicosaurians known so far (PELYCOSAURIA Cope, 1878) do not attain such dimensions as to justify such a large footprint; moreover, their feet belong to a more generalised type, with the digits increasing appreciably from I to IV and fairly divergent and with digit V quite developed. Certain genera of the order THERAPSIDA (Broom, 1905) attain considerable size, but the structure of their feet does not correspond to that of the footprint in question. In particular, digit III is generally the longest, especially in the *manus*, and digit V is considerably developed in length and breadth, more than can be envisaged in the Bletterbach footprint, in spite of the fact that in the latter it lacks the distal extremity. Moreover, in the imprints of Therapsids, in which digit IV is the longest, the foot often has a lacertoid appearance.

In the order COTYLOSAURIA (Cope, 1880) the sub-order CAPTORHINOMORPHA (Watson, 1917) may be excluded and, in the order PROCOLOPHONIA (Seeley, 1888), the super-families PROCOLOPHONOIDEA (Seeley, 1888) and MILLEROSAUROIDEA (Romer, 1966), since they are animals of lacertiform appearance and small size (max 50 cm for the latter) (4).

Likewise in the other super-family (PAREIASAUROIDEA, Seeley 1888) the family RHIPAEOSAURIDAE (Chudinov, 1955) may be excluded and the study restricted merely to the single family PAREIASAURIDAE (Lydekker, 1889), bearing in mind, however, that the giant forms (up to over 3 m in length)

(3) This fact may be extrapolated empirically by multiplying the length of the footprint by four.

(4) Kuhn O., 1969-72.

of this family, which would be in proportion to the Bletterbach footprint, are found—so far as is known—only in the Upper Permian, whereas the “Val Gardena Sandstone” of the Western Dolomites is attributed to the Middle Permian; the footprint in question most probably comes from the middle part of this formation ⁽⁵⁾.

On the other hand, the rare forms that are known of the Lower Permian or Middle Permian are of small size. Hence, neglecting the level at which the various forms appear, we shall resort only to morphological criteria for a more precise attribution of the footprint. In the family PAREIASAURIDAE (Lydekker, 1889), account may be taken, as forms similar—though posterior—to that which is presumed to have produced the footprint in question, of the genera mentioned below with certain data. The genus *Bradysaurus* (Watson, 1914) is known in the *Tapinocephalus* zone of South Africa and may attain, ideally, a length of 3 m. The genus *Pareiasaurus* (Owen, 1876) attains a length of 3 m and is found in the *Endothiodon* and *Kistecephalus* zones of South Africa; *Pareiasuchus* (Broom and Haughton, 1913) is present in all three zones of the Upper Permian of South Africa and in Russia and may attain a length of 2.5 m; *Embrithosaurus* (Watson, 1914), a form that is often very large, is found in the *Tapinocephalus* zone of South Africa. The genus *Scutosaurus* (Hartmann and Weinberg, 1930) of zone IV of Russia attains a total length of 3 m ⁽⁶⁾.

To this reasoning, by process of elimination, may be added the considerable resemblance between the actual osteological structure of the feet of the Pareiasaurs and the structure necessary for impressing a footprint such as the one in question. In fig. 5 a comparison is shown between the structure that we have attributed to our footprint (fig. 5 A), hypothetical but based on the characters visible on the imprint, and those of three autopods of *Bradysaurus* (from Romer and Kuhn, redrawn). It should be noted that, though ours is the print of a right foot, we have preferred to shown a reconstruction of a left foot in order not to turn the imprint over and hence to facilitate comparison between it and the reconstruction, and also because the structures with which we are comparing it are represented by the authors as left autopods.

Fig. 5 B shows the left *manus* of *Bradysaurus*, taken from Romer (1956, fig. 180 D); it corresponds well to ours as regards the phalangeal formula, the general disposition, the very similar size of digits III, IV and V and the small divergence between IV and V.

Fig. 5 C shows the left *pes* of the same genus, again taken from Romer (1956, fig. 188 F), in which there are considerable resemblances in the

(5) “Val Gardena Sandstone” (West Dolomites) corresponds, from a chronological point of view, to the Middle and Upper Rothliegendes, and Lower Zechstein of Germany, as was demonstrated by the botanical studies of Gümbel (1878) and Klaus (1963). But Lower Rothliegendes corresponds to “Quartz Porphyry”.

