

DESCRIPTIONS OF FOSSIL CRABS FROM CALIFORNIA.

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This paper is based on specimens collected in California in 1907 by Dr. Ralph Arnold, Paleontologist, U. S. Geological Survey.^a Three species are from the Miocene of Fresno and Kern counties; the remaining species is from the Cretaceous beds of San Mateo County.

The Tertiary forms differ markedly from one another as to their resemblance to existing types. One is a species of *Loxorhynchus* identical with *L. grandis*, which now occurs locally off the California coast; another is a *Cancer* which is distinct from any of the nine recent species of the genus inhabiting California, but may be the ancestor of one or more of them; while the third, probably a Parthenopid, is quite unlike any now known. The degrees of relationship which these fossil crabs bear to their living allies correspond to the age of the strata in which they are found, the *Loxorhynchus* being stratigraphically above the *Cancer*, though both are in the Miocene, and the *Cancer* in turn far above the Parthenopid, which is also in the Miocene.

The single species from the Cretaceous is a new type which I have designated as *Archæopus antennatus*. In its dorsal aspect it is allied to *Plagiolophus vancouverensis* Woodward from the Cretaceous of Vancouver Island. Of the latter species only the carapace and fragments of the limbs are known, so that it is impossible to tell whether it possesses the peculiar characters existing in *Archæopus*, especially the rudimentary and elevated fifth pair of feet. More interesting is the resemblance to the genus *Retropluma* (see below), represented by an anomalous form from the depths of the Indian Ocean, which was described by its authors as of an archaic type.

^a Doctor Arnold has furnished the notes on localities and also the lists of fossils inserted here.

Family INACHIDÆ.

LOXORHYNCHUS GRANDIS Stimpson.

Plate XLV; Plate XLVI; Plate XLVII, fig. 1.

Loxorhynchus grandis STIMPSON, Proc. Boston Soc. Nat. Hist., VI, 1857, p. 85.*Loxorhynchus grandis* STIMPSON, Jour. Boston Soc. Nat. Hist., VI, 1857, p. 452, pl. xx, fig. 1; pl. xxii, fig. 1.

One specimen, adult female, without appendages except a portion of the coxal joints of some of the legs. Cat. No. 165476, U.S.N.M.; U. S. Geological Survey Locality No. 4783.

This crab occurs in a rather hard, coarse blue-gray sandstone layer about 125 feet stratigraphically below the top of the Etchegoin formation (Upper Miocene) on Canoas Creek, three-fourths of a mile below Hugo Kreyenhagen's ranch house, 16 miles southeast of Coalinga, Fresno County, California.

The specimen is apparently of the same species as the recent *L. grandis*. The spines of the carapace, the form of the buccal cavity and the abdomen correspond to the same parts in *L. grandis*. The rostral and orbital region is lacking.

Measurements.—Greatest width of carapace 93 mm., width at hepatic regions 58.5 mm.

Present distribution.—From the Farallone Islands and San Francisco to San Diego, in 6½ to 68 fathoms. Uncommon.

Only one other species of the genus is known, *L. crispatus* Stimpson,^a which has almost the same marine distribution as the above, but has not been recorded in a fossil state.

No other fossils were found in the immediate bed with *L. grandis*, but overlying it about 25 feet was a bed containing *Ostrea lurida* Carpenter, while in beds equivalent to those 300-350 feet below it are found the following species:

List of fossils from upper Etchegoin formation (Miocene), Zapata Creek, 13 miles southeast of Coalinga, California.

ECHINOIDEA.

Astrodupsis perrini Merriam.*Scutella breweriana* Rémond.*Echinarachnius gibbsii* Rémond.

BRACHIOPODA.

Terebratalia occidentalis Dall.

PELECYPODA.

Arca trilineata Conrad.*Pecten nuttleri* Arnold.*Chama pellucida* Sowerby.*Pecten watti* Arnold.*Macoma nasuta* Conrad.*Saxidomus gracilis* Gould.*Pecten coalingensis* Arnold.

GASTEROPODA.

Nassa californiana Conrad.*Nererita reclusiana* Petit.

^a Jour. Boston Soc. Nat. Hist., VI, 1857, p. 453, pl. xxii, figs. 2-4.

