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A NEW ICHTHYOSAUR FROM THE UPPER CRETACEOUS MOWRY FORMATION OF WYOMING.

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ABSTRACT. *Myopterygius americanus* n. sp. is based upon the first specifically identifiable ichthyosaur remains found in the Cretaceous of North America, and is probably one of the most complete known post-cranial skeletons of this genus. Previous finds of ichthyosaurian remains in the North American Cretaceous, consisting only of fragmentary vertebral centra, have not been generically identifiable. The present specimen is described in detail and adds materially to our knowledge of the skeleton of the latest and most specialized of the ichthyosaur genera.

ALTHOUGH Cretaceous ichthyosaurs were believed by paleontologists to be cosmopolitan, their presence in North America during Cretaceous time was not demonstrated until 1905 when Merriam (9) announced the discovery of ichthyosaurian centra in the Benton (Upper Cretaceous), near the north end of the Medicine Bow Mountains, Wyoming. The material consisted of only two fragmentary, unidentifiable centra. Merriam inferred an affinity to the Jurassic genus *Ophthalmosaurus* ("*Baptanodon*"). A second ichthyosaurian find, from the Mowry member of the Benton group near Casper, Wyoming, was announced nine years later by Gilmore (2). Gilmore noted a strong similarity between these vertebrae and those of *Ophthalmosaurus*. Neither Merriam's nor Gilmore's material was figured or described in detail. In 1928 Merriam and Gilmore (10) announced another discovery, in the marine Cretaceous of Wheeler County, Oregon. The material was described as the complete 3d or 4th cervical centrum and the lateral half of a dorsal centrum.

The specimen upon which the present contribution is based was discovered by Mr. Paul Peterson of Upton, Wyoming. In the summer of 1938 the fossil was shown to Mr. Jack Heathman, of the Geological Survey of Wyoming, who brought part of the skeleton to the University of Wyoming. The remains were called to the writer's attention in late November, at which time he visited the fossil site in company with Mr. Peterson and Mr. Heathman and excavated the remaining preserved portion of the skeleton. Since Cretaceous ichthyosaurs have been scarcely mentioned in North American literature, the

specimen merits detailed description. The writer is indebted to Dr. S. H. Knight, Director of the Geological Survey of Wyoming, for the privilege of collecting and describing this rare fossil. Valuable assistance has been rendered by Mr. R. J. Loeffler, of the University of Wyoming, who abstracted publications in the John Crerar and Chicago Public libraries not available at the University of Wyoming.

Order Ichthyosauria.

Family Stenopterygidae.

Genus *Myopterygius* von Huene, 1922.

The following diagnosis is amplified from von Huene's original characterization of the genus (5, p. 99):

