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Platypterygius Huene, 1922 (Ichthyosauria, Ophthalmosauridae) from the Late Cretaceous of Texas, USA

Thomas L. Adams and Anthony R. Fiorillo

ABSTRACT

A partial ichthyosaur skeleton is described from the Grayson Marl (Late Cretaceous: Early Cenomanian, ~97 Ma) from Tarrant County, Texas. Prior to this discovery, the Cretaceous record of Texas ichthyosaurs consisted of isolated vertebrae. The new specimen consists of a partial disarticulated skull and postcranial elements including a postfrontal, parietal, quadrate, angular, surangular, several teeth, and several vertebrae including the atlas-axis complex, coracoid, and articulated partial forelimb. The forelimb is diagnostic in having a zeugopodial element anterior to the radius, rectangular phalanges, and an intermedium that does not make contact with the humerus allowing referral to *Platypterygius* von Huene 1922. This occurrence is the youngest of that taxon in Texas and is consistent with late European occurrences of the genus *Platypterygius*.

Thomas L. Adams. Roy M. Huffington Department of Earth Sciences, Southern Methodist University, Dallas, Texas 75275-0395 USA tladams@smu.edu
Anthony R. Fiorillo. Museum of Nature and Science, P.O. Box 151469, Dallas, Texas 75315 USA Tfiorillo@natureandscience.org

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INTRODUCTION

The Cretaceous ichthyosaur fauna has been traditionally referred to as a single genus, *Platypterygius* Huene, 1922 (McGowan 1972, Sander 2000). Several species have been recognized from the Albian and Cenomanian including *P. australis* and *P. longmani* (synonymized by Kear 2003, McGowan and Motani 2003) from Australia, *P. hauthali* from Argentina, *P. platydactylus* and *P. hercynicus* from Germany, *P. campylodon* from England and France, *P. kiprijanoffi* and *P. bannovkensis* from Russia, and *P. americanus* from North America (Nace 1939, Wade 1984, 1990, Bardet 1992, 1994, Maisch and Matzke 2000, McGowan and Motani 2003, Kear 2003, Fernández and Aguirre-Urreta 2005). Maxwell and Caldwell (2006) have argued for a second yet unnamed North American species (UALVP 45636) from Northwest Territories, Canada, based on four distal facets that occur on the humerus.

Until recently, all of the diagnostic *P. americanus* specimens have been recovered from Wyo-

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ming, and only fragmentary remains are known from Texas, Oregon, and British Columbia. The published record of Ichthyosaurs in Texas consists of isolated vertebrae (McNulty and Slaughter 1962, Slaughter and Hoover 1963). The identification of these Texas specimens was based entirely on stratigraphic occurrences and not on characters diagnostic at the generic level. We describe here a partial ichthyosaur skeleton (DMNH 11843) of *Platypterygius* Huene 1922 and briefly discuss the taxonomic utility of limb characters employed in species level diagnoses of ichthyosaurs.

Institutional Abbreviations. DMNH, Museum of Nature and Science, Dallas, Texas; MLP, Museo de La Plata, La Plata, Argentina; QM, Queensland Museum, Brisbane, Australia; UALVP, University of Alberta, Laboratory for Vertebrate Paleontology, Edmonton, Alberta, Canada; SMU, Southern Methodist University; UW, University of Wyoming.

STRATIGRAPHIC SETTING

DMNH 11843 was collected by L. and M. Duchouquette, and K. Bridges of the Dallas-Ft. Worth area (Duchouquette, personal commun., 2009). The locality that produced DMNH 11843 is now covered by a housing development, which is unfortunate given that the specimen was recovered near the contact between the underlying Grayson Marl (Late Cretaceous: early Cenomanian) and the overlying Woodbine Formation (Late Cretaceous: early middle Cenomanian). However, the fossil preservation exhibited by DMNH 11843 is very similar in appearance to other isolated ichthyosaur elements that are definitively from the Grayson Marl (e.g., SMU 76508) and unlike that of vertebrate fossil remains from the Woodbine Formation. Given this similarity, we are inclined to consider the lithologic source of DMNH 11843 as the Grayson Marl.