Family CANCRIDÆ.

CANCER FISSUS, new species.

Plate XLIX, fig. 1.

Type.—Cat. No. 165477, U.S.N.M.; U. S. Geological Survey Locality No. 4756.

This crab is found toward the base of the Etchegoin formation near Henry Spring on the east face of "1900 foot hill" 4 miles south of Coalinga, Fresno County, California.

This horizon is about 800 feet stratigraphically below the bed containing *Loxorhynchus grandis* Stimpson.

One specimen showing dorsal view of carapace only. Outer layer of surface absent except along the lateral teeth. Proportion of length to width (measured at the anterior angle of the eighth or penultimate side tooth) as 1 to 1.45. Convexity and areolation much as in *C. magister* Dana.^a The depression about the cardiac region is deeper than in *C. magister* and the region itself is more distinctly divided in the middle into two elevations.

The anterior angle of each lateral tooth scarcely projects sideways beyond the tooth immediately in front of it. The teeth are subtruncate, separated from one another by shallow V-shaped notches and long closed fissures; they are eight in number (including the tooth at the outer angle of the orbit), and are irregular in size and shape; the first, third, fifth, and seventh are larger than the intervening teeth; the shape of the ninth tooth (at the lateral angle of the carapace) is not clear, but it is very narrow as is customary in the genus; the fifth, sixth, seventh, and eighth teeth each have a small horny point at their anterior angle. The surface of the teeth is granular. The most anterior tooth visible on the right side is very evidently the outer tooth of the orbit, the close granulation characteristic of the margin being continued along the inner side of the tooth, which forms a part of the upper border of the orbit. The margin of the first five teeth is preserved on the right side, while that of the third to the eighth inclusive, as well as part of the margin of the second and ninth teeth, is visible on the left side.

Very little of the front is preserved; that is, the tip of a blunt median tooth, the tip of a much smaller lateral tooth on the right not far from the middle, and beyond this last a cavity which may represent still another tooth before the frontal border curves into the tooth which forms the inner border of the orbit. The latter is visible on the left side of the specimen, as are also the two fissures of the orbital margin. The fissures are closed on the margin of the orbit, but widen

^a Proc. Acad. Nat. Sci. Phila., VI, 1852, p. 73; Crust. U. S. Expl. Exped., I, 1852, p. 151; atlas, 1855, pl. vii, fig. 1a-d.

posteriorly, forming a sort of buttonhole effect. A portion of these fissures shows on the right side.

The thickened granulate line which forms the postero-lateral border of the carapace is continued across the posterior margin.

Measurements.—Length of carapace, 30.5 mm.; extreme width at the eighth tooth, 44.2 mm.; fronto-orbital width, 16.5 mm.; width of front between the inner orbital angles, 8.6 mm.

While in form this species resembles *C. magister* more than any other recent Californian species, yet *C. magister* has more prominent, triangular side teeth, 10 in number, its orbital fissures are linear, and the postero-lateral margin is discontinuous with the posterior margin.

The bed containing the crab consists of fine conglomerate and coarse sand, and contains the following fauna:

List of fossils from lower Etchegoin formation (upper Miocene), Henry Springs, ¼ miles south of Coalinga, California.

ECHINOIDEA.

Echinurachus gibbsii Rémond.

PELECYPODA.

Arca trilincata Conrad.

Clidiophora punctata Carpenter.

Diplodonta harfordi Anderson.

Glycymeris, species.

Mulinia densata Conrad.

Panopca generosa Gould.

Solen cf. *sicarius* Gould.

GASTEROPODA.

Nassa californiana Conrad.

Pisania aff. *fortis* Carpenter.

CIRRIPEDIA.

Balanus concavus Brom.

Family PARTHENOPIDÆ.

Genus BRANCHIOLAMBRUS, new.

Carapace rhomboidal, very convex in an antero-posterior as well as in a transverse direction. Branchial regions very extensive and nearly touching each other at the median line. Front and antero-lateral margins dentate; postero-lateral margin a sinuous line, below which the surface is steeply inclined.

Appendages unknown.

(βράγχα, gills, branchiæ, in allusion to the extent of the branchial region; *Lambrus*, until recently the name of a genus of crabs.)

