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FOSSIL CRABS OF THE GAY HEAD MIOCENE.

JOSEPH A. CUSHMAN.

DURING the summers of 1903 and 1904 the writer made two trips to Gay Head for the purpose of obtaining fossils, especially those of the crabs so abundant there. The fossil crabs are found in the greensand layer in close relation to the so called "osseous conglomerate." At the northern end of the exposure, the crabs occur in a layer about six inches below the conglomerate, which is itself at this point a very narrow band. In this greensand layer which here is of a very dark, almost blackish green color when first dug out, the crabs lie in a natural position in the bed. That is, the crabs are in a position with their dorsal and ventral surfaces in the plane of the layer which contains them. As the edge of the layer is here exposed in the cliff and tilted at a very considerable angle, the edges of the crabs are struck in digging them out. They occur in very hard concretions, often entirely covered or as frequently, with a portion of the carapace or legs showing at the surface. The shelly portions of the crabs are decidedly black in color. The calcareous matter is still left, however, and entirely dissolves with effervescence in acid.

In another portion of the cliff, a short distance north of the lighthouse, the crab layer slopes in the opposite direction and is of a creamy white color. The crabs and the material in which they are imbedded are in consistency almost like cheese when dug out. This material is so soft that it can be easily cut with a knife. Upon exposure to the air the material quickly hardens and shrinks in drying, usually cracking considerably. The crab remains are here beautifully preserved in their details, the small papillæ on which the hairs are set being as perfect as they could have been in the living animal.

In certain cases in the larger concretions, there are obtained

remains which give a very good general idea of the crab as a whole. These larger concretions also have the various parts excellently preserved as will be noted in the description.

Dr. Edward Hitchcock was the first definitely to publish the occurrence of the crab remains at Gay Head. He spoke of them in his earlier reports on the geology of Massachusetts. In the Final Report of 1841, he speaks as follows: —

"Crustacea. In the green sand at Gay Head we meet with well-characterized specimens of the genus Cancer, although they are in general much broken, showing that they originally belonged to a formation which was abraded or destroyed anterior to the production of the green sand. The interior part of the specimen consisted of argillaceous matter, probably containing a large proportion of oxide of iron; but the covering of the animal still retains its black shining color, although apparently carbonaceous. The broken state of nearly all the specimens, renders it difficult to determine whether they belonged to more than one species, although they probably did: and for the same reason I have thought that drawings would not be of use."

In 1844, Sir Charles Lyell remarks at some length concerning the structure and fossils of the Gay Head exposure, both in the *Proceedings of the Geological Society of London* and in the *American Journal of Science*. In the latter (vol. 46, 1844, p. 319) he refers to the crab remains in the following words: —

"Crustacea. A species considered by Mr. Adam White as probably belonging to the genus Cyclograpsus, or the closely allied Sesarma of Say, and another decidedly a Gegarcinus."

In 1863, Dr. William Stimpson described *Archæoplax signifera* from the Gay Head greensand and mentioned that there is another species although he did not attempt to name it (*Boston Journ. Nat. Hist.*, vol. 7, pp. 583–589, pl. 12).

In 1900 (*Proc. Amer. Acad. Arts and Sci.*, vol. 36, no. 1, pp. 1–9, pls. 1–2), Professor Alpheus S. Packard describes a new fossil crab, *Cancer proavitus*, from Gay Head and gives a few notes and several photographs of *Archæoplax signifera* Stimpson.

Specimens representing the latter species were especially abundant in the material collected during the last two summers.

These show many points of structure not heretofore described. The material is in the museum of the Boston Society of Natural History, and is referred to by number. The material at the Museum of Comparative Zoölogy at Cambridge was also studied and is also referred to as well as one or two specimens in the teaching collection of the Paleontological Department of Harvard University.

Archæoplax signifera Simpson.

Archæoplax signifera Stimpson, *Boston Journ. Nat. Hist.*, vol. 7, no. 4, April, 1863, p. 584, pl. 12, figs. 1–4; Dall, *Amer. Journ. Sci.*, vol. 48, 1894, p. 297; Packard, *Proc. Amer. Acad. Arts and Sci.*, vol. 36, no. 1, July, 1900, p. 7, pl. 1, fig. 4, pl. 2, figs. 1–3.

