A new reconstruction of *Struthiosaurus austriacus* Bunzel 1871*

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* *dedicated to Prof. Erich Thenius*

Abstract

A novel reconstruction of the nodosaurid dinosaur *Struthiosaurus austriacus* Bunzel 1871 is presented. Because bones and dermal armor are preserved as disarticulated elements only and because of the lack of field notes from the original excavation(s), any attempt to reconstruct the animal is complicated. To date, no reconstruction is available for *Struthiosaurus austriacus*. This study primarily focuses on aspects of function and arrangement of dermal armor. The re-investigation of the original material of *S. austriacus* revealed that - in all likelihood - many plates from the left side of the body may well belong to a single individual. This observation is an important step towards the successful reconstruction of *S. austriacus.*

Introduction

On the occasion of the 650th anniversary of the University of Vienna in 2015, I was asked by Prof. Jürgen Kriwet to prepare a diagram of *Struthiosaurus* Bunzel, 1871, a nodosaurid dinosaur recovered from Late Cretaceous deposits of Austria (Bunzel, 1871). The diagram should have been based on the pre-announcement of a twenty euro coin released later in spring 2014 and showing *Struthiosaurus austriacus* the type species of the genus.

Because previous reconstructions were hampered by insufficient knowledge about the arrangement and position of the osteoderms, it was necessary to re-investigate the original material of *Struthiosaurus* housed at the Department of Palaeontology, University of Vienna (PUIW).

The resulting reconstruction was presented at the anniversary celebration in the Campus of the old AKH (Vienna General Hospital) as a life-size lateral view. This reconstruction was also used as a model for a colour illustration prepared by Mr. Fabricio de Rossi that was also displayed at the ceremony.

However, to date no detailed explanation accompanying the graphical reconstruction has been published. The purpose of the present work thus is *i)* to provide a short summary of the interpretation of the re-examined original material of *Struthiosaurus austriacus*, and *ii)* to present a revised reconstruction (**Figs 1-3**).

Material and methods

The fossil material comprises disarticulated skeleton bones and osteoderms originating from at least three individuals of different size (see also Pereda Suberbiola & Galton, 2001). Only a posterior part of the skull formed the basis for the original description of *Struthiosaurus* by Bunzel (1871) while the more complete collection was subsequently investigated by Seeley in 1879 when invited by the then Professor Suess to revise the dinosaur material housed in Vienna (Seeley, 1881). Seeley noticed that most of the remaining skeletal bones, plates and teeth belong to a single genus, which he named *Crateomus.* Noteworthy, Seeley did not consider the skull itself congeneric with his new genus.

Apparently, the major part of the osteoderm material had not been available when Bunzel made his original description in 1871 and was first mentioned in the work of Seeley (1881). Seeley, correctly, assumed that at least some osteodermal plates might originate from a single individual. This is particularly true for the cervical half-rings and dorsal plates, which appear to represent a perfect series when arranged successively, series of the armor- plates of the tail and for a row of lateral plates of the body.

After the recovery of *Struthiosaurus transylvanicus* (Nopsca, 1929), Nopsca considered *Crateomus* as a synonym of *Struthiosaurus*. A more recent review of the available fossil material of *Struthiosaurus austriacus* along with photos has been provided by Pereda Suberbiola & Galton (2001).

The fact that the bones are preserved as disarticulated elements from various individuals clearly complicates any attempt to reconstruct the fossil animal and to date, no such reconstruction is available.

Therefore, in the present account, an attempt was made to treat separately juvenile elements (figures in Pereda Suberbiola & Galton, 2001: for example '*right dentary: fig.10.2. Q-S, scapula small fig. 10.4. F-H, left and right femur small: fig. 10.7. A-L*) and significantly larger elements (for example *left scapula big: 10.4. A-C, right ilium: fig. 10.6. A-C, right femur: fig. 10.6. I-K*). A main aim of the present study was to improve the understanding of the arrangement and function of dermal armor.