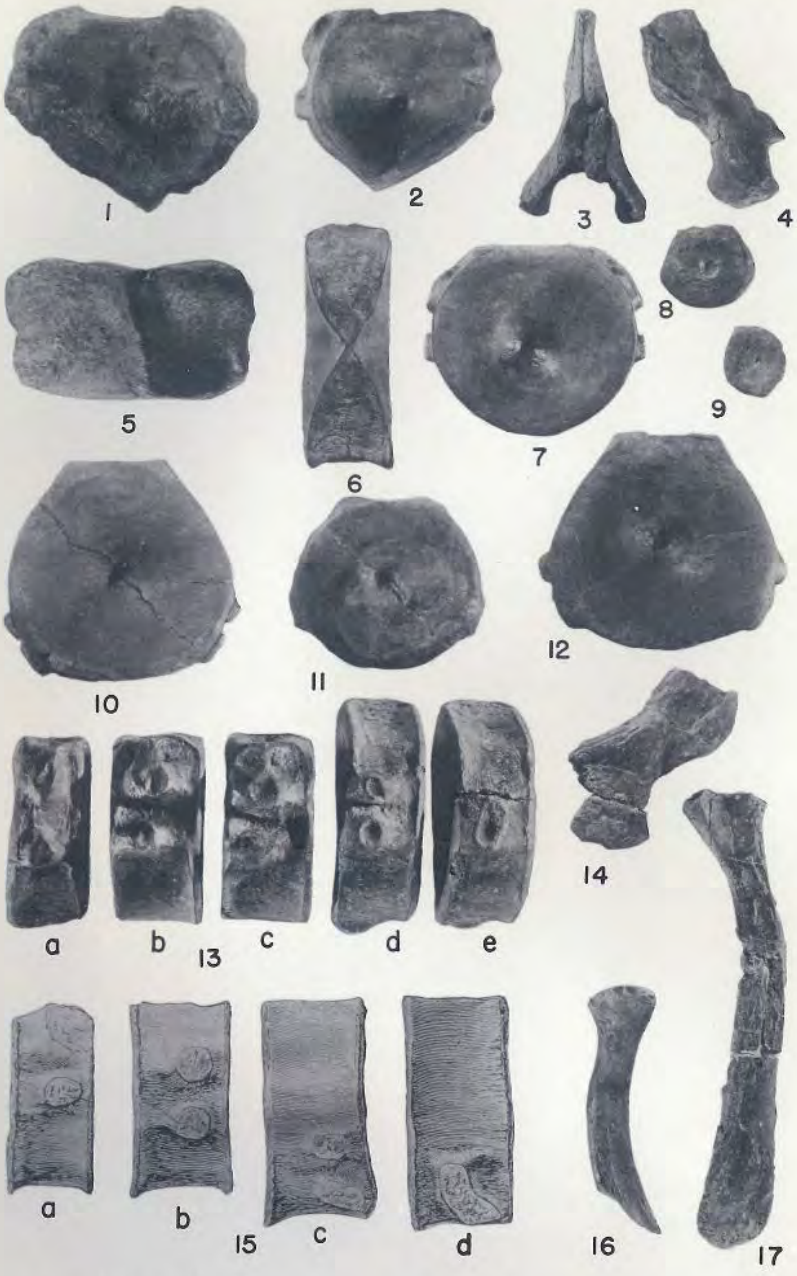
Skull relatively large with long, slender snout. Maxilla large; broad backward, reaching far under orbit; slender forward, reaching scarcely to the nares. Rear half of premaxilla high. Teeth conical, with sharp, narrow flutings in the crown enamel; roots long, expanded, with dentine folds enclosed by cement sheath. Vertebrae short. Cervical centra subpentagonal to cordiform, broader than high; sometimes with prominent ventral keel. Dorsal centra variable in proportion of height to width; round, oval or pyriform in shape; ventral margin smooth or longitudinally furrowed. Caudal centra commonly higher than wide. Neuropophyseal facets of cervical and anterior dorsal centra wide apart; costal tubercles of same double, widely spaced in front, converging backward, marginal or central in position. Vascular perforations numerous in anterior centra. Humerus with two large distal facets, and sometimes a third small one. Femur very short, with two large distal facets. Humerus and femur both with large, expanded dorsal and ventral trochanteric masses, proximally thickened antero-posteriorly. Radius and ulna transversely elongate; intermedium never in contact with humerus. Fins latipinnate; phalanges rectangular to irregularly polygonal.

Myopterygius americanus, n. sp.

Plates I-II.

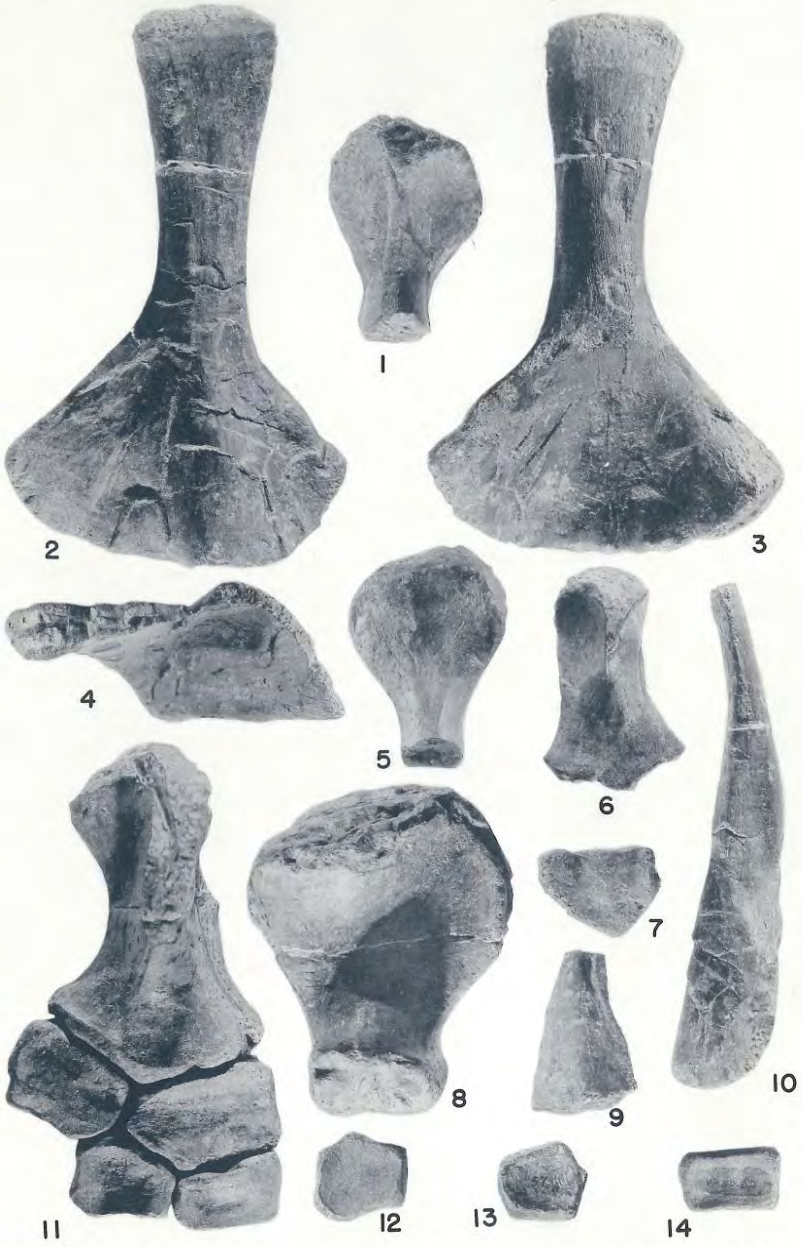
Type.—Holotype; major portion of postcranial skeleton, University of Wyoming Geological Museum No. VP50.

