JOURNAL OF PALEONTOLOGY, VOL. 20, NO. 3, PP. 261–266, PLS. 38, 39, MAY 1946

FOSSIL EGG CAPSULES OF CHIMAEROID FISHES

ROLAND W. BROWN
Geological Survey, Washington, D. C.

ABSTRACT—To the three previously reported fossil egg capsules of chimaeroid fishes this paper adds five specimens and assigns all to *Chimaerotheca*, a new form genus. *Chimaerotheca germanica* and *C. besselsi* are from the Jurassic of Germany; *C. wyomingana*, from the Upper Cretaceous of Wyoming; *C. newmexicana*, from the Upper Cretaceous of New Mexico; *C. montanana*, from the Upper Cretaceous of Montana; and *C. alaskana*, from the Oligocene of Alaska.

LATE in 1944 I found among the specimens of fossil plants in a collection brought from Alaska by Don J. Miller, of the U. S. Geological Survey, a curious impression (pl. 38, fig. 4) on fine-grained sandstone that recalled four other baffling fossils, which I had set aside 10 years ago to await further light on their identity. On comparing the two sets of specimens I was convinced of their organic similarity and relationship and began casting about in earnest for clues leading to their correct identification. Having found all these specimens among collections of fossil plants I surmised that the collectors had assumed that they represented plants or parts of plants, probably portions of palm or cycad leaves, an idea which, as the illustrations show, is not altogether fanciful. The resemblance, however, seemed to me superficial, and, remembering the circumstance that all the fossils came from brackish-water or marine sandstone strata, I turned to the consideration of possibilities among remains of marine animals. Thus, thinking of fishes, I was reminded of a paper by Gill (1905) reporting a Cretaceous chimaeroid egg case. C. W. Gilmore, of the U. S. National Museum, after seeing my material, produced Gill's specimen (pl. 38, fig. 8) and confirmed my tentative identification. To him I am particularly indebted for further valuable help and friendly encouragement in the preparation of this paper.

The living chimaeroid fishes, although somewhat sharklike in appearance and in having cartilaginous skeletons, are neither sharks nor ancestral sharks, but a divergent group that comprises about 25 species distributed among the genera *Chimaera*, *Callorhynchus*, *Harriotta*, and *Rhinochimaera*. These fishes are found in all parts of the world. Some species may be taken in shallow coastal waters, and others at abyssal depths. They range from 60 to 200 cm. in length, display delicate and varied coloration, have powerful dental plates, are omnivorous, probably live in schools, and reproduce by laying large, tough, more or less leathery, brown egg capsules, which are attached by caudal filaments to rocks or other objects. Full details, including colored illustrations, concerning the appearance and anatomy of these fishes can be found in Garman (1899; 1904; 1911) and Dean (1906; 1909; 1912). The latter investigated *Chimaera colliei* Bennett from the Pacific Coast of the United States, made extensive studies of its life habits and embryology, and arrived at significant conclusions pertaining to the evolution of the group. Dean's descriptions and illustrations of the egg capsules of the genera of chimaeroids are particularly enlightening in the present connection.

The egg capsules of living species (see pl. 39) are dartlike to elliptic in overall outline and consist of two obvious parts—the bilaterally symmetric, tough, leathery, centrally located embryo case and a thin membrane or web of variable width that extends outward from the case in the horizontal plane dividing the case into dorsal and ventral sides. These sides, except the dorsal in *Chimaera*, which is keeled, are ordinarily so similar in appearance that, casually examined, they cannot be readily distinguished. For purposes of description the case may be said to have snout, trunk, and tail portions, although these regions are in reality poorly defined. It may be smooth or