The Grayson Marl is a Cretaceous unit from the Comanchean series of north central Texas that overlies the Paw Paw Shale and Main Street Limestone (Kennedy et al. 2005). The section thins westward across Tarrant County by progressive truncation at the top (Foster 1965). The Grayson Marl is a calcareous, gray, blocky claystone interbedded with thin-bedded siltstone (Mancini 1982). The biozonation of the Grayson Marl is based primarily upon ammonites and foraminfers (Mancini 1979). Kennedy et al. (2005) pick the Late Albian – Early Cenomanian boundary at the bottom of the *Graysonites adkinsi* zone near the top of the Main Street Limestone in Tarrant County. This boundary coincides with the boundary of the *Mariella (Plesioturrilites) brazoensis* and *Graysonites adkinsi* Interval Zones (Mancini 1979). The rarity of keeled rotliporids in the Grayson Marl supports the paleoenvironmental interpretation of the Grayson as a normal inner to middle neritic depositional system (Mancini 1979).

MATERIALS

DMNH 11843 consists of disarticulated cranial and post-cranial elements. Cranial elements include a left postfrontal, left parietal, partial frontal, left quadrate, left angular, right surangular, and several teeth. Postcranial elements consist of 40 presacral and caudal vertebrae including the atlas-axis complex, partial ribs, right coracoid, a right humerus, which is badly crushed, and an articulated, partial left forelimb. Material is housed at the Museum of Nature and Science, Dallas, Texas.

SYSTEMATIC PALAEONTOLOGY

Order ICHTHYOSAURIA De Blainville, 1835
Family OPHTHALMOSAURIDAE Motani, 1999
Genus *PLATYPTERYGIUS* Huene, 1922

1922 *Myopterygius*; Huene, p. 98.

1922 *Platypterygius*; Huene, p. 99.

1927 *Myobradypterygius*; Huene, p. 27.

1985 *Simbirskiasaurus*; Ochev and Efimov, p. 76.

1997 *Plutoniosaurus*; Efimov, p. 77.

1998 *Longirostria*; Arkhangelsky, p. 66.

1998 *Pervushovisaurus*; Arkhangelsky, p. 66.

1998 *Tenuirostria*; Arkhangelsky, p. 66.

Type Species – *Platypterygius platydactylus* (Broili, 1907)

Diagnosis– Modified from McGowan (1972) and McGowan and Motani (2003) diagnosis of the genus, as pertaining to the forelimb. Humerus longer than wide with large dorsal and ventral trochanters; two distal facets for radius and ulna; radial facet smaller than ulnar facet; radial facet obliquely set so that its anterior margin is proximal to its posterior margin; an extra zeugopodial element anterior to the radius and a pisiform element, occasionally in contact with humerus via small facets; ulna wider (anteroposteriorly) than radius; intermedium does not contact humerus; phalanges rectangular; no digital bifurcation.

Referred Specimen. *Platypterygius* sp. DMNH 11843.

Occurrence. Fossil material was collected by Lee and Mendy Duchouquette, and Keven Bridges from the Grayson Marl (Late Cretaceous: Early Cenomanian) of Tarrant County, Texas, and donated to the Museum of Nature and Science. Locality information and correspondence is on file at the Museum of Nature and Science.

Description

Cranial Elements. The parietal is a rectangular shaped element anteriorly. Its sides diverge posteriorly to form the supratemporal process (Figure 1.1-1.2). The postfrontal is mostly complete (Figure 1.3-1.4). The anterior portion is dorsoventrally compressed and fan shaped with a crenulated margin. It is crescent shaped lateromedially, contributing to the lateral margin of the temporal fenestra. Posteriorly, the postfrontal is strut like and transversely compressed, forming a ridge on the ventral surface anteriorly. The quadrate is a concentric bone with a ventrally prominent articular condyle (Figure 2.1-2.2). The fragmentary frontal has a highly corrugated ventral surface (Figure 2.3-2.4).

The teeth are stout, conical, and slightly curved (Figure 3.1-3.2). The enamel extends one-third to one-half of the total crown length. The enamel exhibits fine regularly spaced longitudinal ridges. Below the base of the crowns, the teeth bulge slightly and are subrectangular in cross-section with coarser longitudinal ridges. A single tooth is preserved within a fragment of maxilla. The tooth is set into a dental groove without ankylosis, indicating an aulacodont implantation.