Horizon and locality.—Uppermost part of Mowry shale member of Graneros formation, 2 feet below base of Clay Spur



FIGS. 1-14, 16-17—*Myopterygius americanus* Nace, n. sp. 1. Axis-atlas, anterior view; 2, 3d cervical centrum, posterior view; 3, 16th(?) neural arch and spine, frontal view; 4, same, right side; 5, atlas-axis, ventral view; 6, 38th centrum (2d caudal), cross-section; 7, 17th centrum, posterior view; 8, 70th centrum (34th caudal), anterior view; 9, 72d centrum (36th caudal), anterior view; 10, 36th centrum (19th dorsal), anterior view; 11, 60th centrum (24th caudal), anterior view; 12, 34th centrum (17th dorsal), anterior view; 13, lateral view of centra: a—3d cervical, b—17th cervical, c—18th centrum (1st dorsal), d—36th centrum (19th dorsal), e—37th centrum (1st caudal); 14, 5th(?) neural arch and spine, lateral view; 16, anterior caudal rib; 17, mid-dorsal rib. All figures X 4/10.

FIG. 15—*Ophthalmosaurus*, after Gilmore (1, fig. 18). A, anterior cervical centrum; b, anterior dorsal centrum; c, dorsal centrum; d, posterior dorsal or anterior caudal centrum. X 1/3 (approximate).



FIGS. 1-14—*Myopterygius americanus* Nace, n. sp. 1, left femur, frontal view; 2, left scapula, medial view; 3, left scapula, lateral view; 4, left scapula, articular view; 5, left femur, posterior view; 6, left femur, dorsal view; 7 right(?) ischio-pubis, external(?) view; 8, left humerus, frontal view; 9, right(?) ilium; 10, left scapula, front view; 11, left humerus and partial paddle assemblage, dorsal view; 12-14, miscellaneous phalanges. X 4/10.

bentonite bed; NE¼SW¼ sec. 17, T. 49 N., R. 65 W., Crook County, Wyoming.

Name.—The specific name alludes to the first recorded occurrence of the genus *Myopterygius* in North America.

Specific characters.—No intercentra retained in cervical region. Cervical and anterior dorsal centra with no conspicuous flattening of peripheral areas of posterior and anterior faces. Dorsal centra slightly more than half as large as in *Myopterygius campylodon* (Carter), as figured by Owen (11, Fig. 3). Central depression of centra with sharper apex than in *M. campylodon.* Pronounced hypophyseal keel on 3d cervical centrum; keel progressively less conspicuous on succeeding centra, disappearing behind the 12th. Diapophysis and parapophysis of 3d cervical centrum connected by a low, sharp ridge of bone. Amphicoely extreme in the dorsal and anterior caudal regions, most conspicuously so at about the 20th centrum (3d dorsal). Zygapophyses coalesced to form a single median facet at least as far forward as the 5th cervical, possibly throughout the vertebral column. Three distal facets on the humerus, the third posterior in position and very small. Humerus and femur with enormously developed trochanteric masses extending almost their entire length. Anterior surface of femur with strong, sharp ridge extending from head to anterior margin of tibial facet.