finely striated and tapers in varying fashion toward both ends, the posterior being usually the more attenuated. The anterior or snout portion is valved like the bilabiate corolla of some figworts and, at the critical moment, opens horizontally, permitting the young fish to escape. Minuter details, such as lateral ventilating pores or slits, both fore and aft, may be present on the case, but these seem never to have been preserved in the fossil impressions, the sandstone probably being too coarse a medium for recording such delicate features. The membrane or lateral web is thin but may be strengthened by simple or branched riblike thickenings called rugae or costae. These, for the most part, are curved or arched, the convex sides facing forward. The margin of the web may be entire or fimbrillose. Although numerous egg capsules have been collected, none, so far as I am aware, has ever been observed in place. Consequently, the function of the web, whether for helping to maintain a horizontal position of the capsule or for some other purpose, remains conjectural. Other details may be significant in a complete diagnosis, but for convenience the several genera may be distinguished by the outlines of their embryo cases, as follows: *Chimaera*, tadpole-shaped; *Callorhynchus*, spindle-shaped with elliptic trunk; *Rhinochimaera*, spindle-shaped with oblong trunk, the snout being notably wider than the tail portion; *Harriotta*, spoon-shaped, the tail portion being conspicuously widened at the "handle" of the spoon.

Of interest here is the conclusion Dean (1909, p. 265) drew from his tables of measurements of egg capsules and mature fishes, namely, that the "form and size of even an adult chimaeroid can be predicted from its egg-capsule with considerable accuracy". The adult is approximately four times the length of the egg capsule.

Remains attributed to chimaeroid fishes are known from the Middle Devonian to the present. However, there seems to be some doubt concerning the precise identity of the pre-Jurassic specimens. According to Dean's (1906, p. 134) table the Cretaceous was probably the heyday of these fishes. Most species (Hussakof, 1912) have been founded on mandibular plates, teeth, or dorsal fin spines, but a few on entire or nearly entire fishes. Fossil egg capsules appear to be rare, only three, or to be more precise, two and one-half, having been reported to this date. Two of these represent species from the Middle Jurassic of Germany, and the third is the specimen reported by Gill from the Upper Cretaceous of Wyoming. The present collections add five specimens to the list—three from the Upper Cretaceous of New Mexico, one from the Upper Cretaceous of Montana, and one from the Oligocene of Alaska. Obviously, this small number of specimens representing isolated portions of geologic time and scattered geographic localities, reveals only a few items of chimaeroid ancestry; but this condition of scarcity may be remedied once paleontologists are aware of the possibilities.

The fossil "species" of chimaeroid capsules so far reported were tentatively but hesitantly assigned to genera and species based on dental plates or teeth. That the capsules may have been produced by the species that bore the teeth is possible but hardly demonstrable. The Jurassic capsules were taken from a locality different from that yielding the teeth to which they were referred. Furthermore, most of the 33 Jurassic species of chimaeroids are based principally on teeth, thus greatly increasing the improbability of assigning the capsules to the correct tooth genus. No teeth were found with any of the American specimens. In view of this uncertainty concerning the relationship of egg capsules and teeth among fossil chimaeroids I have concluded to erect a form genus to receive all kinds of fossil chimaeroid egg capsules, leaving any speculations as to probable affinities for treatment in the discussion of each species. I, therefore, propose the name *Chimaerotheca* for such egg capsules. It is derived from *chimaero*, pertaining to chimaeroid fishes, and *theca*, capsule, case, container.

The specimens assigned to *Chimaerotheca germanica* and *C. besselsi* were said to have been deposited in the Natural History Museum at Stuttgart, Germany. All the remaining specimens are in the United States National Museum, Washington, D. C.

CHIMAEROTHECA Brown, n. gen.

Egg capsules in general comparable to

those of living chimaeroid fishes, composed of an embryo case fringed by a more or less rugose lateral membrane or web in the plane that divides the case into dorsal and ventral sides.

Genotype: *Chimaerotheca wyomingana* Brown, n. sp.

CHIMAEROTHECA WYOMINGANA Brown, n. sp.
Plate 38, figure 8

Chimaeroid egg-case. Gill, 1905, pp. 601–602. Darton, Blackwelder, and Siebenthal, 1910, p. 10.—Hussakof, 1912, p. 224.
Elasmodus? Dean, 1909, p. 267, pl. 37.

One specimen represents this species. It is a nearly entire, elliptic or slightly ovate capsule, 19 cm. (but originally probably 20 to 25 cm.) long and 9 cm. wide. The embryo case is spindle-shaped to slightly oblong, the greatest width of the trunk portion being 3 cm. at a point well behind the middle of that area. The snout is somewhat wider than the tail portion, but its termination is not preserved. The tail portion first contracts rather abruptly behind the trunk and then tapers narrowly and evenly to a blunt point. The web averages 2.5 cm. in width and maintains this width around the case. Its rugae are simple, unbranched costae, numerous and arched, with the convex sides facing forward.

