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ART. X.—*Tamiobatis vetustus*; a new Form of Fossil Skate; by C. R. EASTMAN. With Plate I.

THROUGH the kindness of Mr. F. A. Lucas, of the United States National Museum, the writer has enjoyed the opportunity of studying a remarkable fossil belonging to the collection under the charge of this gentleman. The specimen (Nat. Mus. Cat. No. 1717) was identified by Mr. Lucas as "the skull of a fossil skate," and is shown by the records to have been found in the eastern part of Powell County, Kentucky. Unfortunately, the exact horizon from which it was obtained is not affirmed by the original memoranda accompanying the specimen, but its history seems to leave no doubt that it was derived from rocks occurring *in situ* in that part of Kentucky.

Characters of the matrix.—The fossil is embedded in a weathered block of greenish-gray limestone having a slightly talcose feel, and soft enough to be easily scraped with a knife. The matrix was examined both macroscopically and in thin sections* for traces of other organic remains; but beyond a

* A thin section and fragments of the surrounding rock were submitted recently to Dr. Charles Palache, who was kind enough to furnish the following note upon their mineralogical characters:

"The rock is a very soft greenish-gray limestone, somewhat greasy to the touch. On the under surface it shows a concentric structure, the nodules being small and developed about many centers; but this structure is not sufficiently pronounced to enable one to decide from it either for or against a concretionary origin for the specimen. The rock dissolved readily in cold dilute acid, leaving a residue which amounted to less than one-fourth of the whole, and proved on examination under the microscope to be composed of fragments of feldspar and scales of a kaolin-like mineral. It is doubtless to these scales of kaolin that the rock owes its greasy feel, for the proved absence of magnesia shows that talc is not present, as was at first suspected. Silica is also absent."

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few minute fragments of Bryozoa and Foraminifera, themselves incapable of precise determination, no accompanying structures were observed. Hence, the only intrinsic evidence as to geological age is that afforded by petrographical characters, and by a study of the fossil itself. But neither class of intrinsic evidence can be altogether relied upon in the present case, owing chiefly to insufficiency of material for comparison; and beyond conceding that the specimen is undoubtedly Palæozoic, we must content ourselves with a statement of opinion that it belongs to such or another horizon. Professor N. S. Shaler, formerly state geologist of Kentucky, is inclined to believe it is from the Waverly group. Mr. Charles Schuchert, who is also familiar with the stratigraphy of the region, ventures the opinion that it was derived from the Corniferous or its equivalent. No other formations besides the Devonian and Carboniferous are represented in the eastern part of Powell County; and this is far beyond the limit of transported material. We may therefore feel a reasonable amount of assurance in assigning our fossil provisionally to the Middle or Upper Devonian.

Description of the remains.—A very fair representation of the specimen is shown in Plate I, and also in the accompanying text-figure, both being of two-thirds the natural size. Obviously it is the cranium of a fossil Elasmobranch, seen from the dorsal aspect; and the characters which at once suggest affinities with the rays are the elongated rostrum, prominent nasal capsules, and antorbital processes for attachment with the pectoral fins. The general form of the skull is fiddle-shaped; there are evenly-rounded cavities for the eyes; the position of the hyomandibular and foramen magnum is indicated; and the median fontanelle as well as openings for the passage of nerves are perfectly distinct. A fontanellé proper does not occur in sharks, the cranial cavity being open in front; and although the tegmen cranii now under discussion differs considerably from existing rays, the above enumeration of features shows that it is decidedly more skate-like than shark-like.

The extreme length of the cranium is 16^{cm}, and its width between the tips of the antorbital spurs is 11^{cm}. It is quite possible that the anterior portion of the rostrum is broken off, although an expansion occurs at the forward part which appears to have been symmetrical and normal. If the rostrum were actually as short, and terminated in the manner shown, a resemblance is to be noted to the conditions existing in *Torpedo*, *Narcine*, and others of the electric rays. But the cutwater is wider, heavier, and less tapering than in recent forms; and the median fontanelle does not appear to have extended forward as

an elongated cavity, nor is it flanked by the compact rods of rostral cartilage, usually so distinct in the skull of both fossil and living skates. In fact, the tegmen cranii would seem to be more completely closed than in either sharks or skates, such as exist at the present day, or are known from the Mesozoic and later rocks. It is scarcely necessary to remark that the substance composing the fossil is calcified cartilage, and the bare spaces are where it has been weathered or worn away. The crust has in places a thickness of about 3^{mm}; superficially it is

Tamiobatis vetustus gen. et sp. nov. $\times \frac{3}{2}$. AO, Antorbital process; F, Fontanelle; FM, Foramen magnum; HM, Position of hyomandibular; N, Nasal capsules; PO, Postorbital process; R, Rostrum.

quite smooth and compact, but where partially abraded it is seen to be composed of small aggregations which represent the centers of calcification. No dental or integumentary structures are to be observed.