Material.—The species is based on the following material: 69 vertebral centra; complete series of 17 cervical centra; 14 dorsal centra, apparently including all but five of the complete series; several fragments of centra, apparently from the dorsal region; 38 caudal centra, representing a complete series as far back as the 3d or 4th centrum below the caudal flexure. Two nearly complete neural arches and spines; various fragmentary arches. One complete posterior dorsal rib; numerous rib head and shaft fragments; various fragmentary abdominal ribs. Left scapula complete; right scapula with free (distal) end and part of coracoid portion missing. Both humeri complete, the right one crushed and distorted, the left one nearly perfectly preserved. Right and left ulnae and radii; right intermedium and ulnare; 17 miscellaneous phalangeal elements, possibly representing parts of all the paddles. Right(?) ischiopubis and lower or articular part of right(?) ilium. Both

femora perfectly preserved. The specimen apparently was rolled and partly disarticulated on the sea-floor prior to burial. Most of the limb and girdle elements and many of the centra were either detached or completely isolated. The 43d to 74th centra were found still articulated.

Description.—In the following description the fused atlas-axis is counted as two vertebrae, so that the first succeeding cervical centrum is No. 3, the next No. 4, etc. Also it is inferred that the 21st and 23d-26th centra are missing, but successive vertebrae are numbered as though these were present. The writer adheres to convention in designating as "cervicals" the centra with double rib tubercles in which the diapophyses are confluent with the neuropophyseal facets, as "dorsals" those which have two distinct rib tubercles, and as "caudals" those which have a single tubercle. It is to be emphasized, however, that in an ichthyosaur as highly specialized as *Myopterygius* there probably was no sharp functional distinction between the vertebrae of the different regions. For convenience of description the "bend" where the vertebral column turned downward into the caudal fin is called the *caudal flexure.*

The atlas and axis are indistinguishably co-ossified, as is usual in adult ichthyosaurs. The resultant compound element, though somewhat distorted by post-mortem processes, is subcordiform in outline and is much wider than high (Pl. 1, Fig. 1). Both the anterior and posterior concavities of the centrum slope inward from the margin with no appreciable peripheral flattening. Near the center the concavity slopes more sharply than near the margins, especially on the posterior side of the centrum. A distinctive character of this element is the prominent ventral keel. A similar keel was noted by Merriam and Gilmore (10) on the 3d cervical centrum found in the Oregon Cretaceous. To this they applied the term, *hypophyseal keel*, which is here adopted. The keel is 12 mm. deep (Pl. 1, Fig. 5), but is somewhat weathered, and was probably even more prominent on the living bone. Gilmore (1, p. 103) noted that on the atlas-axis of *Ophthalmosaurus* the ventral surface

> "is produced into a subtriangular face which looks downward and backward . . . This would be the articulation for the third intercentrum if that bone still exists as a separate element in this form."

In *Myopterygius americanus* no trace of a post-axial intercentrum is present, and there is no process or articular surface

for it. That the keel on the atlas-axis is not a modification of such a prominence is shown by the persistence of the keel backward as far as the 12th cervical.

The third cervical centrum is cordiform in outline, slightly broader than high, with a hypophyseal keel 5 mm. deep (Pl. 1, Fig. 2). Both the keel and the ventral margin of the centrum slope upward posteriad (Pl. 1, Fig. 13a). The costal tubercles are connected by a low, sharp ridge of bone. This character is shown by none of the other centra. The 4th to 6th cervicals are weathered and somewhat crushed, and no reliable measurements can be made. There is, however, a small but definite decrease in size of the centra backward as far as the 6th cervical, after which the height increases gradually to the 37th (1st caudal), the highest centrum of the column. Posteriad from the cervical region the centra increase in length only as far as the 20th (3d dorsal), the longest centrum of the series. Behind the 3d cervical the hypophyseal keel progressively diminishes; it is reduced to a small blunt ridge about 1 mm. deep on the 8th cervical. On four succeeding centra the keel is indicated only by a slight secondary curvature of the ventral outline of the centrum. There is no evidence of a keel behind the 12th cervical. Concurrently with the diminution and disappearance of the keel, the outline shape of the centra changes from cordiform to subcordiform, and finally becomes nearly round at the 17th (last) cervical, which is only 2 mm. wider than high (Pl. 1, Fig. 7). The height and breadth are exactly equal in the 20th centrum (3d dorsal). Backward from the 22d centrum (5th dorsal) the proportion of height to width is somewhat variable; the outline shape becomes subangular to pyriform, and the widest part of the centra is near the base, close to the position of the parapophyses (Pl. 1, Fig. 10). The subangular form is most pronounced at about the 34th centrum (17th dorsal) (Pl. 1, Fig. 12). Behind that the centra again tend to become round in outline, though there is some angularity as far back as the 67th centrum. The 70th and 71st centra are quite round (Pl. 1, Fig. 8), but the 72d to 74th are oval (Pl. 1, Fig. 9). The latter are the only centra in which the height exceeds the width.