The features of this capsule approximate roughly those of the capsules of *Rhinochimaera* (pl. 39. figs. 4, 8). The parent fish was probably 80 cm. long.

This specimen was collected by N. H. Darton and referred to Theodore Gill for identification. Gill (1905) recognized it as a chimaeroid egg capsule and noted its resemblance to the capsules of *Rhinochimaera* and *Harriotta* but did not describe or name it, leaving that function, as he said, to Bashford Dean, who was at that time preparing a paper on chimaeroid fishes. Dean's first paper (1906), the materials and proof of which Gill had seen, cited Gill's article in the extensive bibliography but did not mention Gill's specimen in the text. In 1909, however, Dean figured the specimen and discussed it at length but did not formally name it beyond suggesting that it might have been produced by a female belonging to a species of the Cretaceous tooth genus *Elasmodus*. The Mesaverde formation, which yielded this capsule, although composed of fresh-water continental materials over wide areas, at some localities, as in this instance, has brackish-water or marine facies and contains marine fossils, such as *Inoceramus*, *Avicula*, etc.

Occurrence.—Upper Cretaceous. In the basal sandstone of the Mesaverde formation, 1 mile east of Table Mountain, 20 miles west of Laramie, Wyoming. (Type, U.S.N.M. 5994.)

CHIMAEROTHECA NEWMEXICANA Brown, n. sp.
Plate 38, figures 3, 5, 6

Three specimens represent this species. The best specimen indicates that the original length of the capsule was about 25 cm. and the width 10.5 cm. The outline of the embryo case is more nearly that of a spindle than a tadpole, but the greatest width of the trunk is somewhat behind its midsection, making the trunk oblong. Both anterior and posterior portions taper fairly gradually, the anterior broadly to a blunt, rounded to squarish edge, and the posterior narrowly through an attenuated caudal area to a slender point. The web is nearly 4 cm. wide and of approximately even width around the case. The arched rugae are numerous and coarse at their origin beside the case, some remaining simple, but others branching once or twice before reaching the margin, the convex sides facing forward.

These capsules resemble in general the specimen called *Chimaerotheca wyomingana*, except that the rugae of the latter are simple. They combine features displayed by the capsules of *Callorhynchus* (pl. 39, figs. 1, 2) and *Rhinochimaera* (pl. 39, figs. 4, 8). The parent fishes were probably 1 meter long.

Orestes St. John collected these specimens in the middle 1870's. For an undetermined number of years they lay in the collections of the United States National Museum as unidentified plants or problematica. Portions of the Trinidad sandstone, in which the fossils were found, contain marine shells, *Halymenites*, and fish bones and scales.

Occurrence.—Upper Cretaceous. Trinidad sandstone. Figure 6 (type, U.S.N.M. 16889), from near Raton, New Mexico. Figure 3

(U.S.N.M. 16888) and figure 5 (U.S.N.M. 16886), from Crow Creek Canyon, 1 mile northwest of Koehler, New Mexico

CHIMAEROTHECA MONTANANA
Brown, n. sp.
Plate 38, figure 7

This poorly preserved fragment perhaps scarcely deserves a specific name, and I give it one very reluctantly. It represents only a portion of what appears to be a spindle-shaped embryo case, with greatest width of 2 cm., and the stumps of the medium thick rugae of the web, which is here not clearly demarked from the embryo case—a circumstance that leaves some doubt concerning the identification. Between the bases of the rugae the sinuses are well rounded.

The shape of the case and the distribution of the rugae of this specimen suggest resemblance to the capsules of *Callorhynchus*. The parent fish was probably 50 cm. long.

This fossil was collected by Barnum Brown, according to the label left with it in the fossil plant collections of the United States National Museum. The area from which it came, however, was also examined by Eugene Stebinger about 1912, who named the Horsethief sandstone of the Montana group, the type locality being Horsethief Ridge in the Blackfoot quadrangle, Montana; and Stebinger may have had some connection with bringing this specimen to Washington. The Horsethief sandstone contains brackish-water and marine fossils.