(6) The data reported above on the various forms cited are taken from Kuhn, 1972.

general disposition and the slenderness of digit V. The phalangeal formula, since this is a *pes*, does not correspond, but it is interesting to note that digit III is slightly shorter than II and IV, as is the case in our own specimen.

Fig. 5 D shows another left *manus* of *Bradysaurus* (according to Haughton, from Kuhn Plate 40 fig. 20). Here there is good correspondence as

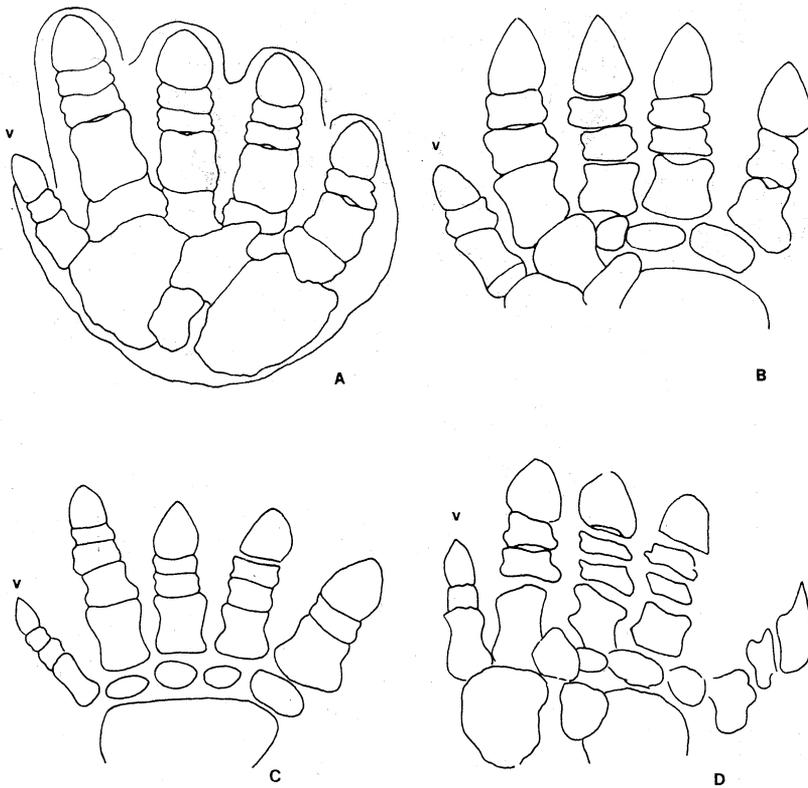


Fig. 5. - A) Hypothetical reconstruction of the bone structure, drawn from the footprint examined. B-C) *Bradysaurus*: left *manus* and *pes* (from Romer, 1956). D) *Bradysaurus*: left *manus* (from Kuhn, 1972).

regards the formula, the relative sizes of II, III and IV and the sub-parallelism of digit V. As regards the disposition of digit I, on the other hand, the foot is curiously different both from those shown here and from *Pareiasaurus baini* Seeley (fig. 6) exhibited in the British Museum (Nat Hist.) in London, with which it has been possible to compare it. To give an idea of the size of the animal that left the footprint described here, on the assumption that it was a *Pareiasaurid* we give below the measurements of the skeleton of *Pareiasaurus baini* mentioned above, the dimensions of which are probably slightly smaller than those of our animal. The measurements were made on the cast of this specimen, exhibited in the collection of fossil vertebrates

