Remarks on the pectoral girdle of *Hydrotherosaurus alexandrae* (Plesiosauria: Elasmosauridae)

S. Sachs
Institut für Paläontologie
Freie Universität Berlin,
Malteser Strasse 74–100
Haus D,12249 Berlin,
Germany
Sachs.Pal@gmx.de

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Abstract

The pectoral girdle of *Hydrotherosaurus alexandrae* Welles 1943, an elasmosaurid plesiosaur from the Upper Cretaceous (Maastrichtian) of California, USA, is redescribed. Some differences to the reconstruction presented in the original description, as well as newly discovered features of the pectoral girdle are discussed and a new reconstruction is provided.

Contents

Abbreviations

AMNH	American Museum of Natural History, New York, USA
RMF	Richmond Marine Fossil Museum, Richmond, Australia
SDSM	South Dakota School of Mines, Rapid City, USA
UCMP	University of California Museum of Paleontology, Berkeley, USA

1. Introduction

In his description of *Hydrotherosaurus alexandrae*, an elasmosaurid plesiosaur from the Upper Cretaceous (Maastrichtian, Moreno Formation) of Fresno County, California, Welles (1943) presented an unusual restoration of the pectoral girdle with asymmetrical coracoids. At the time, the about 8 m long, almost complete skeleton of the type specimen (UCMP 33912) had already been mounted at the University California Museum of Paleontology at Berkeley (UCMP). The exhibit was taken down in the 1960s and apparently has not been studied since. The skeleton was examined by the author during a visit to the UCMP in 2001 and some differences in the description and interpretation by Welles (1943) became apparent. Since all other postcranial elements are accurately described and restored by the original author, the present paper is limited to a re–description and new reconstruction of the elements and relationships of the pectoral girdle.

2. Description

2.1. General remarks

According to Welles (1943: 140; plate 21) the right scapula and coracoid were dislocated and lying under the remains with their ventral side up. The left scapula and coracoid were pulled around to the back and the left scapula was moved slightly out of position (figure 1). Only fragments of the left scapula are present, while the right one is relatively complete, only missing the articular end, and is accurately preserved (figure 2). The right coracoid is nearly complete, except for the posterior section of the coracoidal symphysis. The left coracoid is covered by ribs and is missing most of its blade, leaving the coracoidal symphysis as the only visible part, forming a mirror–image of the right one. The interclavicle and clavicles are not preserved (Welles, 1943: 141).

2.2. Scapula

The ventral plate of the scapula is strongly dorsoventrally flattened and anteroposteriorly plain (figure 2). In ventral view, its medial side is concave, anteriorly having a thin edge that becomes slightly thicker posteriorly. The anterior end of the scapula is the widest part of the element. It is mediolaterally expanded in a fan–like manner and medially inclined. Its dorsal margin is thin and slightly re–curved. The lateral side of the ventral plate consists of a long, straight margin that runs from the lateral corner of the anterior side to the basis of the dorsal process. Ventral to this margin another edge is evident that runs posteroventrally from the posterior third of the former to probably the posterior end of the scapula, called scapular shelf by Welles (1943). The margin between this second edge and the dorsal process is shallowly concave. In lateral view the dorsal process has a high–rectangular outline and is posterolaterally oriented. Its anterior and posterior sides are thin and almost straight, in which the anterior one is somewhat longer so that the dorsal side is slightly anteriorly oriented. The latter is broad, forming a concave long oval facet that is pointed anteriorly.

2.3. Coracoid

The coracoids are lateromedially constricted, especially at the blade. The lateral margin is the longest, reaching over more than half of the length of the coracoid. In ventral view, it is strongly longitudinally concave, thin and rounded. The glenoid fossa and the scapular articular surface are situated anterolaterally. Both are missing on the right coracoid, but are clearly visible at the left one. In lateral view the glenoid fossa has a long oval appearance and a slightly concave surface that is more than twice as long as the scapular one. The latter is comparatively short, in anterior view, has a triangular outline and a slightly concave surface. Both facets are dorsoventrally flattened. The coracoidal symphysis misses most of its posterior portion. The anterior part is complete but covered by ribs. Apparently it reaches anteriorly to the level of the scapular facet, forming a blunt tip. Comparing the visible sections of both coracoids it becomes obvious that the symphysis was originally expanded over more than half of the anteroposterior length of the bone, thus was much longer than reconstructed by Welles (1943, figure 8; 1952, figure 20; 1962, figure 20b). In about the medial third of the coracoid's ventral side, a broad horizontal back is formed that becomes more prominent towards the symphysis where it has a semi–circular appearance in medial view and bears prominent rugosities. The posterior end of the coracoid is wing–shaped lateromedially expanded and shows a lateral orientation. Its posterior margin is convex in dorsal view.

3. Discussion

Welles (1943) provided a complete description of the skeleton of *Hydrotherosaurus alexandrae* that was collected in 1937 from the Panoche Hills in Fresno County, California. In his later (1952) publication he refers to the 1943 paper with regard to the postcranial skeleton but did not provide new or different interpretations.