Occurrence.—Upper Cretaceous. From Horsethief sandstone of the Montana group in sec. 5, T. 31 N., R. 9 W., 3 miles above Holy Family Mission on Two Medicine River, Montana. (Type, U.S.N.M. 17020).

CHIMAEROTHECA ALASKANA Brown, n. sp.
Plate 38, figure 4

One specimen represents this species. It is nearly entire and narrowly elliptic in overall appearance, possibly 15 cm. long and 7 cm. wide originally. The outline of the embryo case is that of a narrow spoon, there being a small expansion at the posterior end of the long caudal "handle" portion. Anterior to the trunk is a constriction followed by a rounded-blunt, spatulate expansion forming the snout. The web, approximating 2.5 cm. in width, makes an even-bordered fringe around the capsule, except at the anterior end. The rugae are numerous, of medium thickness, once or twice branched, and curved with the convex sides facing forward.

This capsule resembles those of *Harriotta* (pl. 39, fig. 7) very closely, except that the rugae are branched, not simple, as in the latter. The parent fish was probably 60 cm. long.

The specimen was collected by Don J. Miller in 1944. The Split Creek sandstone member of the Katalla formation yields marine mollusks and fish vertebrae indicative of Oligocene age.

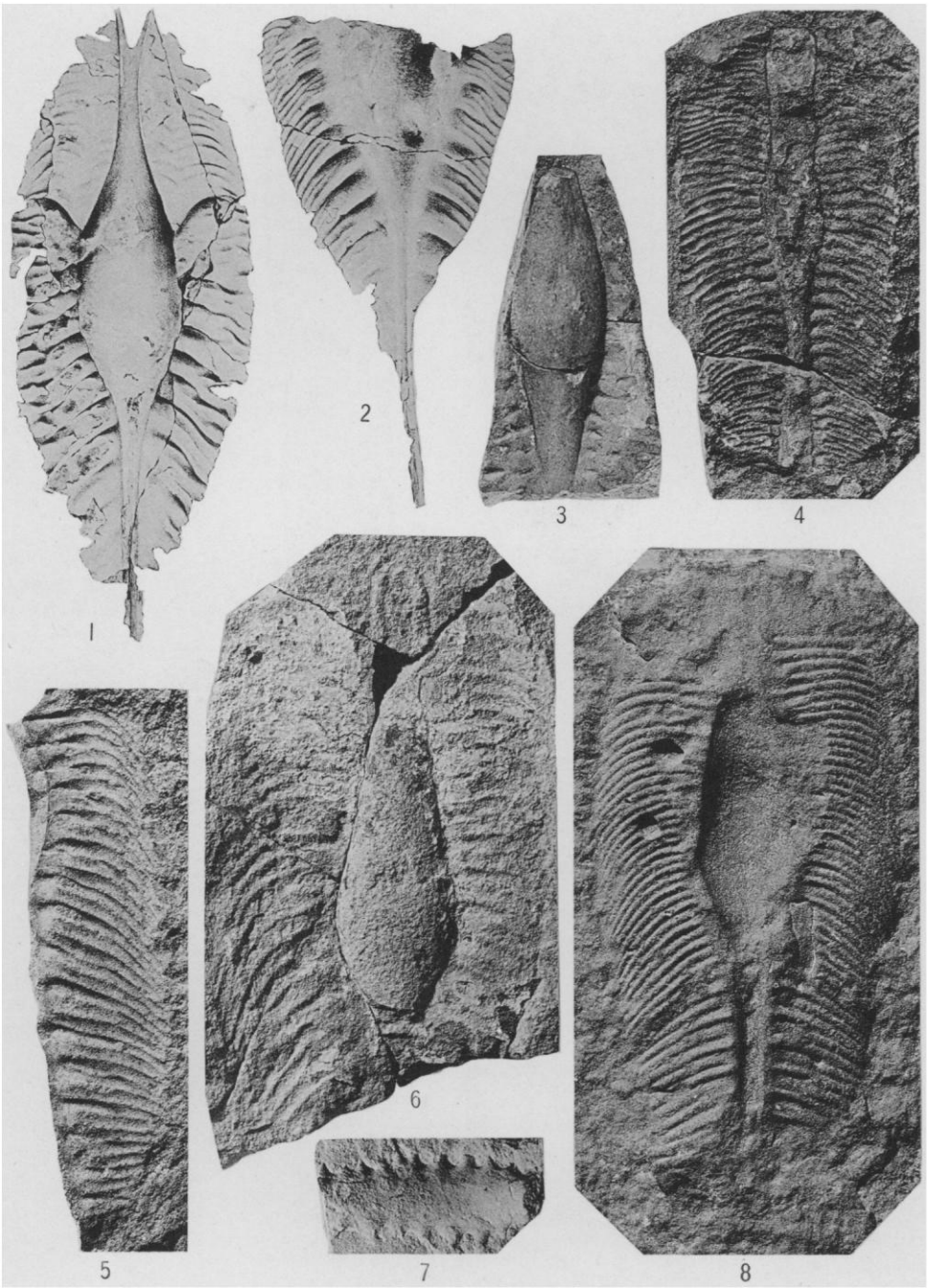
Occurrence.—Oligocene. From Split Creek sandstone member of the Katalla formation at head of Split Creek, 2.16 miles N. 60° W. from the intersection of the two principal tributaries of Burls Creek and 7.27 miles N. 27° E. of Katalla on Controller Bay, Alaska. (Type, U.S.N.M. 16887).