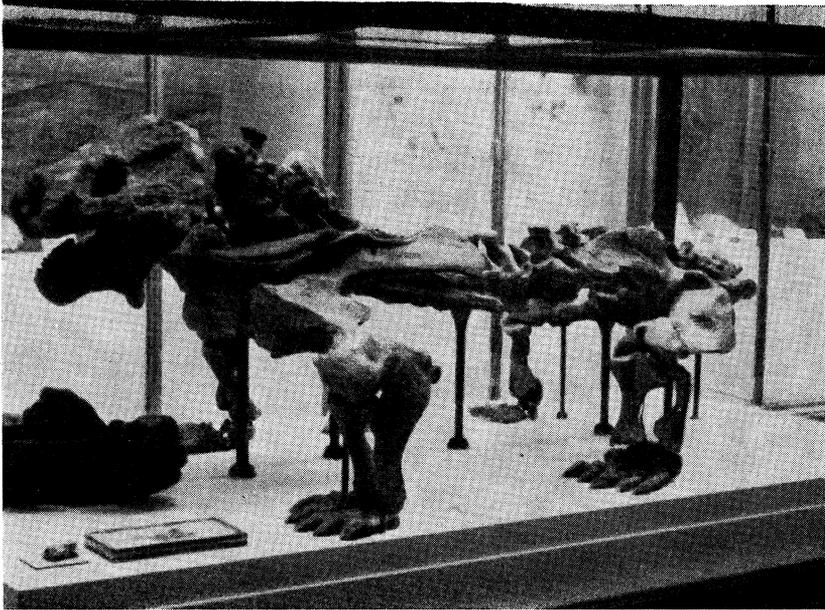


Fig. 6. - *Pareiasaurus baini* Seeley, exhibited in the British Museum (Nat. Hist.) in London. (Photo: P. Leonardi).

in the M.N.H.N. in Paris ⁽⁷⁾. Some of these measurements are to be considered approximate, in view of the probable deformation of certain parts of the skeleton.

MANUS

Maximum breadth	about 26 cm
Maximum length	about 23 cm

PES

Maximum breadth	about 27 cm
Maximum length	about 20 cm
Height from ground to upper edge of glenoid cavity	about 50 cm
Height from ground to upper edge of acetabulum . .	about 50 cm
Gleno-acetabular distance	about 140 cm
Total length of animal	285 cm
Distance from centre of acetabulum to apex of tail, projected onto sagittal axis	about 90 cm
Distance from centre of glenoid cavity to apex of pre- maxillary bone, projected onto sagittal axis . .	56 cm
Distance between <i>manus</i> digit III and <i>pes</i> digit III .	about 100 cm
Distance between left <i>pes</i> digit III and right <i>pes</i> digit III	90 cm

(7) We offer our warmest thanks to Prof. J. P. Lehman for his kind permission to take these measurements.

As far as we know, no-one has previously reported imprints similar in size and structure to the one discussed in the present work. Moreover, Haubold (1971) states that so far no imprints of PAREIASAUROIDEA are known with certainty, and he hints at the possibility that certain forms of *Chelichnus* (Jardine, 1850) or *Laoporus* (Lull, 1918) of the Upper Permian may be interpreted as such, though it should be noted that these forms are rather small. Furthermore, we find no resemblance between our footprint and those belonging to these two genera.

We therefore feel that, although it is an isolated footprint, it is worth attributing it to a new genus.

<i>Class</i>	REPTILIA
<i>subclass</i>	ANAPSIDA
<i>order</i>	COTYLOSAURIA Cope, 1880
<i>suborder</i>	PROCOLOPHONIA Seeley, 1888
<i>super fam.</i>	PAREIASAUROIDEA Seeley, 1888
<i>family</i>	PAREIASAURIDAE Lydekker, 1889.

Pachypes dolomiticus n. gen., n. sp.

Footprint of quadruped, pentadactyl, plantigrade, of large dimensions, of generally subrounded outline, with broad, relatively short and dumpy digits, lacking any obvious signs of claws. In general, the digits increase slightly in size from I to IV; V is small and subparallel to IV. The divergences are slight and fairly regular. The sole, highly developed, occupies a much larger area than that occupied by the digits and is characterised by the presence of extensive pads.

Stratigraphical position: "Val Gardena Sandstone"-Middle Permian.

Locality: Bletterbach, Redagno (Bolzano), West Dolomites (North Italy).

Repository: Museum of the Geological Institute of Ferrara University, No. 73/III.

Derivatio nominis: The generic name derives from *παχύς*: big, robust, solid, on account of the obvious characteristics of the footprint. The specific name derives from the Dolomites, the region, already geologically famous, in which the place of discovery is situated.

Post scriptum. In the course of the paleontological studies carried out in August of 1974, other footprints of various sizes were found, ascribed to the same animal.