Type of the genus.—*Branchiolambrus altus*, new species.

BRANCHIOLAMBRUS ALTUS, new species.

Plate XLVII, figs. 2 and 3.

Type.—Cat. No. 165478, U.S.N.M.; U. S. Geological Survey Locality No. 4859. One specimen.

This crab is found in a yellow calcareous layer in the gypsiferous shales immediately underlying the Vaqueros (lower Miocene) beds on Wagon Wheel Mountain, southeast quarter, section 36, township 25 south, range 18 east, Devils Den District, Kern County, California, about 36 miles southeast of Coalinga. Associated with the crab are *Yoldia impressa* Conrad, *Phacoides acutilineatus* Conrad, and an abundant species of *Arca*. The beds are believed to be of lower Miocene age, and closely related to the overlying Vaqueros.

Carapace about five-sevenths as long as wide, front subtriangular, antero-lateral margin long and arcuate, postero-lateral margin sinuous. The widest and highest part of the carapace is at about its posterior third; from the summit of the branchial region the surface slopes to the margins, the longest incline being toward the front.

Entire surface covered with sharp granules. Cervical suture shallow for its anterior two-thirds, becoming deep and narrow posteriorly, where the gastric region is much constricted, ending in an obtuse point. Cardiac region correspondingly narrow, depressed below the branchial level and furnished with two tubercles side by side. At the inner angle of the branchial region and either side of the gastro-cardiac furrow, there is a small but sharp tubercle.

Frontal teeth three, subequal, broad and blunt, the two outer directed a little obliquely, their inner margins having an almost transverse direction. The intervals between the tips of the median and lateral teeth are a little less than those between the tips of the lateral and inner orbital teeth, the second sinus being more concave. Orbital tooth acute; width of orbit equal to sinus just in front of it.

Antero-lateral margin very incomplete; hepatic portion perhaps straight or a little concave; teeth along the branchial region at least seven, shallow and broad, separated by closed sinuses, tips broken off. A notch just behind the lateral angle forms a small blunt postero-lateral tooth similar to that which occurs so often in the genus *Cancer*. Postero-lateral margin for most of its length concave, posteriorly convex; margin slightly raised and ornamented with a line of fine granules. The posterior end of the carapace is broken off so that its outline is conjectural. The surface below the postero-lateral margin is steep but not perpendicular, and in a direct view its upper border appears convex (Plate XLVII, fig. 3); this surface may represent a distinct facet, as near its anterior end and bounding it below there is a remnant of a horizontal granulated ridge.

Measurements.—Length (approximate), 18.2 mm.; width (approximate), 27.2 mm.; height at least 5 mm.

Relationship.—There is no recent form closely approximating the above. The characters of the carapace point more strongly to the Parthenopidæ than to any other family, but it is possible that a knowledge of the appendages would compel the removal of the genus to another family. The general shape as well as the antero-lateral teeth and the orbits are Parthenopid. The front is more Cancerid. The suberect postero-lateral surfaces may be analogous to those in *Solenolambrus*. The amplitude of the branchial regions and the corresponding contraction of the cardiac and gastric regions are unique.

List of fossils from Vaqueros formation (lower Miocene), immediately overlying beds containing Branchiolambrus altus at Wagon Wheel Mountain, Kern County, 36 miles southeast of Coalinga, California.

ECHINOIDEA.

Astrodapsis merriami Anderson.

PELECYPODA.

Chione temblorcensis Anderson.
Melis, species.

Pecten andersoni Arnold.
Pecten crassicardo Conrad.

GASTEROPODA.

Comus, species.
Turritella ocoyana Conrad.

Siphonatia (?), species.

Family OCYPODIDÆ.

Genus ARCHÆOPUS, new.

Carapace transverse, sides converging anteriorly, posterior angles rounded. Front or rostrum linear; orbits deep and wide. Basal joint of antennules very large, inflated, and much exposed. Buccal cavity wide. Chelipeds of moderate size; fingers long and slender. Last pair of legs very small, subdorsal and probably attached at the margins of the abdomen which does not cover the whole width of the sternum at its base.

(*αρχαῖος*, belonging to former times; *πῶς*, foot, in allusion to the reduction of the last pair.)

Type of the genus.—*Archæopus antennatus*, new species.