CHIMAEROTHECA GERMANICA Brown, n. sp.
Plate 38, figure 1

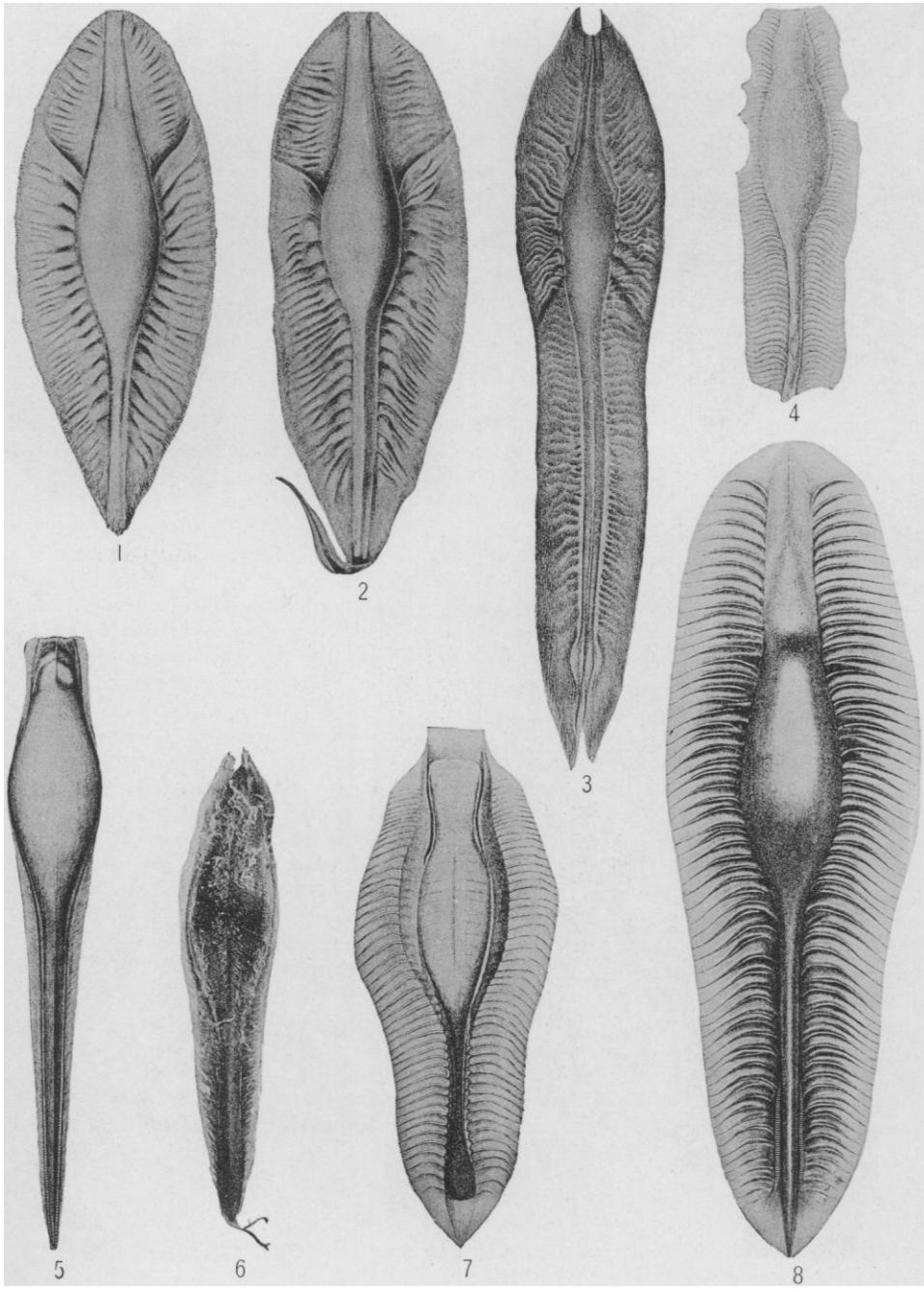
Chimaeroid egg capsule. Bessels, 1869, pp. 152–155, pl. 3, fig. 1.
Aletodus ferrugineus Jaekel (part), 1901, pp. 551–556, pl. 22, fig. 3.—Dean, 1906, p. 31, fig. 14.