BIBLIOGRAPHY

- ACCORDI B., *Contributo alla conoscenza del Permiano medio-superiore della zona di Redagno (Bolzano)*, « Annali Univ., Ferrara », N.S. ser. IX, « Sc. Geol. e Min. », 3 (2), Ferrara 1958.
- CARROL R., KUHN O. and TATARINOV L. P., *Bathracosauria (Anthracosauria) Gephyrostegida-Chronosuchida*, in « Handbuch der Paläoherpetologie », Ed. by O. Kuhn, 5/b, 1-81, 49 figs. Gustav Fischer, Stuttgart-Portland 1972.
- CONTI M. A., LEONARDI G., MARIOTTI N. and NICOSIA U., *Tetrapod footprints, fishes and molluscs fauna from the Permian of Dolomites (N. Italy)*. (1974 in print).
- DIETER A. and HAUBOLD H., *Erste Information über die Richtgrenze Unteres/Oberes Autun (Unteres Perm, Unterrotliegend) im Niveau der Goldlauterer Schichten des Thüringer Waldes*, « Z. geol. Wiss. », 1 (5), 509-514, Berlin 1973.
- GIANNOTTI G. P., *La serie permo-carbonifera delle Alpi orientali*, « Studi e ricerche della Div. geomin. del C.N.R.N. », 1 (1), Roma 1958.
- GÜMBEL W., *Vorläufige Mitteilung über das Vorkommen der Flora Fünfkirken in sogenannten Gröden Sandstein, Südtirol*, « Verh. K. K. Geol. Reichsanst », 1, 23-26, Wien 1877.
- HAUBOLD H., *Ichnia Amphibiorum et Reptiliorum fossilium* in « Handbuch der Paläoherpetologie », Ed. by O. Kuhn, 18, 1-VIII/1-124, 65 figs. Gustav Fischer, Stuttgart, Portland 1971.
- HAUBOLD H. and KATZUNG G., *Die Abgrenzung des Saxon*, « Geologie », 21, 88-910, Berlin 1972.
- HAUBOLD H. and KATZUNG G., *Das Typus-Gebiet der Autun/Saxon-Grenze im Thüringer Wald*, « Ber. deutsch. Ges. geol. Palaont. », 17 (6), 849-863, Berlin 1972.
- JOLLIE M., *Chordate Morphology*. Reinhold, 1-XIV/1-478, London 1962.
- KLAUS W., *Sporen aus dem Südalpinen Perm*, « Jahrb. Geol. Bundes. », 106 (1), 229-361, 38 pls., 20 photos, Wien 1963.
- KUHN O., *Proganosauria, Bolosauria, Placodontia, Araeoscelidia, Trilophodontia, Weigeltisauria, Millerosauria, Rhyncocephalia, Protosauria*, in « Handbuch der Paläoherpetologie », Ed. by O. Kuhn, 9, 1-74, 27 figs. Gustav Fischer, Stuttgart, Portland 1969.
- KUHN O., *Cotylosauria*, « Ibidem », 6, 1-90, 47 figs. Gustav Fischer, Stuttgart, Portland 1972.
- LEONARDI P., *Flora e fauna delle Arenarie di Val Gardena (Permiano medio-inferiore) dell'Alto Adige Sud-Orientale*, « Atti 42° Riun. Soc. ital. Prog. Sc. », Roma 1951.
- LEONARDI P., *Orme di Tetrapodi nelle Arenarie di Val Gardena (Permiano medio-inferiore) dell'Alto Adige Sud-Orientale*, « Mem. Ist. Geol. e Min. Univ. Padova », 17, Padova 1953.
- LEONARDI P., *Le Dolomiti-Geologia dei monti tra Isarco e Piave*, Manfrini, Rovereto (TN), 1968.
- PIVETEAU J., *Traité de Paléontologie*. 4-5, Masson, Paris 1955.
- ROMER A. S., *Vertebrate paleontology*, 1-VIII/1-468, 443 figs. The University of Chicago Press, Chicago (Ill.), 1933. (II Ed. 1945; III Ed. 1966), III Impr. 1971.
- ROMER A. S., *Osteology of the Reptiles*. University of Chicago Press, 1-XXI/1-772, 248 figs. Chicago (Ill.), 1956.