Results

Descriptions and comments to the reinvestigated material (including figured material in Pereda Suberbiola & Galton, 2001)

Skull (**Figure 1**):

For the estimation of the skull length, a lower jaw fragment ('right lower jaw, symphysis') PIUW 2349/(B5b) was used. In combination with a juvenile lower right dentary PIUW 2349/5(C4a), the two fragments of the skull roof PIUW 2349/17(B6a,b), and the skull fragment PIUW 2349/6(C4c), still showing imprints of scalation and therefore probably from the same juvenile individual, it is evident that the longitudinal growth of the skull was decelerated in adults as compared to juveniles. The condylus is distinctly ventrally oriented, typical for long-necked Nodosaurids. In addition, a postorbital bone, not mentioned in previous publications was recovered in the collection. In contrast, the distal end of a quadratum, described in Pereda Suberbiola & Galton (2001), could not be found during the re-examination.

The mouth is very narrow and the preserved teeth are strongly abraded. Assuming that this is not the result of taphonomic alteration, this may indicate that *Struthiosaurus* was digging for food (e.g. ants, termites).

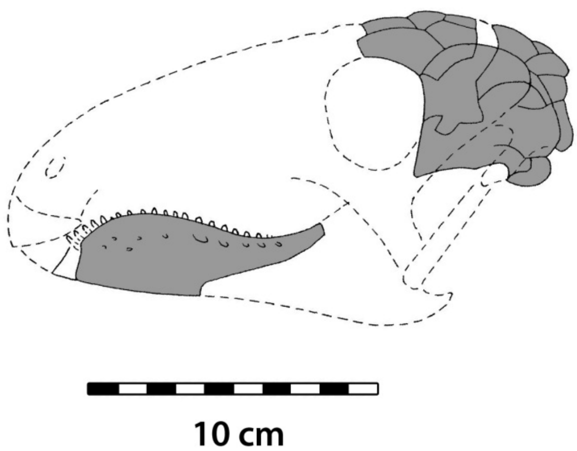

Figure 1. *Struthiosaurus austriacus*. Reconstruction of skull. Skeleton elements present in the collection PIUW are shaded.

Cervical vertebrae, ribs (**Figure 2**):

Two cervical vertebrae PIUW2349/(B7a) & *s. n.* are markedly elongated. A single cervical rib is present.

Dorsal vertebrae, dorsal ribs (**Figure 2**):

Vertebrae are strong, high; dorsal ribs appear to be wide-protruding.

Sacral vertebrae:

Not preserved.

Caudal vertebrae (**Figure 2**):

Indicate restricted mobility, both in dorsoventral and lateral directions.

Scapulocoracoid (**Figure 2**):

The scapulocoracoid is tightly attached to the torso and therefore immobile as typically found in reptiles. The scapula bears a well-developed, hooked acromion process with a knobbed end in adult specimens.

Humerus (**Figure 2**):

The humerus is poorly preserved. Generally, in *Struthiosaurus* it is short and proximally strongly dilated. The latter may be an indication of digging.

Ulna / Radius (**Figure 2**):

The ulna is proximally dilated and strong, radius moderately strong.

Ilium (**Figure 2**):

The Ilium is flat, tapering, pointed and smooth. No dermal armor attached.

Ischium (**Figure 2**):

The ischium is short, broad anteriorly, slender distally.

Femur (**Figure 2**):

The straight femur is relatively long and moderately strong.