Carapace. — In the specimens the length of the carapace varies from 1 to 2.5 inches, in greatest breadth from 1.2 to 2.75 inches, and in posterior breadth from 0.75 to 1.8 inches. The superior outline along the median antero-posterior line is decidedly curved as noted by Stimpson. This is shown in an outline side-view of a typical carapace (Pl. 1, Fig. 1). A similar view in the median line (Pl. 1, Fig. 2) shows at the slope at the sides and the depressions at each side of the median portion. The surface of the carapace is smooth, finely punctate or granular, the coarser granulation being in definite portions of the central region as well as of the anterior and lateral regions. The color pattern of the carapace is very well made out in several specimens. In the great majority of the specimens it is shown by a difference in smoothness and in luster of the surface, but may be seen as black markings against a dark gray background, as in Pl. 2, Fig. 3, or best of all on the under side of the upper surface as black markings on a very light brownish white background (Pl. 2, Fig. 4). Here the markings stand out with remarkable clearness. There is considerable variation in the markings of this species but all follow the same general pattern. The central lunate markings are important as a means of orienting any large or small part of a specimen of this species which

shows them. The variation in the central markings is shown in the two figures. In certain specimens examined the two sides of the same specimen varied much from each other.

As a whole the carapace is quadrangular, considerably broader in front than behind. The front angles have four teeth as described by Dr. Stimpson. Three of these are large, the first, second, and fourth, while the third is decidedly smaller. The orbits, as described, occupy about one third the breadth of the front of the carapace. The border is entire and raised, and is composed of crowded granules.

The front is nearly one fourth the width of the carapace and has a somewhat different form from that figured by Dr. Stimpson as a comparison of the figures will show. Excellent specimens of this part were obtained showing the complete form. There are two lateral lobes on the anterior border and a median lobe which is cut on the median line, making it emarginate. The front as a whole is bent downwards as shown in Pl. 1, Fig. 1. In the restoration it is drawn as though slightly raised to give its true shape (Pl. 1, Fig. 3).

In the specimens broken from large concretions the eyes have very frequently been excellently preserved. They have a prominent basal joint, with an expanded cylindrical outer portion of the shape shown in the figure. It seems strange that Dr. Stimpson did not obtain good specimens of the eyes for they have appeared very frequently in the collections of the last two summers.

Of the antennæ little was made out except their position which is but very slightly anterior to the base of the eyes. The bases of the antennæ appear as cross sections and as small bits now and then.

One specimen (Pl. 2, Fig. 5), showed the pair of antennules extending slightly beyond the front, but here again it was impossible to make out much more than their presence and position.

Turning to the ventral side, almost the entire features have now been made out and are included in the synthetic figure (Pl. 2, Fig. 6). The sternum is excellently preserved in a considerable number of specimens. A cast from the white layer showing all the minute tubercles was obtained (B. S. N. H. no. 12,977).

In drying, this specimen has cracked considerably. As a whole the sternum is nearly a plane surface except where it is hollowed in the center to receive the abdomen. The anterior portion, triangular in shape, is usually well separated from the rest. It varies considerably in size and shape. The main part of the large anterior plate is divided into three parts by a Y-shaped combination of sutures as seen in the figure. This is an incomplete division but the sutures are nearly always in evidence. As noted by Dr. Stimpson the "male genital tubercles" are found on the posterior margin of the second segment. These are situated just within the edge of the abdomen so that they are covered by it.

Dr. Stimpson found the abdomen of the male only, but in the collections of the past two years there are a few specimens of the abdomen of the female. The males appear to have been much more common. The male abdomen is approximately as figured by Dr. Stimpson, none of the segments being fused. A figure of the female abdomen is given (Pl. 2, Fig. 10). The third joint from the end is the widest, and there is an abrupt tapering from it toward either end. Of the abdominal appendages but one specimen, and that very incomplete, has appeared (Pl. 2, Fig. 11). This specimen indicates at least two pairs of these appendages.

One specimen (Pl. 2, Fig. 12) shows a cast of the outer maxilliped from which a fairly complete idea of these appendages may be obtained. Several other specimens show the basal joints in place and the minutely tuberculated surface (Pl. 2, Fig. 9).

The front legs are shown in a number of specimens, the basal and outer joints being those most frequently preserved. The teeth on two of the joints as figured by Dr. Stimpson, were not made out. The chelæ have a series of alternating teeth alike in both the left and the right sides. The various joints were more or less ornamented with a color pattern, portions of which are well preserved in a number of specimens. The teeth and the tips of the chelæ are much lighter colored than the other portions. The portion of the shell about the base of the anterior pair of legs has a raised beaded edge. This portion is often broken away and variously placed in some of the specimens.

Of the posterior four pairs of legs we have with the help of one specimen obtained in 1904 (Pl. 2, Fig. 2), a knowledge of all the parts. This specimen had the last four joints of a single leg very well preserved. The main characteristic of these appendages is the great length of the fourth joints. These joints are considerably flattened in some cases but usually appear in cross section as shown in Pl. 2, Fig. 13.