Vertebrae. The atlas-axis complex shows complete fusion, with the atlantal intercentrum fused with the atlas. There is no indication of sutures between the elements. Presacral vertebrae are discoidal, with an average height/length ratio of approximately 3.0 (Table 1). Position of rib facets indicate vertebrae ranging from the cervical to sacral regions. No neural arches are preserved.

Pectoral girdle. The coracoid is a broad plate-like element that is slightly wider (mediolaterally) than long (Figure 4). The articular margins are thicker and rugose. There is no indication of an anterior emargination of the coracoid.

Humerus. The proximal end of the right humerus is crushed anteroposteriorly (Figure 5). The distal end preserves all four facets. The left humerus is a short and robust element that is wider (anteroposteriorly) distally than proximally with an un-constricted shaft (Figure 6). This difference in width is most likely due to deformation during burial. Crest-like dorsal and ventral trochanters are restricted to the proximal portion of the shaft and decrease in size distally. There are four distinct articular facets on the distal surface. The two larger middle facets articulate with the radius and ulna, with the radial facet being concave and smaller than the ulnar facet. The posterior facet is half as small as either the radial or ulnar facet and articulates with the pisiform element. The smaller anterior facet articulates with the extra zeugopodial element.

Zeugopodium. The zeugopodium consists of four elements (Figure 6). The pisiform is rectangular in shape being longer than wide. It articulates with the humerus, ulna, and metacarpal five, but does not make contact with the ulnare. The ulna is both longer and wider than the radius. Its entire proximal surface articulates with the humerus. It is slightly concave on its distal surface and rounded on the antero-distal corner. The radius is roughly pentagonal and tapers posteriorly. It is obliquely set so that its anterior edge is proximal to its posterior edge. The anterior surface is concave and articulates with the anterior zeugopodial element. The extra zeugopodial element is rounded. Its proximal surface tapers slightly to fit into a small facet on the distal surface of the humerus.

Autopodium. The radiale is rectangular and lies distal to the radius. The intermedium is pentagonal and does not make contact with the humerus. It articulates between the radius' postero-distal corner and the ulna's antero-distal corner. The intermedium articulates with a single digit distally. The ulnare tapers anteriorly and lies distal to the ulna. Metacarpal five lies posterior to the ulnare and distal to the pisiform. The distal carpals and metacarpals, as well as the phalanges, are all rectangular in shape and do not form a mosaic pattern. The forelimb has only five digits preserved, but there are facets along both margins of the forelimb suggesting the presence of additional digits. There is no indication of digital bifurcation. The longest digit present preserves nine phalanges. The distal end of the forelimb is not present.

DISCUSSION

DMNH 11843 is identified as *Platypterygius* Huene, 1922 based on the presence of large dorsal and ventral trochanters, rectangular phalanges, and the ulnar facet anteroposteriorly wider than the radial facet. It differs from *Caypullisaurus* Fernández, 1997, in which the facet for the radius is larger than that for the ulna and with *Brachypterygius*

FIGURE 1. Cranial elements of DMNH 11843. **1.1** parietal, dorsal view, **1.2** ventral view; **1.3** postfrontal, dorsal view, **1.4** ventral view. Scale equals 10 cm.