Allied to *Plagiolophus* Bell,^a in which, however, the four ambulatory legs are similar to one another, and the orbits are less extensive. The carapace of our species has a strong resemblance to that of the so-called *Plagiolophus vancouverensis* Woodward,^b but in that species, although the orbits extend to the anterior corners of the carapace, the front or rostrum is of considerable width and bifid, and, as mentioned above, the hind feet are not known.

^a Mon. Fossil Malac. Crust. Great Britain, Pt. 1, 1857, p. 49.

^b Quart. Jour. Geol. Soc. London, LI, 1896, p. 226, text figs. 5, 6.

In the reduction of the last pair of legs, *Archæopus* shows an affinity to the deep-sea Ocypodan genus *Retropluma* Gill^a = *Archæoplax* Alcock and Anderson^b (not Stimpson) = *Ptenoplax* Alcock and Anderson,^c which has also a large ovoid basal antennular article and similar chela.

ARCHÆOPUS ANTENNATUS, new species.

Plate XLVII, figs. 4-7; Plate XLVIII; Plate XLIX, figs. 2-4.

Type.—Cat. No. 31069, U.S.N.M. One adult female, type; one immature female, cotype; one male, cotype. Locality 27, Santa Cruz Quadrangle.

Found in a soft blue grey sandstone of Chico, upper Cretaceous, age at Bolsa Point one mile north of Pigeon Point, San Mateo County, California.

Carapace about $1\frac{2}{3}$ times as broad as long, antero-lateral margins straight and anteriorly converging, postero-lateral margins very convex, curving into the bilobed posterior margin.

Surface uneven; a transverse ridge across cardiac and branchial regions; cervical suture well marked, its anterior portion straight and oblique; the depressions in the center of the carapace form a broad H. A groove parallel to the posterior margin defines the intestinal region. Surface punctate. A few irregular bands of small well-separated granules are distinguishable on the more elevated portions. A conical tubercle crowns the hepatic region: five conical tubercles, irregular in size and position, are ranged on the antero-lateral margin, one is hepatic, the others branchial; of the latter the anterior is the largest and most elevated, the next two are small, the last is considerably larger.

Anterior margin sinuous. Front or rostrum slender, acuminate, obliquely inclined, extending forward to a point opposite the outer angles of the orbit. Each orbit occupies about one-fourth of the anterior border of the carapace and is deep and well defined (Plate XLVII, fig. 4); its highest part (at its middle) nearly as great as its transverse width; upper margin with a triangular tooth or spine near the inner angle (Plate XLVIII, fig. 1), and a more prominent tooth at the outer angle (Plate XLVII, fig. 6) which forms also the antero-lateral angle of the carapace; lower margin also marked at its inner end with a tooth or spine (Plate XLVIII, fig. 2) which is nearer the median line of the crab than that of the upper border. On either side of the rostriform point of the front (which may, however, be a sub-frontal prolongation of the true rostrum), there is a large, swollen

^a Amer. Nat., XXVIII, 1894, p. 1044.

^b Jour. Asiat. Soc. Bengal, LXIII, Pt. 2, 1894, p. 180.

^c Illus. Zool. Investigator, Crust., Pt. 3, 1895, explanation of pl. xv.

and somewhat prismatic nodule (Plate XLVIII, fig. 2) which doubtless represents the basal segment of the antennules.

Antennae and maxillipeds unknown. Buccal cavity with parallel sides, and very broad, equaling half the width of the carapace (Plate XLIX, fig. 2).

The chelipeds of the female (Plate XLVIII) are of moderate size, subequal, and if extended, would measure in length about $1\frac{1}{3}$ times the width of the carapace. Merus thick, not much longer than wide. Dorsal aspect of carpus about $1\frac{1}{2}$ times as long as wide. Chelae narrow and strongly arcuate, fingers somewhat longer than palm, very slender, grooved, their apposed edges meeting and edged with low teeth. Low granular rugae can be detected on the palm. The margins of the various segments appear to be bluntly rounded.