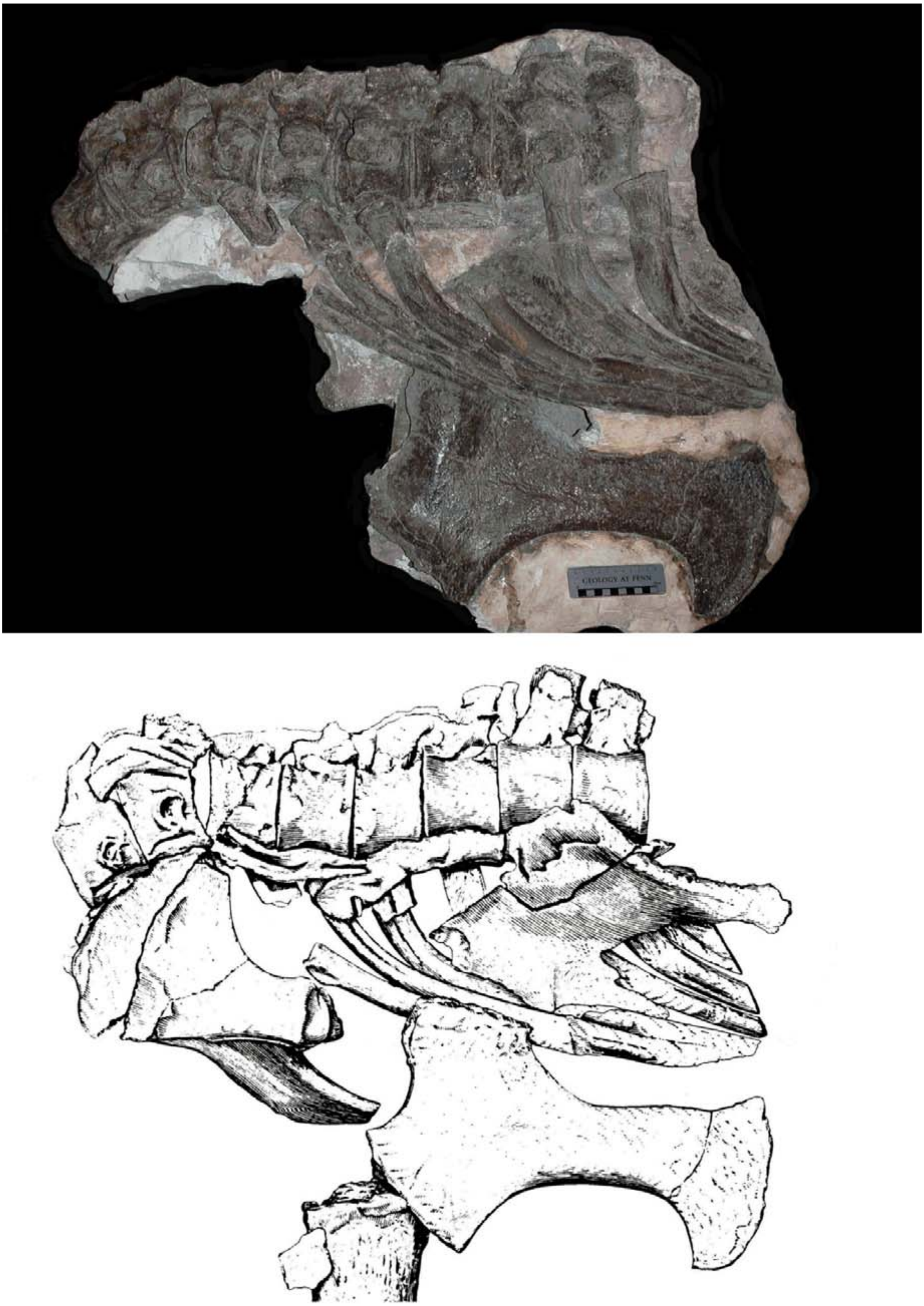

Figure 1. UCMP 33912, pectoral girdle (ventral view) in its original embedding posture. The figure below (from Welles, 1943, plate 13) shows also the scapula, which has been removed afterwards. Scale bar unit = 1 cm. Photograph by A. Hungerbühler.

Figure 2. UCMP 33912, right scapula in dorsal view. Scale bar unit = 1 cm. Photograph by A. Hungerbühler.

In Welles (1962, figure 20), however, the scapulae are figured in a different way without explanation. The revised figure shows a laterally widely diverging gap in the area of the scapula-coracoid contact so that only the medial-most corners of the coracoidal and scapular articular surfaces are in connection and the scapulae touch each other anteromedially over a long distance. Welles probably suggested that because of the large rugosities, a prominent cartilageous area was established here (see also Welles, 1943: 141). As other articulated pectoral girdles demonstrate, *e.g. Styxosaurus glendowerensis* (RMF R271, Sachs, 2004) and *Hydralmosaurus septimanicus* (AMNH 1495, Welles, 1962, figure 16), the scapulae and coracoids had no bony contact in elasmosaurids, but the distance between these bones was rather small, indicating that the suggested cartilage layer (Welles, 1943: 141) was not too prominent.

