A Publication of the
Department of Geology
Brigham Young University
Provo, Utah 84602

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Brigham Young University Geology Studies is published by the Department of Geology. This publication consists of graduate student and faculty research within the department as well as papers submitted by outside contributors. Each article submitted is externally reviewed by at least two qualified persons.

ISSN 0068-1016
2-93 600 2157

BRIGHAM YOUNG UNIVERSITY GEOLOGY STUDIES

Volume 39, 1993

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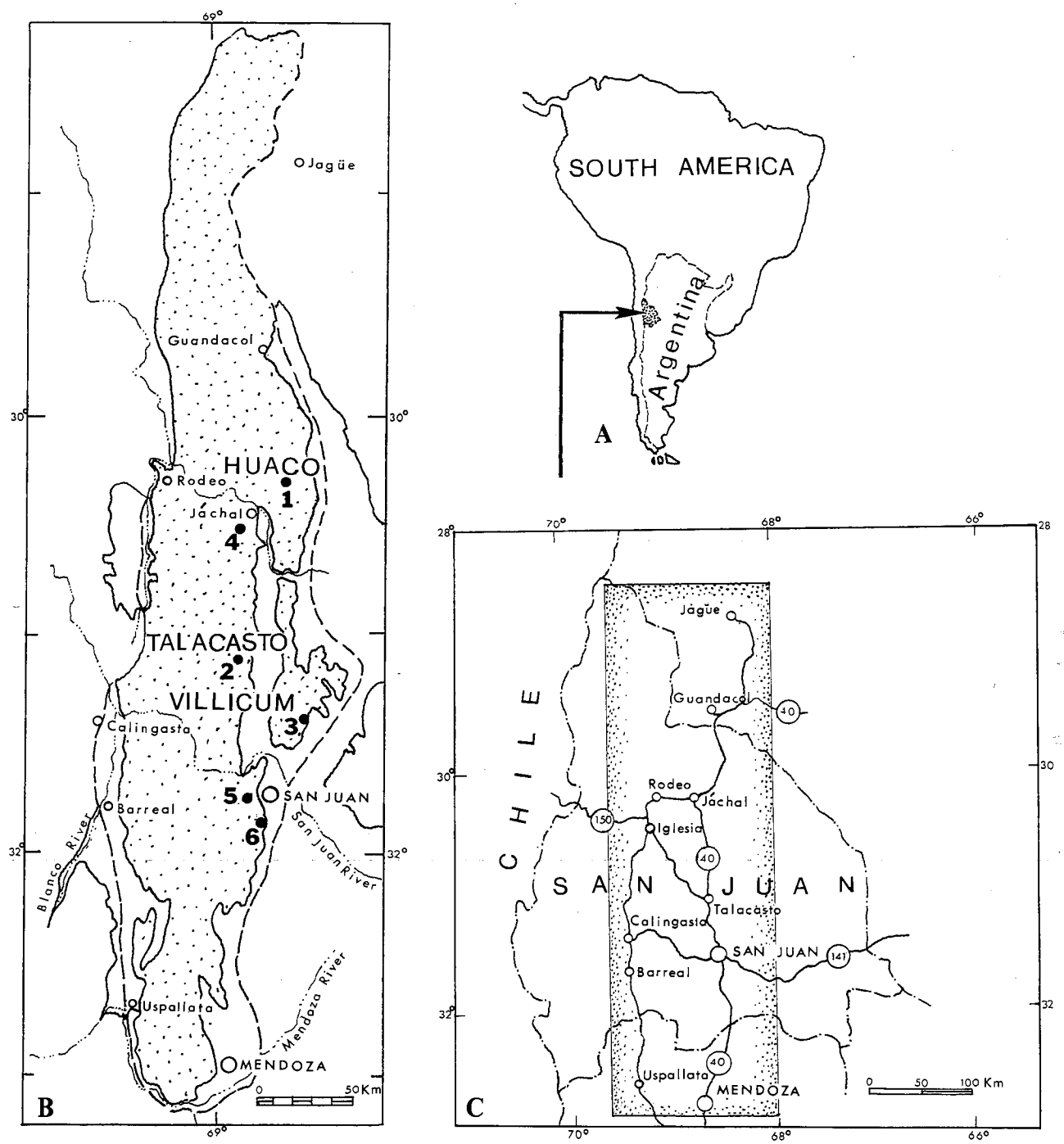