Between the insertion of the cheliped and that of the first ambulatory, there is a considerable space (Plate XLVII, fig. 6; Plate XLVIII, fig. 3) which tends to indicate the presence there of a large afferent branchial opening. The first three pairs of ambulatory legs are similar and of ordinary size; they are too fragmentary for description; the merus is flattened, a cross section being nearly twice as long as wide. The bases of these three legs occupy the entire length of the after part of the sternum (Plate XLVII, fig. 6; Plate XLVIII, fig. 3). The fourth and last leg, unfortunately missing, must obviously have a subdorsal position and be of slender build; the indications are that the legs of this pair were attached not at the outer margin of the broad sternal plate, as in *Palicus Philippi*,^a but nearer together close to the outer edge of the abdomen (Plate XLVII, fig. 7; Plate XLIX, fig. 4), where the latter folds against the sternum, as in *Retropluma*.^b

The abdomen of the type female (Plate XLVIII, fig. 3) is as broad as the length of the fourth to seventh segments inclusive and does not nearly cover the sternum; second, third, and fourth segments subequal in length; fifth a little longer; sixth the longest and twice as long as the fourth; seventh broader than long, subtriangular. In the male also (Plate XLVII, fig. 6) the sixth segment is the longest but may represent the fusion of two or more segments; the two segments preceding it are subequal in length; the more proximal segment or segments are crushed and indistinguishable.

Measurements.—Type female (Plate XLVII, fig. 7; Plate XLVIII): length of carapace, 24.5 mm.; width of same, 34.5 mm.; width between anterior angles, 27.5 mm. Male (Plate XLVII, figs. 4-6): width of carapace, 25.7 mm.; width between anterior angles (approximate), 20.7 mm.

Associated with *Archaeopus antennatus* at the same locality or within the same formation at near-by localities is the following fauna.

^a Zweiter Jahresber. d. Vereins f. Naturk. in Cassel, 1838, p. 11.

^b Amer. Nat., XXVIII, 1894, p. 1044.

(Those species marked by an "*" are found at the same locality as the crab.)

List of Chico, upper Cretaceous, fossils from the Santa Cruz Quadrangle.

PELECYPODA.

<i>Anatina trygoniana</i> Gabb.	<i>Ostrea brewerii</i> (?) Gabb.
<i>Arca rancouverensis</i> Meek.	<i>Panopca concentrica</i> Gabb.
<i>Cucullæa bowersiana</i> Cooper.	* <i>Pholadomya subelongata</i> Meek.
* <i>Glycymeris veatchii</i> Gabb.	* <i>Pinna calamitoides</i> Shumard.
* <i>Inoceramus subundatus</i> Meek.	<i>Trigonia eransiana</i> Meek.
* <i>Mactra stantoni</i> Arnold.	<i>Trigonia leana</i> Gabb.
<i>Nucula truncata</i> Gabb.	

GASTEROPODA.

* <i>Cinulia obliqua</i> Gabb.	* <i>Perissolar brevirrostris</i> Gabb.
* <i>Lunatia</i> , new species.	<i>Turritella pescaderoensis</i> Arnold.
* <i>Margaritella</i> , new species.	

EXPLANATION OF PLATES.

PLATE XLV.

- Fig. 1. *Lororhynchus grandis*, nat. size, dorsal view.
2. *Lororhynchus grandis*, nat. size, front view.

PLATE XLVI.

- Fig. 1. *Lororhynchus grandis*, nat. size, ventral view.
2. *Lororhynchus grandis*, nat. size, rear view.

PLATE XLVII.

- Fig. 1. *Lororhynchus grandis*, left side, nat. size.
2. *Branchiolambrus altus*, dorsal view, $\times 2$.
3. *Branchiolambrus altus*, rear view, $\times 2$.
4. *Archæopus antennatus*, male, front view, $\times 2$.
5. *Archæopus antennatus*, male, dorsal view, $\times 2$.
6. *Archæopus antennatus*, male, ventral view, $\times 2$.
7. *Archæopus antennatus*, type female, rear view, $\times 2$.

PLATE XLVIII.

- Fig. 1. *Archæopus antennatus*, type female, dorsal view, $\times 2$.
2. *Archæopus antennatus*, type female, front view, $\times 2$.
3. *Archæopus antennatus*, type female, ventral view, $\times 2$.