Certain of the specimens preserved in the concretions show the internal characters very well. The doubly triangular skeletal mass shown in Pl. 2, Fig. 5, is often seen perfectly preserved. The divisions of the posterior part of the body are also seen in the same figure. In rare cases the gills are found lying in their cavities. In one case a small piece was taken out, softened and mounted. In this condition it showed the tubes and something of the structure of the gill. Apparently it was simply dried and not in any degree impregnated by mineral matter. A small rod-like mass is often seen when the front is broken away exposing the interior.

Altogether it seems that we now have a very fair knowledge of this Miocene species. In Pl. 1, Fig. 3, is given a restoration of this species from the specimens studied.

Cancer proavitus Packard.

Cancer proavitus Packard, *Proc. Amer. Acad. Arts and Sci.*, vol. 36, no. 1, July, 1900, p. 3, pl. 1, figs. 1–3.

Of all the specimens examined there seems to be but one which is in any way referable to this species. This specimen from the white leached layer already mentioned, consists of the cast of the sternum, abdomen, and outer maxilliped of a small female individual. Its main characters are shown in Pl. 2, Fig. 14. From a study of the type the specimen is referred to this species as it seems to be a Cancer and is from the same bed as was the type of this species. The type was a male and this is in all probability a small female of the same species. It will be at once seen that it cannot be referred to Archæoplax, which has

a very different sternum, abdomen, and outer maxilliped from that shown in the specimen under discussion. This species represented by the male specimen and the hand originally described, and now by this cast of the under side of a female, shows that it must have been far less common than the Archæoplax. Further search, however, should yield more specimens of this species. I am greatly indebted to Dr. Walter Faxon of the Museum of Comparative Zoölogy for help in placing this specimen in its present position, for although its condition would not give its complete relations there was nothing to preclude its being a Cancer.

Many of the Archæoplax had specimens of *Balanus concavus* Bronn attached to the carapace, as has been already noted in a previous paper.

Boston Society of Natural History,
March, 1905.

Explanation of Plates.

Plate 1. Natural size.

Fig. 1. Outline of side view of a typical carapace.
Fig. 2. Outline of front view of section through middle of carapace.
Fig. 3. Restoration of *Archæoplax signifera*, dorsal view.

Plate 2. $\frac{3}{4}$ natural size.

Fig. 1. Ventral view, sternum and joints of front leg (B. S. N. H. no. 12,946).
Fig. 2. Last four joints of one of the walking legs (B. S. N. H. no. 12,944).
Fig. 3. Color pattern of one side of carapace (M. C. Z.).
Fig. 4. Color pattern of small specimen from inside (B. S. N. H. no. 12,969). $\times 2\frac{1}{2}$.
Fig. 5. Specimen broken open showing antennules, plates of interior, and double triangular plate (B. S. N. H. no. 12,945).
Fig. 6. Synthetic figure from ventral side.
Fig. 7. Portion of hand and finger with teeth (B. S. N. H. no. 12,941).
Fig. 8. Portion of two chelæ, partly broken (B. S. N. H no. 12,942).
Fig. 9. Ventral view of sternum, abdomen, maxilliped, basal joints of legs and portion of chela (M. C. Z.).
Fig. 10. Abdomen of female (B. S. N. H. no. 12,940).
Fig. 11. Specimen showing abdominal appendages (B. S. N. H. no. 12,943).
Fig. 12. Outer maxilliped of right side (B. S. N. H. no. 12,947).
Fig. 13. Outline of section of one of the rear legs.
Fig. 14. *Cancer proavitus*, portion of abdomen, sternum, maxilliped, and basal joints of two legs (B. S. N. H. no. 12,970).