In the first 36 centra there is no appreciable flattening of the peripheral parts of the articular concavities. In all, however, there is a central more sharply depressed area. The centra are all deeply amphicoelous. In a few the central exca-

vations almost pierce the centra, though none are actually notochordal. The most deeply amphicoelous centrum is the 20th (3d dorsal), in which the length through the functional center is only 1.5 mm. In centra immediately behind the 36th the peripheries are somewhat flattened for about one-half the radius, then slope abruptly toward the center (Pl. 1, Fig. 6). Posteriad the flattened areas progressively include more and more of the faces of the centra, and the last six preserved are almost flat, with a very small but deep, cone-shaped central depression. In the 71st centrum (35th caudal) the cone is only 5 mm. wide at the open end, while the centrum itself is 20 mm. wide.

Costal tubercles and facets are present on all the collected centra except the last four (71st-74th); they are paired on the first 36. In the first 16 the diapophyses are confluent with the neurophophyseal facets on the dorsal surface of the centra (Pl. 1, Fig. 13a). Separation of the diapophyses and neurophyseal facets is incipient on the 17th centrum, on which the two are connected only by a narrow bridge of bone (Pl. 1, Fig. 13b). Separation is complete on the 18th centrum (1st dorsal) (Pl. 1, Fig. 13c). The specimen in this respect agrees essentially with *Ophthalmosaurus*, in which Gilmore (1, p. 105) inferred that the separation occurs on the "sixteenth or later" centrum. Behind the 17th centrum the paired costal tubercles descend positionally on successive centra, so that on the 36th the parapophyses are ventrolateral (Pl. 1, Fig. 13d). On succeeding centra the single remaining tubercle maintains the ventrolateral position as far as the 52d (Pl. 1, Fig. 13e), after which they gradually ascend to a nearly central position on the 70th, the last centrum which bears rib facets.

On cervical and anterior dorsal centra the lateral distance between the dorsal neuropophyseal facets is remarkably large. The greatest distance was measured on the atlas-axis where it is 25 mm. This diminishes to 16 mm. on the 5th dorsal. The anterior pair of articular facets on the atlas-axis is much smaller than the posterior pair. Probably the anterior arch and spine was much reduced. The neural arch and spine shown in Pl. 1, Figs. 3-4, seems to belong to the 16th centrum, though it was not found articulated. On this arch the zygapophyses are single, fore and aft, the originally paired facets having coalesced to form a single, median articular surface. Another arch in the collection, probably from the 5th cervical, is com-

plete to the base of the spine (Pl. 1, Fig. 15), with enough of the zygapophyses retained to show that here also they are single. If the position of this arch is correctly determined, coalescence of the originally paired facets occurs farther anteriad than in *Ophthalmosaurus*, in which Gilmore (1, p. 107) found the union to occur between the 6th and 9th cervical arches. Nine additional incomplete neural arches in the collection show no trace of paired zygapophyses. Possibly they had coalesced throughout the column in this species. The 5th(?) neural spine is much broader than the 16th(?), especially near the base. The articular facets on the pedicles of the anterior neural arches are bluntly subtriangular. On the 16th(?) arch they are elongate-elliptical; on the dorsals they are very long and narrow.

Ribs preserved in the collection show no diagnostic characters. They were apparently moderately robust and comparatively short, with broadened, spatulate distal ends. The only complete rib in the collection is from the mid-dorsal region (Pl. 1, Fig. 17). It is double-headed but not forked. Wide spacing of the costal tubercles on the cervical centra indicates that in that region the cervical ribs were probably forked, as well as double-headed.

The scapula is moderately long and powerful, with the lower or articular end greatly expanded antero-posteriorly (Pl. II, Figs. 2-3). The anterior and posterior borders are strongly concave. The articular end is markedly convex on the medial side and concave on the lateral side. The posterior portion of the articular end is thickened where it entered into the formation of the glenoid fossa (Pl. II, Fig. 4). Anteriad from the thickened glenoid portion, the edge is thin where it articulated with the coracoid. The coracoid portion of the scapula is antero-posteriorly bent, forming an obtuse angle of about 55 degrees. The proximal expansion of the scapula is thus markedly convex on the medial side and concave on the lateral side. Longitudinally the shaft of the scapula is gently curved, with the concavity on the medial side (Pl. II, Fig. 10). The distal end is flattened and somewhat spatulate. Near the middle of the anterior border of the shaft there is a flattened area, elliptical in shape, apparently for ligamentous attachment of the clavicle, as in *Ophthalmosaurus*. Unfortunately other elements of the shoulder girdle were not preserved.