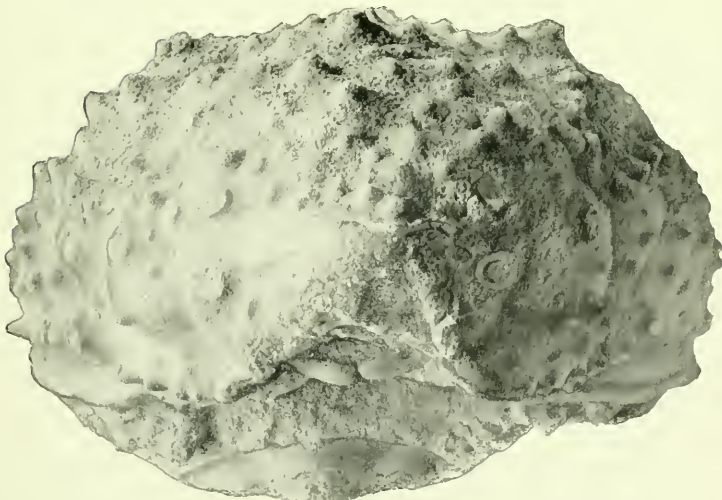
PLATE XLIX.

- Fig. 1. *Cancer fissus*, dorsal view, $\times 2$.
2. *Archæopus antennatus*, immature female, dorsal view, $\times 2$.
3. *Archæopus antennatus*, immature female, front view of palm, $\times 2$.
4. *Archæopus antennatus*, immature female, rear view, $\times 2$.





1



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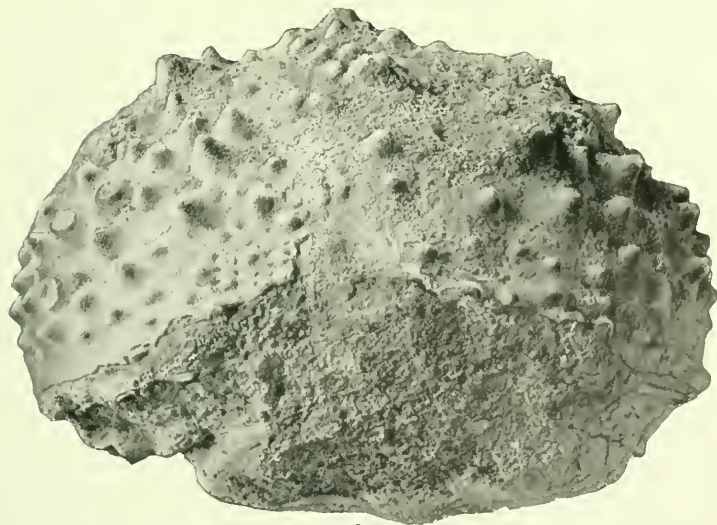
LOXORHYNCHUS GRANDIS.

FOR EXPLANATION OF PLATE SEE PAGE 349.