EXPLANATION OF PLATE 38

FIGS. *1–8*—Fossil chimaeroid egg capsules, ×½. *1*, *Chimaerotheca germanica* Brown, n. sp., from the Dogger (Middle Jurassic), near Heiningen in Württemberg, Germany. (After Jaekel.) *2*, *C. besselsi* Brown, n. sp., from the Dogger (Middle Jurassic) near Heiningen in Württemberg, Germany. (After Jaekel.) *3*, *5*, *6*, *C. newmexicana* Brown, n. sp., from the Trinidad sandstone (Upper Cretaceous) near Raton (fig. *6*) and Koehler (figs. *3*, *5*), New Mexico. *4*, *C. alaskana* Brown, n. sp., from the Split Creek sandstone member of the Katalla formation (Oligocene), northeast of Katalla, Alaska. *7*, *C. montanana* Brown, n. sp., from the Horsethief sandstone member of the Montana group (Upper Cretaceous) on Two Medicine River, Montana. *8*, *C. wyomingana* Brown, n. sp., from the Mesaverde formation (Upper Cretaceous) west of Laramie, Wyoming.



Brown, Egg Capsules of Chimaeroid Fishes



Brown, Egg Capsules of Chimaeroid Fishes

This specimen is a nearly entire capsule, narrowly elliptic in outline, 17.5 cm. long and 7 cm. wide. The case is spindle-shaped and 3 cm. in diameter at its widest point. The web approximates 2 cm. in width and maintains this width evenly around the case. Its rugae are few, coarse, and obscurely branched. They curve slightly in the posterior but more prominently in the anterior portion, where the convex sides face forward. A little beyond the middle of the trunk of the case, anteriorly, there is a pair of unusually heavy rugae with convex sides facing forward. These appear to have counterparts in living *Callorhynchus* capsules (pl. 39, figs. 1, 2). Beyond the pair of heavy rugae are more numerous rugae, less coarse, apparently unbranched, but broken by conspicuous angles, a feature displayed by no living species. As I have not seen this specimen I cannot vouch for the accuracy of the illustration, which, however, seems somewhat more realistic than that of Bessels. Indeed, some features of the specimen, as for example, the rather abrupt change in the character of the rugae at the prominent anterior ridge or fold suggest that the forward portion represents an impression of part of one side, and the rear portion a part of the reverse side of the original egg.

The general similarity of this capsule to those of *Callorhynchus* was remarked by Bessels, Jaekel, and Dean, but Dean emphasized the differences between them and demurred from assigning the capsule to *Callorhynchus*. The parent fish was probably 70 cm. long.

This and the specimen I am referring to *Chimaerotheca besselsi* were first reported and correctly classified by Bessels, then discussed and refigured by Jaekel, who assigned them to a new tooth genus erected for teeth from a different horizon at another locality in the Dogger of Württemberg, Germany. I have stated in the introduction why I consider it infeasible to refer these capsules to a tooth genus.

Occurrence.—Middle Jurassic. From a marine sandstone in the lower Dogger near Heiningen, in Württemberg, Germany. Specimen said to be in the Natural History Museum, Stuttgart, Germany.