Elements of the left pectoral limb were found associated as

shown in Pl. II, Fig. 11. The humerus is the most distinctive bone in the skeleton. It is proportionately extremely short, but very substantially and powerfully constructed (Pl. II, Figs. 8, 11). A relatively enormous trochanteric ridge on the dorsal surface extends nearly the whole length of the bone. A complementary ridge is present on the opposite, ventral side, but is less prominently developed. The proximal end of the humerus is thus greatly expanded dorso-ventrally. The portion of the humerus which entered the glenoid cavity of the shoulder girdle is somewhat expanded antero-posteriorly, and considerably roughened, probably for attachment of a cartilaginous pad. The left humerus, though the best preserved of the two, is somewhat crushed in the proximal half of the posterior surface. Distally the humerus has two conventionally large facets for articulation with the radius and ulna. There is a small third surface in the usual position of the pisiform facet. Apparently, however, the pisiform bone was lost in the *Macropterygius-Myopterygius* stem (von Huene, 5, p. 100), and the extra facet, when present, is for articulation of the proximal member of a post-ulnar supernumerary row of marginal phalanges. The radius (Pl. II, Fig. 11) is roughly subpentagonal in outline and somewhat wider than long. Its anterior border was thin and smooth, except at the fronto-distal corner, where it is somewhat thickened, with a small facet for articulation with a phalangeal element. The ulna, also roughly pentagonal, is considerably larger than the radius, with the proportion of width to length much greater. On the posterior margin of the ulna there is a well developed face for articulation with a posterior marginal element which was not recovered. This was undoubtedly the same element which articulated with the small third facet on the humerus. The ulnare has no characters which distinguish it from phalangeal elements, other than a strongly developed flange on its proximal edge. The intermedium was moderately large but did not project between the radius and ulna to an articulation with the humerus.

The paddles were obviously latipinnate. Most of the phalangeal elements recovered are rectangular or subrectangular in outline, as in some other specialized latipinnates (Pl. II, Fig. 14), though a few are polygonal (Pl. II, Figs. 12-13).

Two dissociated elements in the collection appear to be the ischio-pubis and ilium of the right side (Pl. II, Figs. 7, 9). The ischio-pubis is complete and well preserved, but has no out-

standing characters other than its extreme simplicity and vestigial size. The upper end of the ilium is missing. The lower end is greatly expanded, both laterally and antero-posteriorly.

The femur, though much reduced, is constructed on a robust plan similar to that of the humerus. Most of the length of the femur is occupied by a relatively enormous trochanteric ridge on the dorsal surface, and a complementary though less exaggerated ridge on the ventral surface. The anterior surface of the femur is occupied by a high, sharp ridge which extends from the head to the frontal margin of the tibial facet (Pl. II, Fig. 1). The posterior surface is quite smooth, with a gentle undulation near the head (Pl. II, Fig. 5). Distally the femur has two articular facets, of nearly equal size, for articulation with the tibia and fibula.

Remarks.—All previously named species of Cretaceous ichthyosaurs have been described from abroad. Many have been based on fragmentary material and are little more than names in the literature. Von Huene (5, p. 102) recognized two Cretaceous genera: *Macropterygius* and *Myopterygius*. *Macropterygius* ranges from Middle Jurassic to late Lower Cretaceous (Dogger to Aptian). *Myopterygius*, an offshoot of *Macropterygius*, ranges from Lower Cretaceous to middle Upper Cretaceous (Senonian). Von Huene (5, p. 101) pointed out that "In the body skeleton of *Myopterygius* general distinctions from *Macropterygius* are not known."[1] It is hoped that the present contribution may aid establishment of such distinctions by writers who have access to foreign material, since the type of *Myopterygius americanus* is one of the most complete body skeletons of this genus yet to be found. The chief known distinctions between the two genera are in the paddles, and on this basis there is no question of the affinities of the Mowry species. It appears to be distinguished from other members of the same genus chiefly by the characters of the vertebrae. The pronounced hypophyseal keel is distinctive. Merriam and Gilmore (10) described a small hypophyseal keel on the centrum from the Oregon Cretaceous. This may indicate affinity of the specimen to *Myopterygius*, but the great size of the centrum indicates a species different from the writer's. Von Huene (5, p. 98) tentatively assigned Merriam's Benton specimen to *Myopterygius*, but Hay (3, p. 128) referred it and Gilmore's

[1] "Im stammeskelett von *Myopterygius* sind allgemeine Unterschiede von *Macropterygius* nicht bekannt."

Mowry specimen to *Ophthalmosaurus*. The known range of *Ophthalmosaurus*, however, seems to exclude the possibility that any of the Benton specimens can belong to it.