The olfactory capsules (*N*) are slightly abraded along the anterior margin, and it is impossible to detect a suture between them and the antorbital spurs (*AO*). On the other hand, there is a small cleft, which might easily be mistaken for a suture, passing across each of the postorbital processes in a longitudinal direction. But these fissures have every appearance of being fortuitous, and moreover show tool-marks along the edges where they were probed into before reaching the hands of the present writer. Although of unusual size for postorbital processes, we have no choice but to regard them as such; for, if suturedly united with the cranium, they can be homologized with nothing else than the metapterygoid, an element with which they agree neither in shape, size, nor point of attachment. Again, if it were possible to detect sutures here, like indications ought also to exist where the antorbital processes are attached. Granted that they are postorbital processes ("sphenotic" Parker), their size and distal expansion may be accounted for, perhaps, by supposing that membranes were attached to them for the support of the anterior gill arches or other structures. They slant outward and downward so as to occupy the same level, distally, as the tips of the antorbital processes.

The hyomandibular was presumably attached along the sinus marked *HM*. Bounded on either side by prominent occipital condyles was the foramen magnum (*FM*), and here the chondrification was very dense. Just back of the capsules for the eyes on either side is to be seen a small reëntrant angle in the cranial wall. The cartilage is quite thick in this vicinity, and appears to have been eroded by natural causes in the first instance, and further pricked away with the needle so as to produce the effect indicated. It is rather curious that accidents of fossilization and weathering should have affected both sides of the object symmetrically in so many particulars.

The nerve openings are readily identifiable, and have been lettered to correspond with the classic illustrations of Gegenbaur* and Parker.† The superior opening of the ethmoid canal is at *ee*, that of the preorbital canal at *ep'*; *es* marks the foramina supraorbitalia, present here in two pairs only; and *aq.v.* is the aqueductus vestibuli. All of these openings are very distinct, and their walls densely chondrified.

Probable relationships and systematic position.—If remains of the dentition or dermal ossifications had been preserved in connection with the present specimen, or if skeletons of other

* Untersuchungen zur vergleichenden Anatomie der Wirbelthiere, Heft III. Das Kopfskelet der Selachier, 1872.

† On the Structure and Development of the Skull in Sharks and Skates (Trans. Zool. Soc. London, vol. x. pt. iv), 1878.

Palæozoic Tectospondyli were known, we would not have so slender a basis for comparison; but as it is, we are singularly limited. True, evidence is not wanting to show that cartilaginous fishes with a much-depressed body, probably like that of existing rays, were plentiful in the Palæozoic. The teeth known as Psammodonts, for instance, belonged undoubtedly to ray-like Elasmobranchs; but no trace of their skeletons has yet been discovered. We should not expect them, however, to differ very widely from Mesozoic or even recent rays; their bodies were more generalized, of course, partaking of the nature of both shark and skate; but the idea that the distinction between a shark-skull and a skate-skull was not brought about until the skates began to specialize markedly along particular lines (i. e., since the Jurassic), cannot be entertained. In fact, it does not strike us as surprising that a Palæozoic skull, such as has just been described, should present the resemblance it does to the crania of existing skates. The specimen at hand merely proves what has long since been postulated,—that there were Palæozoic forerunners which were very like Mesozoic rays; and it is to be observed that a number of Mesozoic genera survive at the present day. So far material has been lacking to demonstrate the conservatism as well as remote antiquity of the ray tribe; but as the palæontological record becomes more fully revealed, we shall probably find that this group diverged very early from the parent stem, and did not become highly modified until comparatively late in time.

Of existing families, the Rhinobatids and Myliobatids are generally believed to represent the most nearly ancestral form of ray, and it is natural to look to them first of all for furnishing points of resemblance to the present specimen. But as we have here nothing more than the skull to base comparisons upon, and this is not sufficiently characteristic, it is manifestly impossible to single out any one genus or even family and declare that the fragment approaches it more closely than other living types. We can only affirm that the fossil skull indicates a very generalized condition; it presents some features that are shark-like, and differs notably from the skulls of existing rays. Doubtless the fin-structures and body-parts were also generalized; the indications are that the skeleton of the pectoral fins was not continued forward to the snout; and the dentition was probably weak. In all these respects there is an agreement with *Rhinobatus*, obviously because it, too, possesses a generalized organization; but there are differences in detail which prevent it from being included under the same family. With still less propriety can it be assigned to any other recognized family; but as the group to which it belongs is imper-

fectly definable, there seems to be no other course than to leave it under the head of *incertæ sedis*, or to place it in an appendix to the *Rhinobatidæ*, or possibly the *Myliobatidæ*.

A knowledge of the remainder of the organization of so ancient a fish could not fail to prove of exceptional interest. Where one stratum or concretion is capable of preserving a fragile structure like this, the chances are that more abundant and more perfect material will eventually be forthcoming; and it is not without the hope of stimulating further research that the present contribution is put forward.

As it becomes necessary to designate the above described individual by a special title, notwithstanding its imperfect condition it is suggested that the name *Tamiobatis* be employed for the genus, in allusion to its fancied resemblance to the body of *Tamias*. Specifically it may be known as *Tamiobatis vetustus*.

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TAMIOBATIS VETUSTUS.

Dorsal aspect of cranium, two-thirds natural size. From a photograph taken by Dr. T. A. Jaggar, Jr.