FIGURE 1.—*Index map to Ordovician sponge localities in Argentina. A—South America showing the position of the province of San Juan within Argentina (arrow). B—Sponge localities within the Precordillera (stippled) of central San Juan Province. Major localities (1–3) include: 1, the Huaco locality along sulfurous Agua Hedionda Creek, 30 miles east of Jáchal City; 2, Talacasto Gulch section in the Precordillera Central, approximately 89 km northwest of San Juan City; 3, Don Braulio Gulch in the Villicúm Range, approximately 40 km northwest of San Juan City. Other minor localities (4–6) include: 4, Loma del Piojo at San Roque Hill; 5, Las Lajas Gulch, west of San Juan City; 6, La Flecha Gulch in the Chica de Zonda Range, south of San Juan City. C—Map of San Juan Province showing the position of map B in the central part of the province.*

The First Record of Ichthyosaurs from Utah

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ABSTRACT

Three previously unreported specimens collected over 40 years ago in northeastern Utah constitute the first record of ichthyosaurs from the state. The material consists of centra and intervertebral disks. The extreme amphicoely, short anteroposterior centrum length, lack of fusion between centra and neural arches, and double-headed rib articulation are characteristic of ichthyosaurs. Although locality data are poor, all material is apparently from the Redwater Member (Jurassic: upper Callovian–lower Oxfordian) of the Stump Formation. On morphological grounds the specimens are indeterminate, but biogeographical considerations suggest that they may belong to the genus *Opthalmosaurus*.

INTRODUCTION

Ichthyosaurs are abundant, geographically widespread, moderately diverse Mesozoic marine reptiles convergent with porpoises and dolphins. The group first appeared in the Early Triassic and continued into the Late Cretaceous (Carroll 1988, p. 251–59). Considering the extensive exposures of Mesozoic marine sequences in Utah, it is surprising that no ichthyosaurs have been reported from the state (see Madsen and Miller [1979] for an exhaustive review of Utah fossil vertebrates), especially as these reptiles have been discovered in these same sequences in several adjacent states (Camp 1980; Gilmore 1905, 1907, 1914; Knight 1903; McGowan 1972; Merriam 1905, 1906, 1910; Nace 1939, 1941; Romer 1968). Three specimens on exhibit at the Utah Field House of Natural History State Park (Vernal, Utah) are ichthyosaur and constitute the first record of these reptiles in Utah.

HISTORY OF SPECIMENS

The three specimens have a complex history that has been difficult to reconstruct and casts doubt on the assignment of specimen numbers. Thus, a brief account of their history is given here. In 1982 the Utah Field House of Natural History State Park had parts of three ichthyosaurs on exhibit. Two specimens consisted of articulated centra, the third of an isolated centrum and intervertebral disk. One string of centra bore the catalog number V-189 on one centrum. The second series had no numbers on it but was exhibited with a specimen label bearing the number V-273. The isolated centrum and intervertebral disk had no number on either the bone or its specimen label.

The museum's records show three separate accessions for ichthyosaur material. These entries are (1) "#15. (includes 4 coral, 3 *Inoceramus*, 1 metate), vertebrae from an ichthyosaur, Reynolds 1948"; (2) "7/9-12/53 V-189 Ichthyosaur vertebrae, rib fragments, etc. Curtis Formation, Up. Jurassic, McFarley Flat, E. of Brush Creek outside W. DNM boundary, G. E. & B. R. Untermann"; and (3) "1954 V-273 Icthyosaur (sic) (pieces of vertebrae), McFarley Flat, East of Brush Creek, Curtis Formation Jurassic, G. E. & B. R. Untermann."

In 1983 a box of fragmentary ichthyosaur vertebrae were discovered in the collections of the Field House. All of these vertebrae bore the number V-273. Because the specimen collecting, museum exhibits, and museum labels were all done by the Untermanns, the writer assumes that one of the articulated series and the set of fragmentary vertebrae are all part of V-273. By the process of elimination the isolated centrum and intervertebral disk are assigned to "#15." The rib fragments mentioned as part of V-189 could not be found and are presumed lost.