A remarkable character of the vertebral column of *M. americanus* is the fact that the centra attain their greatest size in the posterior dorsal and anterior caudal regions. This specialization was doubtless a response to the need for strong attachments for the great muscles which manipulated the caudal fin. The writer is of the opinion that some of the centra here called anterior caudals, because they have only one costal tubercle, are actually posterior dorsals. This opinion involves the assumption that coalescence of the diapophyses and parapophyses was progressing forward, resulting in a single tubercle in the posterior dorsals. The only evidence for this opinion is (1) the very small number of double-faceted "dorsals," (2) the proportionately great shortness of this "dorsal" series, (3) the relatively great number of the single-faceted "caudals," (4) the great length of the "caudal" series in front of the caudal flexure.

The writer's specimen furnishes some evidence on the possible homology of the single costal tubercle of ichthyosaurian caudal centra. Gilmore (1, pp. 106-107) has cited Owen's opinion that in "Ichthyosaurus" the tubercle is a result of backward convergence and coalescence of the diapophysis and parapophysis. Gilmore contended, however, that in *Ophthalmosaurus* the single tubercle is apparently not a product of union, but rather appears to be the true parapophysis, and that the diapophysis is merely lost in the caudal region. As evidence he figured the *Ophthalmosaurus* centra which are here reproduced (Pl. 1, Fig. 15), remarking:

> "It will be noticed in the cervical [15a] region that the diapophysis presents the more robust articular surface of the two; the interior dorsal [15b] shows the two facets nearly equal; the median dorsal [15c] indicates an increase in size of the parapophysis with a corresponding decrease of the diapophysis. It will be observed that in all three regions the distance between the facets remains about constant."

It seems to the writer that some of the facts, as shown in the figure, are at variance with Gilmore's statements and conclusions. On centra 15a, b, c the distances between the edges of the facets are, respectively, 10.9 mm., 8.9 mm., and 8.5 mm. There is, then, at least a slight actual convergence of the fa-

cets. When it is considered that 15c is about 14 percent larger than 15a this convergence assumes significance. A very small part of the convergence may be only apparent; in the preparation of the drawings the draftsman was looking at the tubercles on 15c obliquely and there may have been some apparent convergence due to parallax. This would not apply to 15b, however. In Pl. I, Fig. 13 a series of vertebrae of *Myopterygius* is shown. Here the vertebrae are all oriented with the tubercles aligned so that no parallax distortion occurs. The convergence of the apophyses is very marked in these centra, as shown by the following measurements between the edges of the costal facets:

13a—12 mm.	13c—7.8 mm.
13b— 9.7 mm.	13d—4 mm.

Moreover the general shape and appearance of the single face on the first caudal centrum (Fig. 15e) suggests a result of coalescence of two adjacent tubercles, as held by Owen, rather than by accentuation of the parapophysis and disappearance of the diapophysis, as suggested by Gilmore. Such an inference, likewise seems more harmonious with observed characters of ichthyosaur ribs. In the anterior region they are double-headed and distinctly forked. Farther back they become merely double-headed, without apparent forking (Pl. I, Fig. 17). Eventually the two heads appear to merge to form the single head of the caudal ribs (Pl. I, Fig. 16).

Since the writer's specimen is a new species it cannot as yet be used for close intercontinental correlation. The following stratigraphic note, for which the author is indebted to Mr. Heathman, may prove of future value:

> "The remains of *Myopterygius americanus* were found in the Mowry shale member of the Graneros formation. They occurred two feet below the base of the Clay Spur bentonite bed, which marks the top of the Mowry shale in the Black Hills and adjacent areas (Rubey, 14, p. 4). The Mowry immediately underlies the Belle Fourche shale, the top member of the Graneros formation. Elsewhere the Mowry shale is ranked as a formation. Rubey (14, pp. 4-5) considered the Graneros the oldest Upper Cretaceous formation in the Black Hills region. Previously (13) he held that the Mowry is a time equivalent of the Aspen formation of western Wyoming.
>
> "A badly weathered and fragmented skull of another ichthyosaur was noted south of Clifton, Wyoming, at the same horizon as that which yielded the type of *M. americanus*."