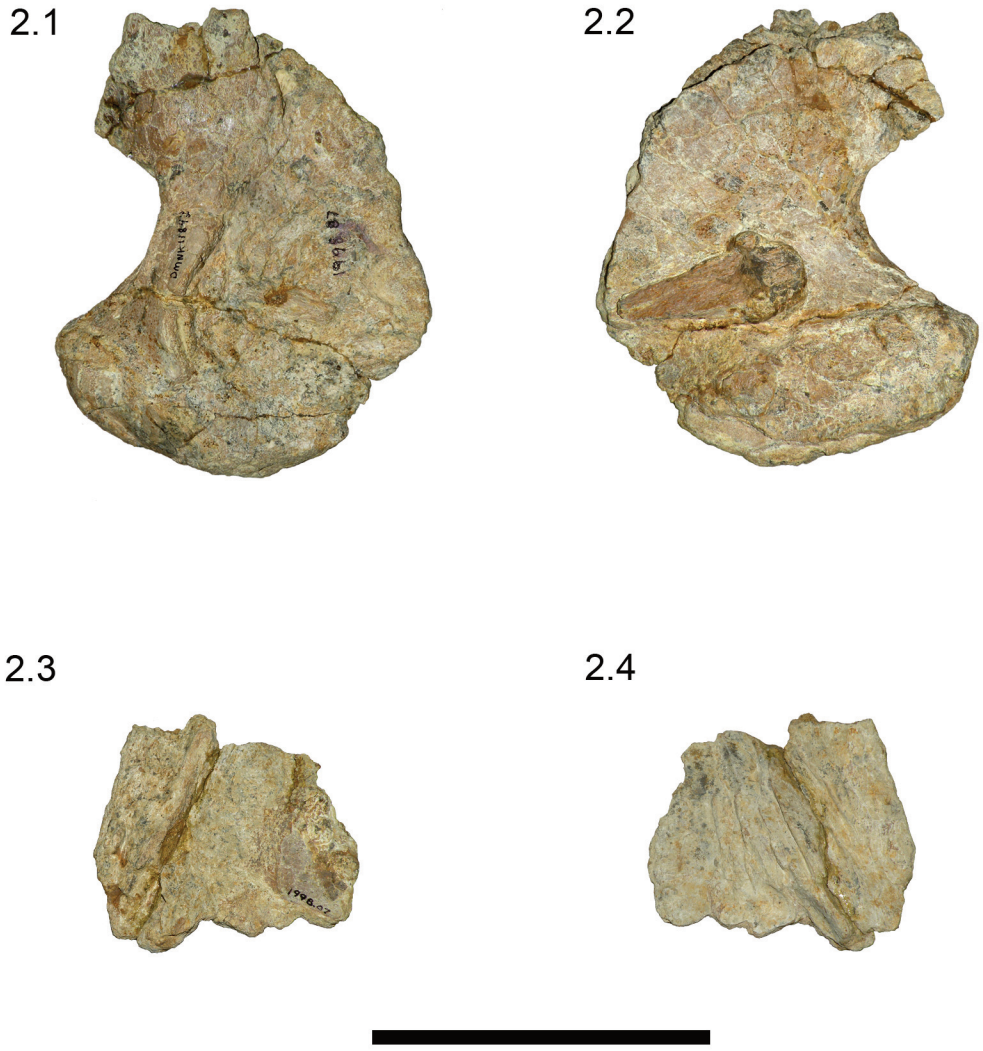

FIGURE 2. Cranial elements of DMNH 11843. **2.1** quadrate, lateral view, **2.2** medial view; **2.3** frontal, dorsal view, **2.4** ventral view. Scale equals 10 cm.

Huene, 1922, where the intermedium makes contact with the humerus.

DMNH 11843 is slightly larger than the now destroyed holotype of *Platypterygius platydactylus.* Based on this comparison, it is reasonable to estimate a total body length of 5 – 6 m for DMNH 11843 (Maxwell, written commun., 2009). DMNH 11843 is of similar size to the referred specimens of *Platypterygius americanus*, but the lack of more complete cranial material in this specimen prohibits DMNH 11843 from being described to species level with any degree of certainty.

DMNH 11843 differs from UALVP 45636, in which the end of the humerus is expanded more

FIGURE 3. Tooth of DMNH 11843 **3.1** labial and **3.2** lingual views. Scale equals 2 cm.

proximally than distally (Figure 7.1-7.2). It differs from *P. americanus* (Nace 1939), in which McGowan (1972) described only the radius, ulna, and pisiform making contact with the humerus (Figure 7.3). It also differs from *P. hauthali* Huene, 1927, where the intermedium articulates distally with two digits (Figure 7.4). DMNH 11843 is more consistent with *P. hercynicus* Kuhn 1946 and *P. australis* McCoy 1867, based on the number of elements distal to the humerus (Figure 7.5-7.6).

Wade (1984) stated that a "four-bone wide fore-arm" could be used to diagnose the genus *Platypterygius*, and the number of articular facets on the distal humerus can be used to differentiate species referred to that genus. Maxwell and Caldwell (2006) indicated that the four distal facets that occur on the humerus of UALVP 45636 are sufficient in recognizing a second unnamed species for North America.