Figure 2

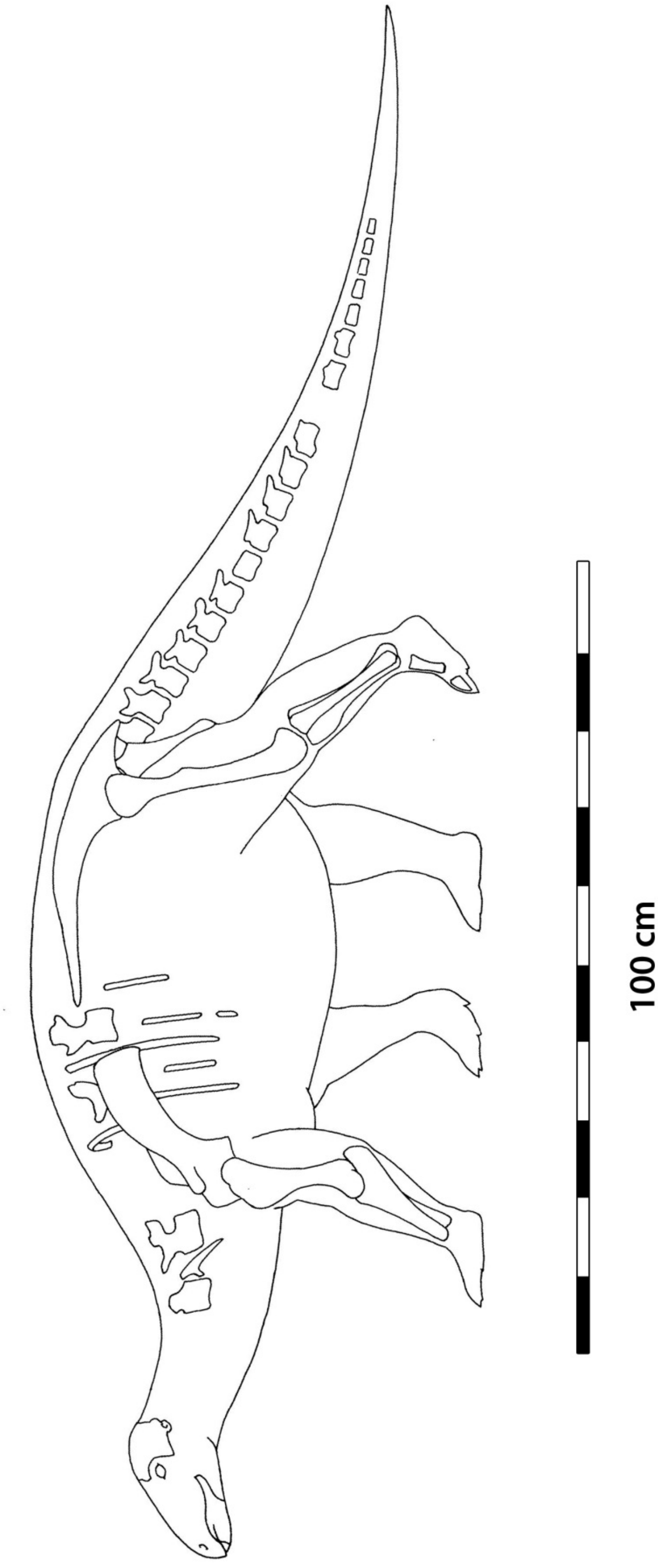

Figure 2. Reconstruction of *Struthiosaurus austriacus* indicating skeleton elements present in the collection PIUW.

Tibia and fibula (**Figure 2**):

The tibia and fibula are relatively short and strong, but incomplete.

Metatarsus (**Figure 2**):

Only one metatarsus is preserved: It is relatively short, broad and strong.

Ungual phalanx (**Figure 2**):

The only ungual phalanx is flat, short, laterally rounded and with a blunt end.

The poor representation of pes and manus does not allow accurate reconstruction of these parts of the body. In the sketch, the animal is shown with strong digits and claws, which would enable it to dig for insects.

Osteoderms (**Figure 3**):

Cervical half-rings – The material consists of a complete(?) series of *left lateral* half-rings. Importantly, the lateral position would permit free mobility of the long neck. This is in contrast to the interpretation of Pereda Suberbiola who considered the cervical half-rings to be right dorsal half-rings.