Locality data are meager (see above). Both G. E. and B. R. Untermann worked as directors of the museum from the late 1940s through the mid–1970s. The specimens are not mentioned in any of the major geologic works on the Uinta Basin (Kinney 1955; Untermann and Untermann 1954, 1968, 1969). This is peculiar, for the Untermanns were aware that this was the first record of ichthyosaurs from Utah (Grant Merrell personal communication 1984).

The Curtis Formation determination is probably correct, for the Untermanns were quite knowledgeable about the regional geology (Untermann and Untermann 1954, 1968). However, Rowley and others (1979) have called this rock unit the Stump Formation, which includes the "Curtis Formation" of this area as a member. Which member of the Stump Formation produced V-189 and V-273 is not known with certainty, but Grant Merrell

(personal communication 1984) was told by the Untermanns that the ichthyosaur specimens came from a cut along the pipeline running near the western boundary of Dinosaur National Monument in Uintah County. As shown in Rowley and others (1979), the pipeline passes only through the Redwater Member of the Stump Formation. Imlay (1980, fig. 27) lists the Redwater Member as uppermost Callovian–lower Oxfordian in this region of Utah.

Even less is known about specimen number 15. No information is available concerning the locality or the collector (Reynolds) despite conversations with several individuals who worked as curators at the museum during the 1950s. Nor is there any mention of this specimen in the Untermanns' field notes. The color, preservation, and texture of the bone is identical to that of V-189 and V-273, and all three specimens probably came from the same locality.

During 1983 the museum's collections were reorganized and recataloged. The new specimen numbers and their old equivalents are (1) V-UFH-48-15 (1–2) = no. 15; (2) V-UFH-53-50 (1–26) = V-189; and (3) V-UFH-54-30 (1–38) = V-273.

DESCRIPTION

V-UFH-53-50

This specimen consists of twenty-six strongly amphicoelous centra lacking neural arches and spines. The lack of fusion between centrum and neural arches is characteristic of ichthyosaurs and not an indication of relative age of an individual. Most of the centra show breakage along the rim.

The first centrum in the series (53-50-1, plate 1, A, B) has a pentagonal outline in anterior view. The diapophyses are situated anterodorsally and laterally and are confluent with the neurapophyses. The parapophyses are at midheight along the anterior edge of the centrum. The ventral surface is rounded and lacks a hypophysial ridge.