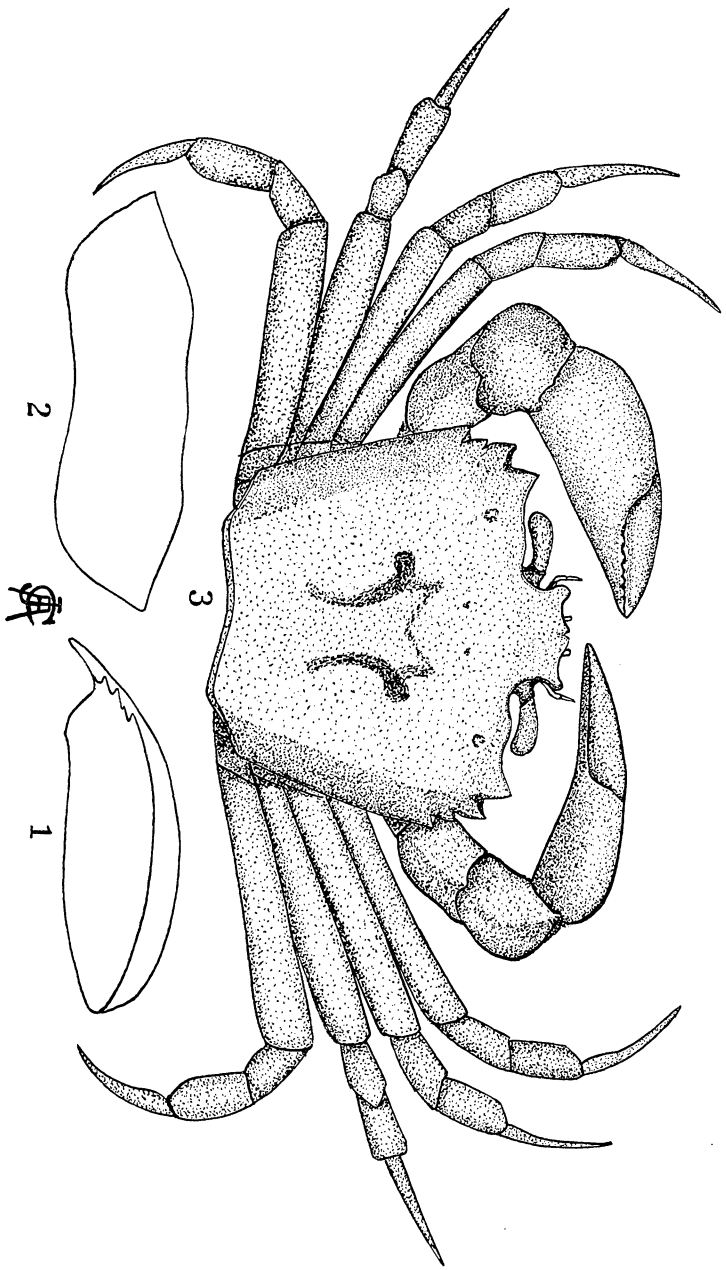

PLATE 1.

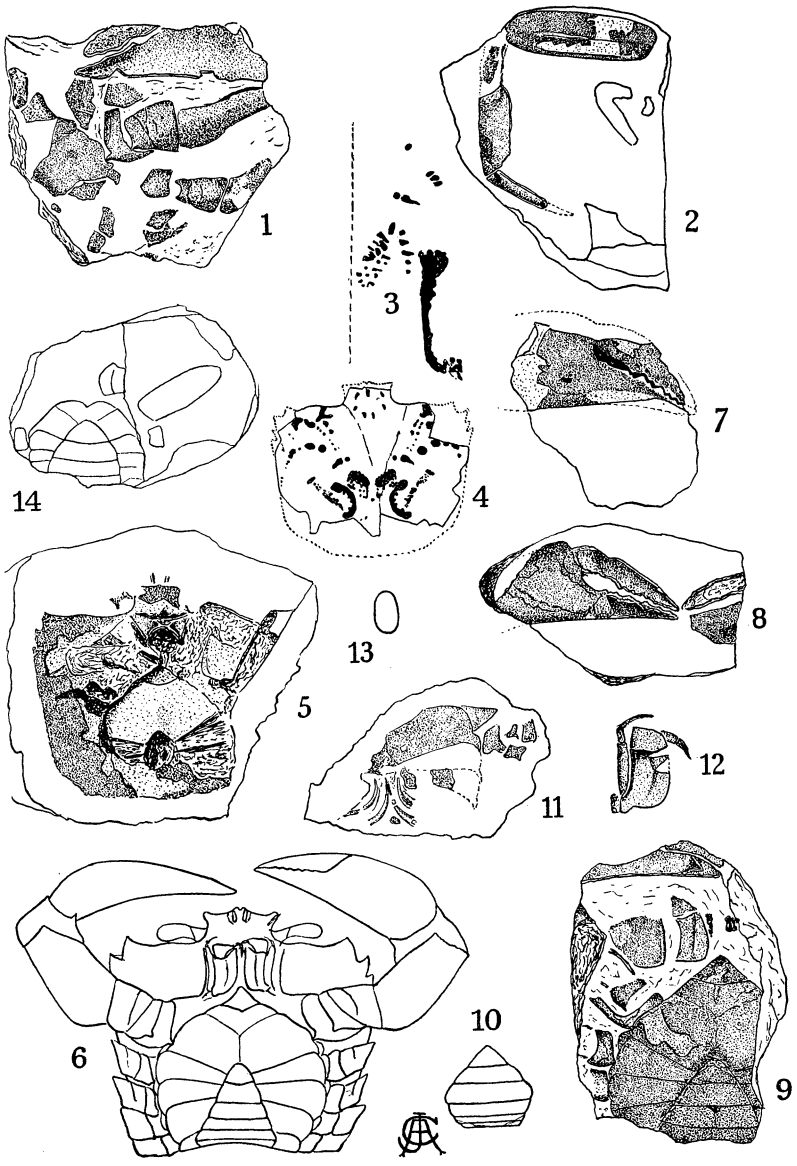

PLATE 2.