However, Wade (1990) describes *P. longmani* (synonymized with *P. australis*) as occasionally having articulation with the extra zeugopodial element. Wade (1990, p. 129) also suggested that *P. hercynicus* demonstrated variability between right and left forelimbs. The left forelimb has facets for an anterior zeugopodial and pisiform element, but on the right forelimb there are no facets and these elements appear to make contact against the distal corners of the humerus. This within-individual difference would suggest individual variability. Arkhangelsky's (1998) and McGowan and Motani's (2003) diagnosis of the genus *Platypterygius* includes the description of pre- and post- axial accessory elements contacting the humerus, occa-

TABLE 1. Measurements of DMNH 11843 (in mm), max. L = maximum Length, max. W = maximum Width, max. p. W = maximum proximal Width, min. m. W = minimum middle Width, max. d. W = maximum distal Width, H/L = Height/ Length ratio.

Cranial	**max.L**	**max. W**
jugal	249	95
quadrate	144	89
post frontal	192	94
parietal	189	86

Post Cranial	**max. L**	**max. p. W**	**min. m. W**	**max. d. W**
scapula	141	128	71.8	60.35
coracoid	143	175		
	max. L	**max. p. W**	**min. m. W**	**max. d. W**
humerus	135	83.3	72.9	128.9
	Length	**Width**		
radius	36	56.2		
ulna	40.6	61.43		
radiale	38.5	44		
intermedium	32.26	50		
ulnare	28.12	39.46		

Presacral Centra	**Height**	**Width**	**Length**	**H/L**
atlas-axis complex	91.6	73.88	51.01	1.80
C1	87.45	87.44	25	3.50
C4	90.55	90.57	28.13	3.22
C5	82.43	81.42	24.97	3.30
C6	91.6	87.43	28.1	3.26
C9	80.18	81.19	29.13	2.75
C11	75.5	74.93	25.1	3.01
C12	87.43	85.37	27.8	3.14
C14	91.58	92.63	24.97	3.67
C16	70.99	70.78	27.08	2.62
C18	74.95	73.9	25.1	2.99
C20	80.14	-	31.24	2.57
C23	94.7	96.78	33.3	2.84
C25	92.62	90.53	32.25	2.87
C28	85.56	80.19	27.8	3.08
C29	82.25	80.15	28.13	2.92
C30	72.85	77.3	31.22	2.33
C33	88.48	86.38	29.14	3.04
Exact vertebra number unknown				
C?	87.45	85.38	29.13	3.00
C?	85.35	86.4	26.3	3.25
C?	91.6	92.6	30.2	3.03
C?	91.61	92.65	26.05	3.52
C?	94.69	93.66	29.12	3.25
C?	91.63	90.57	31.24	2.93

FIGURE 4. Right coracoid of DMNH 11843 in dorsal view. Scale equals 10 cm.

sionally via small facets. Given the amount of variability in *Platypterygius* Huene 1922 forelimbs, the presence of facets for an extra zeugopodial and pisiform element may not be a definitive character for diagnosing species.

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FIGURE 5. Right humerus of DMNH 11843. **5.1** posterior view; **5.2** anterior view. **Abbreviations:** ef, facet for extra zeugopodial element; pf, facet for pisiform; Rf, facet for radius; Uf, facet for ulna Scale equals 10 cm.

FIGURE 6. Left forelimb of DMNH 11843 in dorsal view. **Abbreviations:** e, extra zeugopodial element; H, humerus; I intermedium; p, pisiform; R, radius; r, radiale; U, ulna; u, ulnare. Arabic numerals are distal carpals, roman numerals are metacarpals. Scale equals 10 cm.