Welles (1943: 141) noted that the scapulae met in the midline. When articulating the scapulae with the coracoids (figure 3) it can be seen that a small section at the anteromedialmost part of the scapulae have met as has been reconstructed by Welles (1943: figure 8). A similar contact is established in *Styxosaurus snowii* (SDSM 451, formerly *Alzadasaurus pembertoni*, see Welles & Bump, 1949: figure 4) and *Styxosaurus glendowerensis* (RMF R271, Sachs, 2004). As shown by Carpenter (1999: figure 1) on basis of the cryptoclidid *Cryptoclidus eurymerus*, the scapulae can be far apart in the juvenile stage and grow together in the early adult stage. Similar conditions are also present in elasmosaurs (see Carpenter 1999: figure 6). However, in the adult and late adult stage they have usually been connected over a distance that is comparatively longer than present in UCMP 33912. Welles (1943: 141) suggested that the type specimen of *Hydrotherosaurus* might be a juvenile, however based upon some features (*e.g.* a well ossified skull, a co–ossified atlas–axis complex and neural arches fused with the vertebrae) the specimen is considered here to be adult.

Some elasmosaur taxa like *Elasmosaurus platyurus* and *Libonectes morgani* (Welles, 1952: figure 1; figure 2) have formed a pectoral bar that connected the scapulae and coracoids in the midline. Such a bar was clearly not developed in *Hydrotherosaurus alexandrae*.

Welles (1943: 142) indicated that the "two coracoids met in the midline with a 14 cm long suture." As mentioned before the coracoidal symphysis was not completely preserved (so only over 14 cm) at the right coracoid, while the one of the left is complete and supplements the other. Welles (1943) noted the asymmetry. However at the right coracoid a slight medial expansion is visible over the whole length of the corresponding left symphysis, indicating that the margin is not preserved instead of not developed as suggested and reconstructed by Welles (1943).

Interestingly the coracoid blade is narrow in its midsection and becomes widened at the posterior end. Although the posteromedialmost corner is not preserved it can be reconstructed by following the medial edge that it was only moderately medially expanded (figure 3). This is noteworthy because in most elasmosaurs a far larger medial expansion is present, giving the intercoracoidal foramen a heart–like shape. As the named slenderness of the coracoid blade and the minor medial expansion of the posterior coracoid section are apparently only present in *Hydrotherosaurus* these structures could be diagnostic at the genus level. However, this statement cannot be confirmed as we only know few pectoral girdles of Cretaceous elasmosaurs, which can safely be referred to a valid taxon.

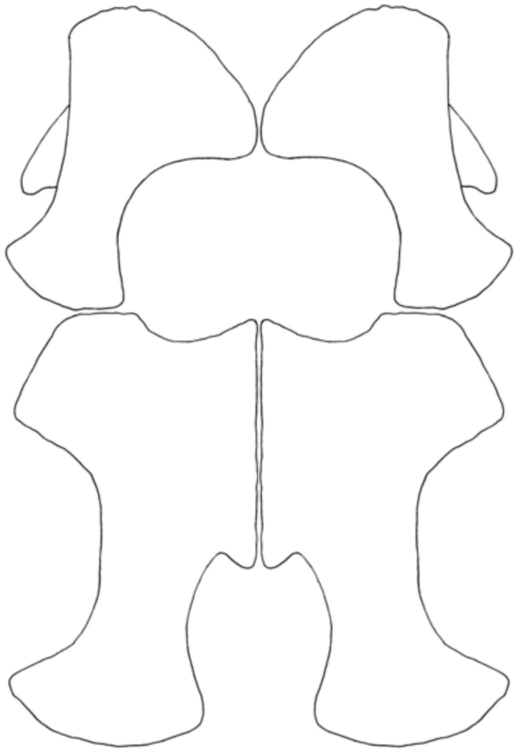

Figure 3. Schematic reconstruction of the pectoral girdle of Hydrotherosaurus alexandrae *in ventral view. Not to scale. Drawing by the author.*

4. Conclusions

The pectoral girdle of *Hydrotherosaurus alexandrae* is characterised by the following features: (1) the scapulae, which meet each other medially with the medialmost corner; (2) a long coracoidal symphysis, reaching over more than half of the length of the coracoids and (3) a narrow coracoid blade that posteromedially is only moderately expanded. The last named feature is unique for the taxon, but cannot be quoted as safe autapomorphy as ontogenetic variation cannot be proven. Prominent rugosities at the scapular articular surface, the glenoid fossa and at the coracoidal symphysis indicate the presence of moderate layers of cartilage. The reconstructed assemblage of the scapulae and the coracoidal symphysis is therefore similar to *Styxosaurus*.

5. Acknowledgements

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