MEASUREMENTS OF SKELETON.

	mm.
Atlas-axis (1st and 2d cervicals)	
Height, including ventral keel	54
Width	65
Depth of ventral keel	12
Length, at margin	37
Length, through center	10
3d cervical centrum	
Anterior height, including ventral keel	57
Posterior height, including ventral keel	52
Width	57
Depth of ventral keel	5
Length at margin	23
Length through center	2.5
8th cervical centrum	
Height including ventral keel	53
Width	52
Depth of ventral keel	1.5
Length at margin	21
Length through center	4.5
15th cervical centrum	
Height	53
Width	56
Length at margin	25
Length through center	2.5
17th cervical centrum	
Height	53
Width	55
Length at margin	26
Length through center	2.3
3d dorsal (20th centrum)	
Height	56
Width	56
Length at margin	27
Length through center	1.5
17th dorsal (34th centrum)	
Height	61
Width	65
Length at margin	25
Length through center	2.5
24th caudal (60th centrum)	
Height	50
Width	51
Length at margin	17
Length through center	2.5
31st caudal (67th centrum)	
Height	30
Width	33
Length at margin	13
Length through center	4.5
36th caudal (72d centrum)	
Height	18
Width	17
Length at margin	11
Length through center	6

Mid-dorsal rib	
Length	129
Width of distal end	21
Width of head	23
Left Scapula	
Antero-posterior width, articular end	108
Antero-posterior width, distal end	44
Length	173
Width of center of shaft	27
Thickness of center of shaft	24
Thickness of glenoid portion of articular end	18
Thickness of coracoid portion of articular end	4–9
Maximum thickness of distal end	10
Left humerus	
Length	103
Greatest antero-posterior width of proximal end (approximate)	42
Least antero-posterior width of shaft (approximate)	31
Greatest antero-posterior width of distal end	68
Greatest dorso-ventral thickness	82
Least dorso-ventral thickness	37
Greatest dorso-ventral thickness of distal end	42
Width of ulnar facet	36
Width of radial facet	32
Width of supernumerary facet	11
Left radius	
Length	34
Width	39
Left ulna	
Length	35
Width	47
Ischio-pubis	
Greater length	37
Lesser length	26
Thickness	5–14
Ilium	
Thickness of shaft at broken end	7
Width of shaft at broken end	13
Greatest thickness of lower end	15
Greatest width of lower end	32
Left femur	
Length	66
Greatest antero-posterior width of proximal end	25
Greatest antero-posterior width of distal end	42
Greatest dorso-ventral thickness	46
Least dorso-ventral thickness	18
Width of tibial facet	26
Width of fibular facet	21

REFERENCES.

1 Gilmore, C. W.: Osteology of *Baptanodon* (Marsh): Carnegie Inst. Washington Mem., Vol. II, No. 2, pp. 77-129, Pls. VII-XII, 1905.

2 ———: A second occurrence of ichthyosaurian remains in the Benton Cretaceous: Science, NS., Vol. 39, p. 210, 1914.

3 Hay, O. P.: Second bibliography and catalogue of the fossil Verte-

brata of North America: Carnegie Inst. Washington Pub. No. 390, Vol. II, pp. 127-129, 1930.

4 Hector, J.: On the fossil Reptilia of New Zealand: Trans. New Zealand Inst., Vol. 6, p. 335, Pls. 27-31, 1873.

5 Huene, F. von: Die Ichthyosaurier des Lias und ihre Zusammenhänge: Berlin, Gebrüder Borntraeger, 114 pp., 22 Pls., 1922.

6 ———: Lines of phyletic and biological development of the Ichthyopterygia: Geol. Soc. America Bull., Vol. 34, pp. 463-468, 1923.

7 Lydekker, R.: Indian pre-Tertiary Vertebrata; Fossil Reptilia and Batrachia: Geol. Survey India Mem., ser. 4, Vol. I, pt. 3, pp. 27-28, 1879.

8 ———: Catalogue of the fossil Reptilia and Amphibia in the British Museum. Pt. II. Ichthyopterygia and Sauropterygia: London, Longmans and Co., pp. 13-40, 1889.

9 Merriam, J. C.: The occurrence of ichthyosaur-like remains in the Upper Cretaceous of Wyoming: Science, NS., Vol. 22, pp. 640-641, 1905.

10 Merriam, J. C., and Gilmore, C. W.: An ichthyosaurian reptile from the marine Cretaceous of Oregon: Carnegie Inst. Washington Pub. No. 393, pp. 3-4, fig. 1, 1928.

11 Owen, Richard: Monograph of the fossil Reptilia of the Cretaceous formations: Paleontog. Soc., Pt. I, pp. 79-80, figs. 3-4, 1851.

12 Philippi, R. A.: Ichthyosaurier in der argentinischen Cordillere: Zeitschr. Dtsch. Geol. Gesell., Vol. 47, p. 558, 1895.

13 Rubey, W. W.: Origin of the siliceous Mowry shale of the Black Hills region: U. S. Geol. Survey Prof. Paper 154, pp. 153-170, 1928.

14 ———: Lithologic studies of the fine-grained Upper Cretaceous sediments of the Black Hills region: U. S. Geol. Survey Prof. Paper 165, pp. 1-54, 1930.

Laramie, Wyoming.