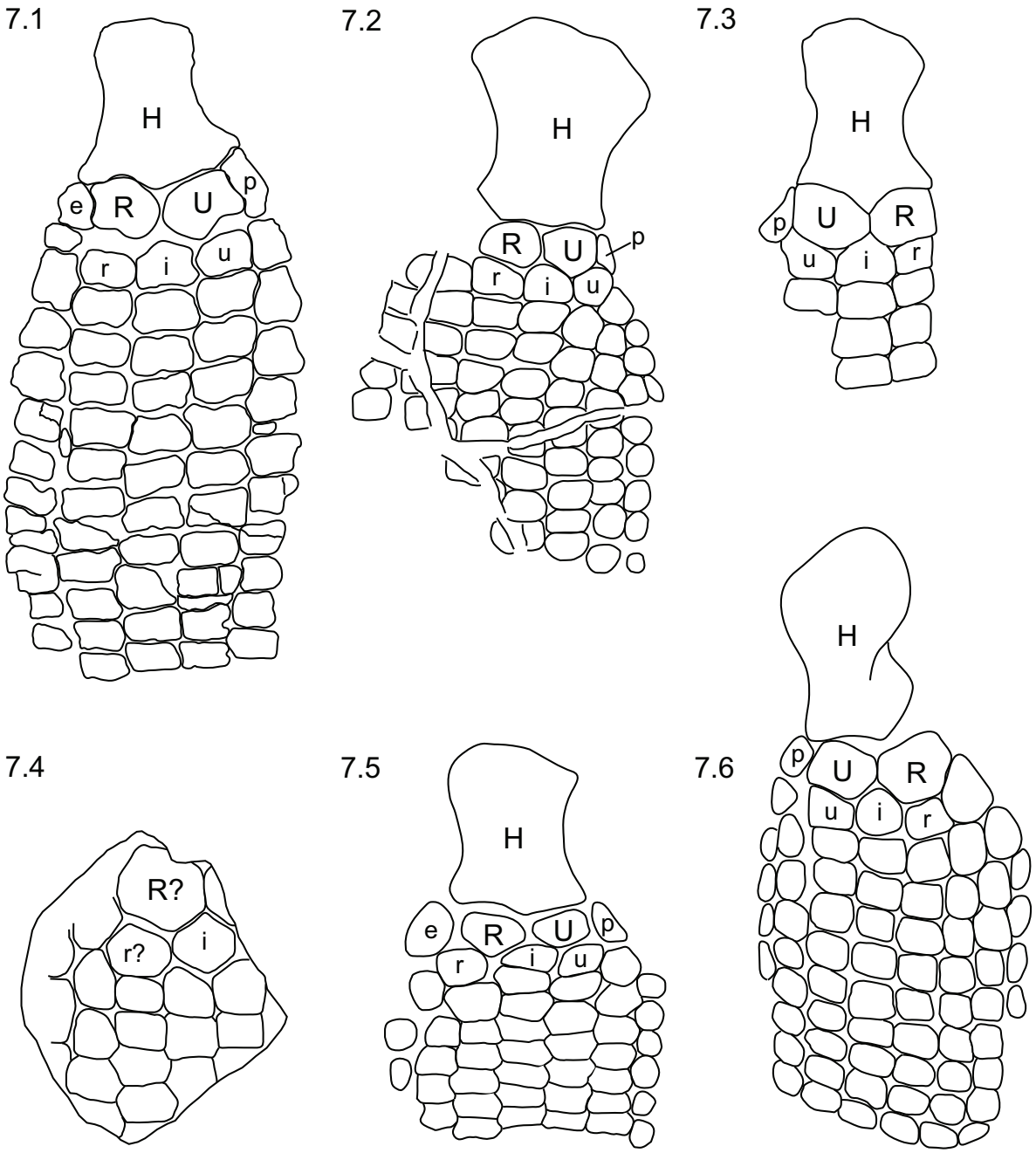

FIGURE 7. Comparison of forelimbs among different *Platypterygius* species. **7.1** DMNH 11843, left forelimb in dorsal view; **7.2** UALVP 45636, right forelimb in ventral view (modified from Maxwell and Caldwell 2006); **7.3** *P. americanus*, UW 2421, right forelimb in dorsal view (modified from McGowan 1972); **7.4** *P. hauthali*, MLP 79-I-30-2, position and view unknown (modified from Fernández and Aguirre-Urreta 2005); **7.5** *P. hercynicus*, left forelimb in dorsal view (modified from Maisch and Matzke 2000); **7.6** *P. australis*, QM F3348, right forelimb in dorsal view (modified from McGowan and Motani 2003). Abbreviations same as in Figure 4. Not to scale.