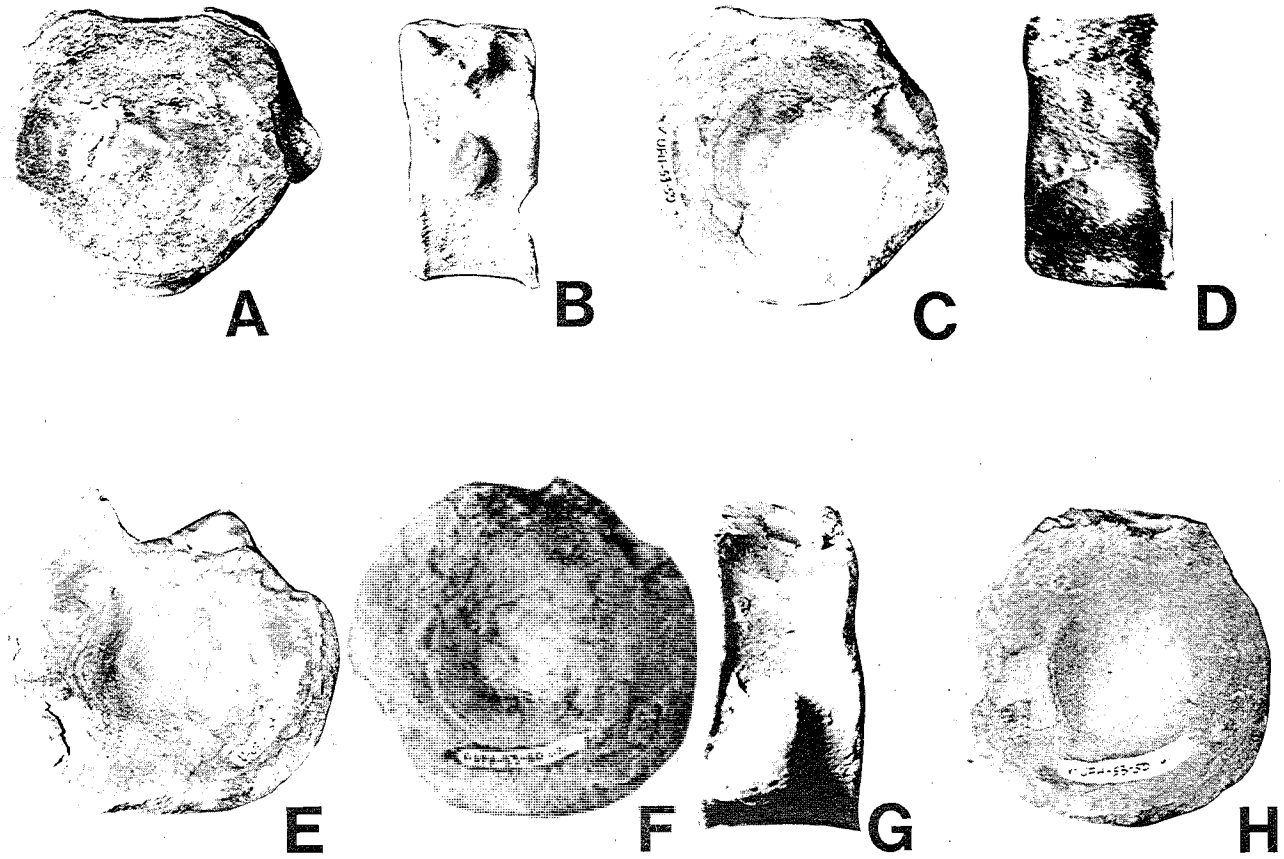
On the second vertebra of the series (53-30-2), the diapophyses are barely separated from the neurapophyses, but by the fourth vertebra (53-30-4, plate 1, C, D) this separation is large. Among ichthyosaurs there is a wide variation in which vertebra the diapophysial-neurapophysial separation first occurs. Gilmore (1905) noted that in *Opthalmosaurus* (=his *Baptanodon*) this separation does not occur until at least the sixteenth vertebra and that the separation occurs on either the fourteenth or fifteenth vertebra in *Ichthyosaurus*. Merriam (1902) has shown that in one species of *Shastasaurus* the separation does not occur until at least the thirty-fifth vertebra. Because of this wide variation it is not possible to use this feature to identify the exact position of the first centrum in 53-50. However, the pentagonal outline in 53-50-1 is characteristic of ichthyosaur cervicals and dorsals (cf. Gilmore 1905, figs. 14–16). In anterior view, ichthyosaur anterior cervicals are narrower ventrally than are anterior dorsals (see Andrews 1910, text fig. 24; Merriam and Gilmore 1928, fig. 1b) and bear a hypophysial ridge. The rounded ventral outline and absence of a hypophysial ridge indicates that 53-50-1 is either a posterior cervical or anterior dorsal.

On the first four vertebrae of the series, 53-50 (1–4), the diapophyses are larger than the parapophyses, and on the first seven vertebrae, 53-50 (1–7), the parapophyses are situated along the anterior half of the centrum. From

EXPLANATION OF PLATE 1

Ichthyosaur remains from the Redwater Member (upper Callovian–lower Oxfordian) of the Stump Formation, Uintah County, Utah. Scale in centimeters.