Put in a line, the preserved left lateral cervical half-rings and dorsal(?) plates would make up a perfect sequence of armor. Therefore, they are here considered to belong to a single individual.

A (Figure 3) - Cervical plate (probably first left cervical half-ring) PIUW 2349 (B10b) – Interpreted as first cervical half-ring, left side.

B (Figure 3) - Anterior (2.) cervical half-ring PIUW 2349/14 (B10a) – This cervical ring is interpreted as left anterior cervical half- ring.

C (Figure 3) - Posterior (3.) cervical half-ring PIUW2349/13(B10c) – This cervical half-ring is interpreted as left posterior cervical half-ring.

D1, D2 (Figure 3) - Plates PIUW 2349 (B12a,b) – In contrast to Perdea Suberbiola & Galton (2001) plates PIUW 2349 (B12a,b) are here interpreted as originating from the

Figure 3

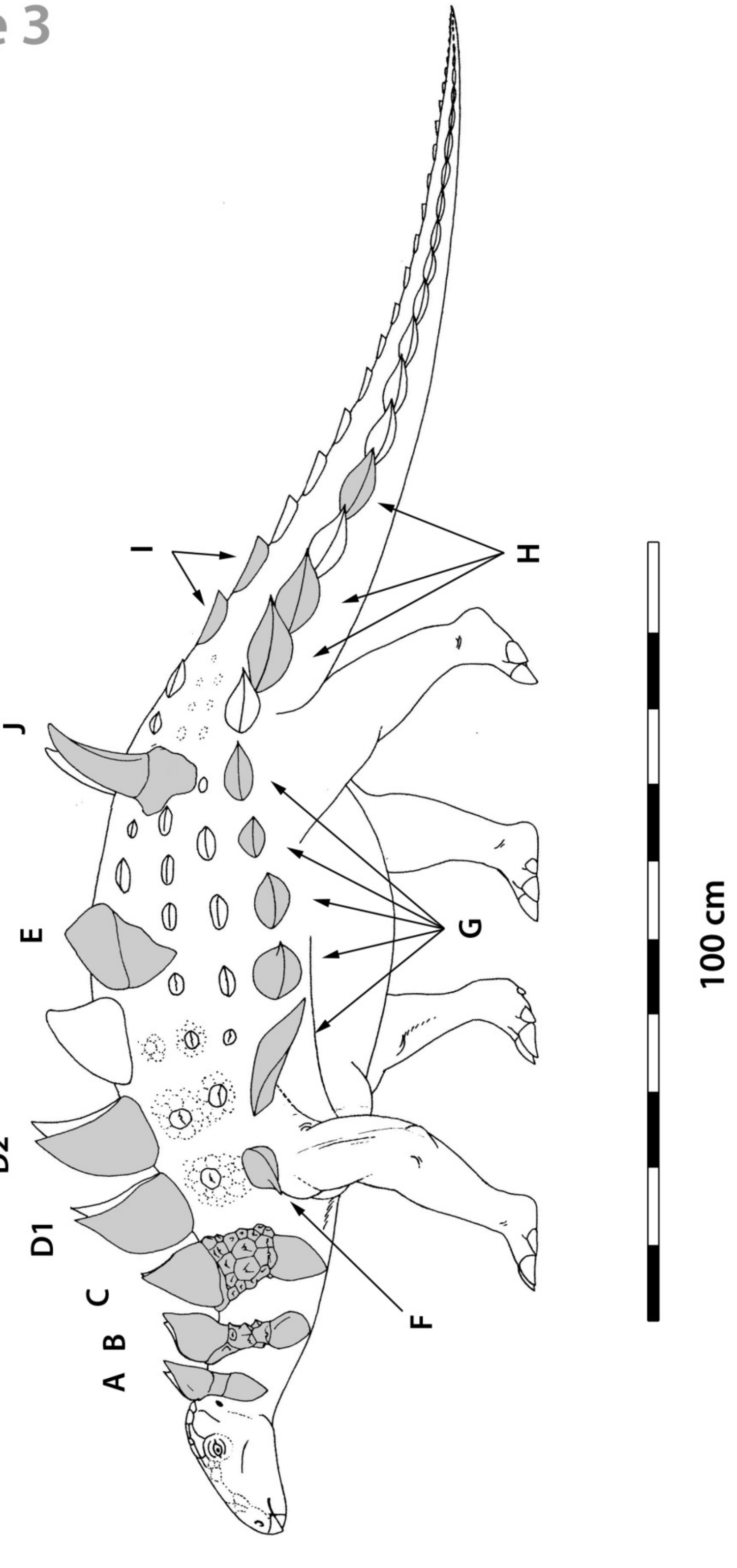

Figure 3. Reconstruction of *Struthiosaurus austriacus* with dermal armor. **A-J** (shaded parts) refer to dermal plates described in the text.

shoulder area; no dermal bone attached, perfectly fitting the dorsal plates of the cervical half-rings.

E (Figure 3) - Plate PIUW 2349 (A1c) – Right dorsal plate, ventrally fused with broken part of dermal bone, therefore interpreted as positioned on the anterior part of the ilium.

F (Figure 3) - Plate (broken and possibly overlooked by previous authors) PIUW 2349, *s. n.* – Here interpreted as positioned at the Acromion process. Its base is circular, shallowly concave.

G (Figure 3) - Plates fig. 10.8 R, S, V, W in Pereda Suberbiola & Galton (2001): PUIW2349, no.? – These plates are here interpreted as a complete lateral series of plates from the left side of the body. Their bases are moderately concave and do not overlap. This would permit free movement of rib-cage for breathing.

H (Figure 3) - Plates fig. 10.8 T, U & N-Q in Pereda Suberbiola & Galton: PUIW 2349, no.? – Sharply keeled, acute-tapering plates with a depression at their distal ends. Here interpreted as lateral caudal plates that are distally overlapping (posterior) and thus hampering lateral movement (see caudal vertebrae). At least some of them represent short series. Their bases are distinctly concave.