CHIMAEROTHECA BESSELSI Brown, n. sp.
Plate 38, figure 2

Chimaeroid egg capsule. Bessels, 1869, pp. 152–155, pl. 3, fig. 2.
Aletodus ferrugineus Jaekel (part), 1901, pp. 551–556, pl. 23, fig. 4.

This specimen represents the posterior half of an elliptic capsule, whose length must have been at least 25 cm. and width 7 cm. The case was evidently spindle-shaped and 3.5 cm. in greatest diameter. The web, averaging less than 2 cm. in width, encircles the case evenly. The main rugae are few, and seldom, if at all, branched. They separate groups of two or sometimes three, minor, and apparently unbranched rugae. All the rugae are only slightly arched.

It is possible that this specimen may be a variant of *Chimaerotheca germanica*, but the differences in size and in the features of the rugae of the two specimens impel me to regard the specimens as representing different species. I name this species for Emil Bessels, who was the first person to recognize the true status of this and the specimen of *C. germanica*, which had been known for 40 years to the members of the Verein für vaterländische Naturkunde in Württemberg but had remained unidentified, there being but one suggestion, namely, that they might represent crustaceans.

Occurrence.—Middle Jurassic. From a marine sandstone in the lower Dogger near Heiningen, in Württemberg, Germany. Specimen said to be in the Natural History Museum, Stuttgart, Germany.

EXPLANATION OF PLATE 39

FIGS. *1–8*—Egg capsules of living chimaeroids, showing ventral aspect. (After Dean, 1906. Courtesy of the Carnegie Institution of Washington.) *1*, *Callorhynchus* sp., from Cape of Good Hope, Africa, ×¼. *2*, *Callorhynchus* sp., from Australia, ×¼. *3*, Unidentified capsule from mid-Pacific, ×⅜. *4*, *Rhinochimaera indica* from Indian Ocean, ×⅜. *5*, *Chimaera monstrosa*, from Norway, ×½. *6*, *Chimaera colliei*, from Puget Sound, Washington, ×¼. *7*, *Harriotta?* sp., from North Atlantic, ×½. *8*, *Rhinochimaera pacifica* from Misaki, Japan, ×½.

REFERENCES

BESSELS, EMIL, 1869, Ueber fossile Selachier-Eier: d. Ver. vaterl. Naturkunde Württemberg Jahresh., Band 25, pp. 152–155, pl. 3, figs. 1, 2.

DARTON, N. H., BLACKWELDER, ELIOT, and SIEBENTHAL, C. E., 1910, U. S. Geol. Survey. Geol. Atlas, Laramie-Sherman folio (no. 173).

DEAN, BASHFORD, 1906, Chimaeroid fishes and their development: Carnegie Inst. Washington Pub. 32.

——, 1909, Studies on fossil fishes (sharks, chimaeroids, and arthrodires): Am. Mus. Nat. History Mem. 9, pp. 209–287.

——, 1912, Orthogenesis in the egg capsules of Chimaera: Am. Mus. Nat. History Bull., 31, pp. 35–40.

GARMAN, SAMUEL, 1899, Report on an expedition off the west coast of Mexico: Harvard College Mus. Comp. Zoology Mem. 24, p. 20, pl. 64, fig. 2.

——, 1904, The chimaeroids (Chismopnea Raf. 1815, Holocephala Müll. 1824), especially *Rhinochimaera* and its allies: *idem*, Bull. 41, pp. 243–272.

——, 1911, The Chismopnea (chimaeroids): *idem*, Mem. 40, pp. 81–101.

GILL, THEODORE, 1905, An interesting Cretaceous chimaeroid egg-case: Science, n. ser., vol. 22, pp. 601–602.

HUSSAKOF, LOUIS, 1912, The Cretaceous chimaeroids of North America: Am. Mus. Nat. History Bull. 31, pp. 195–228.

JAEKEL, OTTO, 1901, Ueber jurassiche Zähne und Eier von Chimäriden: Neues Jahrb. Beilage-Band 14, pp. 540–564.

PUBLISHED BY PERMISSION OF THE DIRECTOR OF THE GEOLOGICAL SURVEY. MANUSCRIPT RECEIVED JULY 7, 1945.