A. V-UFH–53–50–1 posterior cervical or anterior dorsal, anterior view
B. V-UFH–53–50–1 posterior cervical or anterior dorsal, left lateral view
C. V-UFH–53–50–4 ?anterior dorsal, anterior view
D. V-UFH–53–50–4 ?anterior dorsal, right lateral view
E. V-UFH–53–50–8 mid-dorsal, anterior view
F. V-UFH–53–50–15 caudal, anterior view
G. V-UFH–53–50–15 caudal, right lateral view
H. V-UFH–53–50–16 caudal, anterior view
I. V-UFH–53–50–16 caudal, right lateral view
J. V-UFH–54–30–25 posterior cervical or anterior dorsal, anterior view
K. V-UFH–54–30–26 median dorsal, anterior view
L. V-UFH–54–50–16 intervertebral disk, lateral view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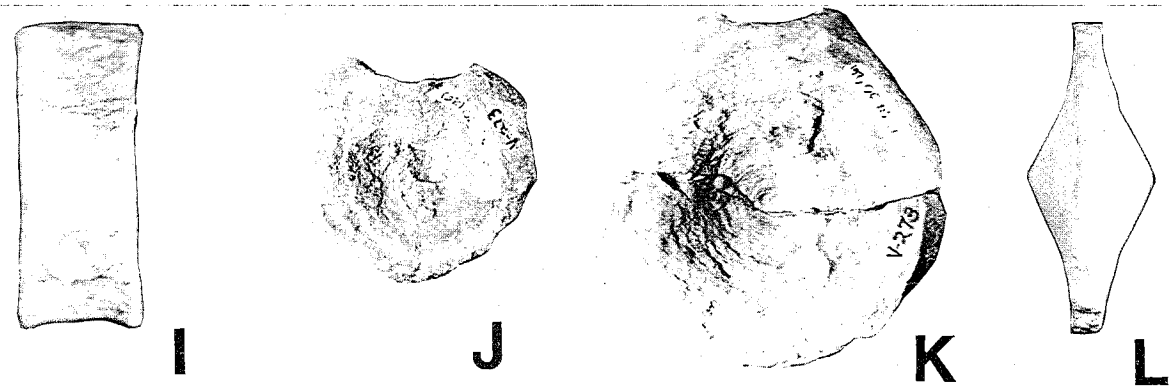
I
J
K
L

53-50-1 to 53-50-7 the diapophyses and parapophyses move toward the ventral edge of the centrum.

By the eighth vertebra of the series (53-50-8, plate 1, E) the centrum is pear-shaped in anterior view. This shape is characteristic of ichthyosaur mid-dorsals. In addition, by this vertebra the diapophyses have moved to below midheight and the subequal diapophyses and parapophyses have shifted to the posterior half of the centrum.

On the fourteenth vertebra of the series the parapophyses have become larger than the diapophyses. On the fifteenth vertebra of the series (53-50-15, plate 1, F, G) the diapophyses are either lost or have fused with the parapophyses. Andrews (1910, p. 40) considered this condition in *Opthalmosaurus* to be the result of fusion of the parapophyses and diapophyses (=his "transverse process") and believed that it is characteristic of the first caudal. However, Camp (1980) interpreted a vertebra with the same structure in *Shonisaurus* as a posterior dorsal. The lack of a distinct sacrum in ichthyosaurs makes the identification of the transition from dorsal to sacral to caudal vertebrae difficult.

The parapophyses of the sixteenth vertebra in the series (53-50-16, plate 1, H, I) are worn but show a smooth, cupped surface for the articulation of the caudal ribs. Caudal ribs are present on the anterior caudals in ichthyosaurs (see Andrews 1910, figs. 27 a and b). The seventeenth through twenty-sixth vertebrae in the series, 53-50 (17–26), have severely eroded parapophyses, and the presence or absence of articular surfaces for caudal ribs cannot be determined.

V-UFH-54-30

This specimen consists of twenty-six centra lacking neural arches and spines, and twelve intervertebral disks. Twelve of the centra and all of the intervertebral disks form an articulated series [54-30 (1–24)], but the rest of the specimen is incomplete and not articulated [54-30 (25–28)]. See comments under History of Specimen, above, concerning the referral of bones to this specimen number.