I (Figure 3) - Another type of scales (fig. 10.8., I in Pereda Suberbiola) is tentatively interpreted as originating from the dorsal part of the tail. They are narrow, with a low but sharp keel dorsally and shallow concave bases.

J (Figure 3) - Dorsosacral plate with spine PIUW 2349/15 (A1a), fig. 10.8 F, G in Pereda Suberbiola & Galton (2001) – Lateral end of a boomerang-shaped dorsal plate of the sacral region. The position of the spine is dorsally of the hip-joint in *Struthiosaurus* because the (completely preserved) lateral end bends ventrally. Otherwise this plate is similar to the analogous plate in *Hungarosaurus* (see Ösi, 2005).

For the reconstruction, the horn-sheet of dermal armor was considered to have been relatively thin, as also observed in recent turtles and crocodiles.

Discussion

Considerations to the palaeoecology and the phylogenetic placement of *Struthiosaurus*

Struthiosaurus austriacus was a conspicuously small (ca. 200 – 260 cm total length), long-necked member of Nodosauridae. Probably, it was feeding mainly on ants and termites, at least when a juvenile animal.

The reconstruction of dermal armor is highly plausible as it would serve as effective protection against attacks from smaller carnosaurs, particularly with bent forelimbs and downward flexion of the neck. In contrast, defensive sideward directed slashes with the tail would appear unlikely, because of its limited flexibility.

Despite its occurrence during the latest Cretaceous *S. austriacus* preserved a great number of plesiomorphic characteristics and generally is considered a basal member of Nodosauridae (e.g. Ösi, 2005). Essentially, many of the osteoderms and plates show some similarities with Jurassic scelidosaurids.

Acknowledgements

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