Centrum 54-30-25 is incomplete, with dorsolaterally situated diapophyses, separate nodelike parapophyses, and a pentagonal outline in anterior view (plate 1, J). This is either a posterior cervical or an anterior dorsal (cf. Gilmore 1905, fig. 14), but the ventral surface is too eroded to determine the presence or absence of a hypophysial ridge. However, the small size of the centrum suggests that it is a cervical. Centrum 54-30-26 (plate 1, K) is pear-shaped in outline with subequal parapophyses and diapophyses and is a median dorsal. Centrum 54-30-27 is a midcaudal, the smallest known from any of the three specimens.

The articulated series of centra and intervertebral disks is from the anterior caudal region. The first three centra bear saddle-shaped parapophyses that slant posteriorly. All other centra bear parapophyses with circular articular facets for the caudal ribs. The intervertebral disks are biconvex (plate 1, L).

V-UFH-48-15

This specimen consists of a single anterior caudal centrum and intervertebral disk. The centrum is strongly amphicoelous and pear-shaped in outline. The left side is damaged, but the right bears a parapophysis below midheight. It is likely that the intervertebral disk does not belong with this specimen as only a single vertebra is listed under this accession. The disk probably belongs to V-UFH-54-30.

DISCUSSION

The extreme amphicoely, short anteroposterior length of the centrum, lack of ossification between the centrum and the neural arch, and the double-headed rib articulation are a combination of features unique to ichthyosaurs. Sauropterygians, the other major group of Jurassic marine reptiles, have dorsal vertebrae that are only weakly amphicoelous and single-headed ribs. Furthermore, the caudals of sauropterygians bear well-developed transverse processes. In both the dorsal and caudal regions of sauropterygians, the neural arches are fused to the centra (Romer 1956).

McGowan (1976) gave a brief but important review of Upper and Middle Jurassic ichthyosaurs. He recognized only four genera: *Grendelius* (with one species, *G. mordax*, from the middle Kimmeridgian of England); *Nannopterygius* (with one species, *N. enthekiodon*, from the middle Kimmeridgian of England); "Munich 5" (an undescribed genus from the Kimmeridgian of Germany); and *Opthalmosaurus* (=*Baptanodon* of authors), with several species.

As noted by McGowan, nearly all identifiable ichthyosaurs from the Middle and Upper Jurassic can be referred to *Opthalmosaurus*. Opthalmosaurs have a wide geographic distribution, with specimens reported from France (Lennier 1870), Argentina (Rusconi 1948), the Canadian Arctic (McGowan 1978), and the western United States (Gilmore 1905, 1907; Knight 1903), but most specimens have come from England (Andrews 1910, Appleby 1956, Lydekker 1889, Seeley 1874).

Unfortunately, vertebral morphology is relatively uniform in Jurassic forms, and generic diagnoses are based on cranial and appendicular features. Thus, the generic assignment of the Utah material is not possible on morphological grounds. McGowan (1978) has discussed the difficulties of using geographic distribution in the identifi-

cation of ichthyosaur taxa. However, the referral of the Utah specimens to *Opthalmosaurus* is suggested by (1) the very limited geographical distribution (as presently understood) of most Middle and Upper Jurassic ichthyosaur genera, (2) the widespread geographic distribution of *Opthalmosaurus*, and (3) the fact that *Opthalmosaurus* is the only known ichthyosaur genus from the Upper Jurassic of the western United States.

ACKNOWLEDGMENTS

I thank Alden Hamblin, director of the Utah Field House of Natural History State Park (Vernal, Utah), for allowing me to study material in his care. Ivan Hall, Grant Merrell, Ashell Adams, Dee Hall, Arnie Lewis, and Jim Madsen all helped in reconstructing the known locality data. Alden Hamblin, Curt Sinclair, and Peter Laraba provided assistance in the museum and conducted record searches. Wade Miller and Sue Ann Bilbey read the manuscript and provided useful information and/or comments.

NOTE ADDED IN PRESS

While this paper was in press, Sue Ann Bilbey informed me that a single, incomplete vertebra has been collected north of Vernal, Utah. The specimen is in the collections of the Utah Field House of Natural History in Vernal, cataloged as UFH-90.5. The locality is also in the Redwater Member of the Stump Formation (detailed locality data is in the files of the Utah Field House). Although the specimen adds no morphological information to the present report, it does indicate that ichthyosaurs may be common in some horizons within the state.

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