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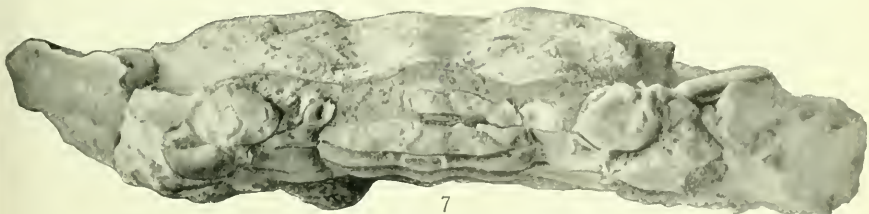
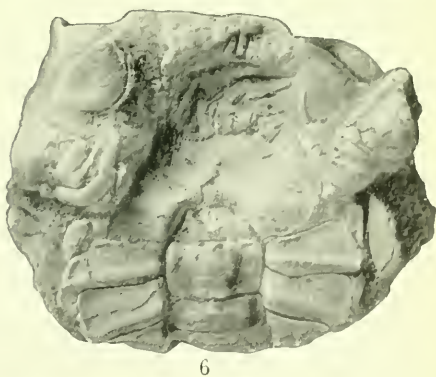
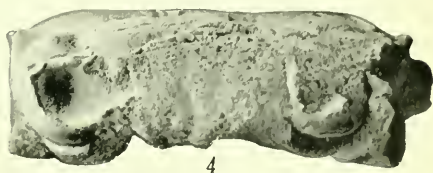
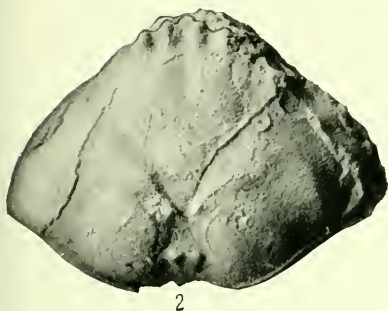
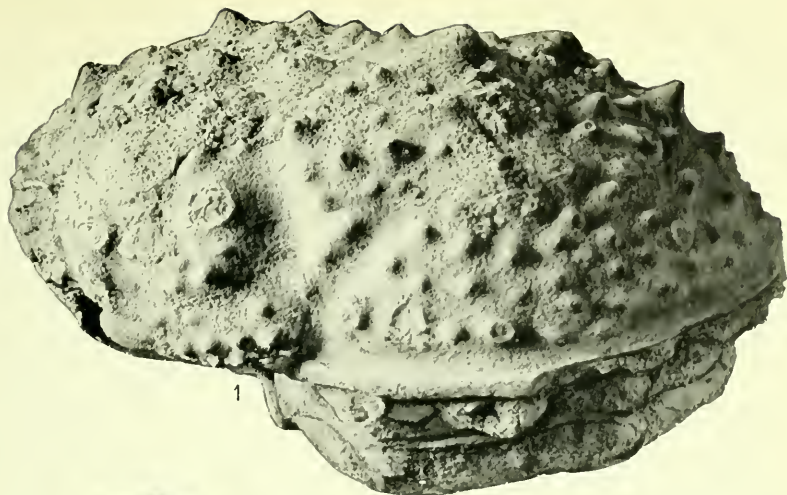


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LOXORHYNCHUS GRANDIS.

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1, *Loxorhynchus grandis*; 2 and 3, *Branchiolambrus altus*; 4-7, *Archæopus antennatus*.

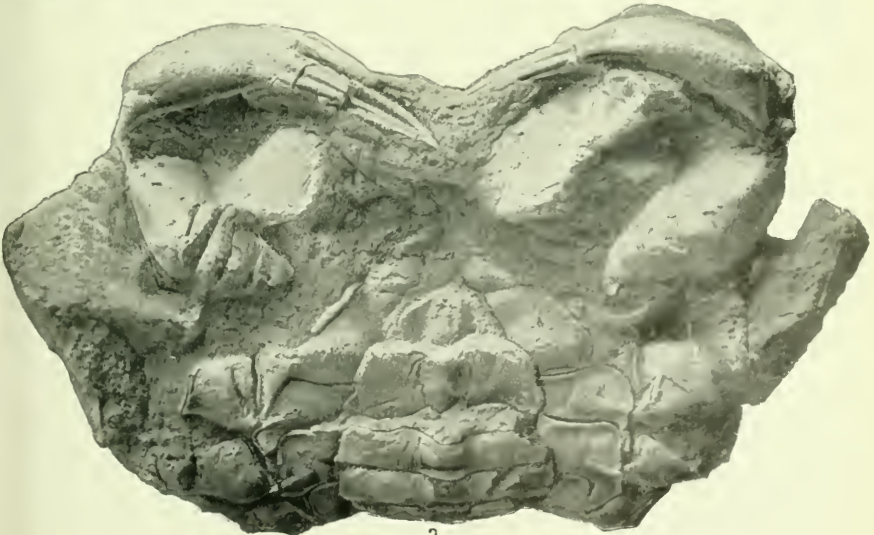




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ARCHÆOPUS ANTENNATUS.

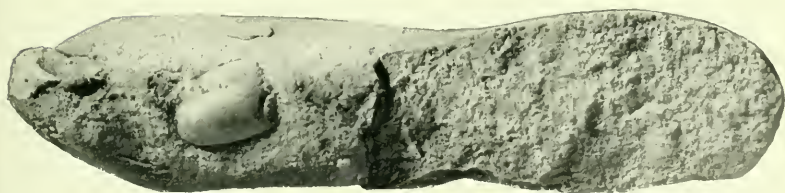
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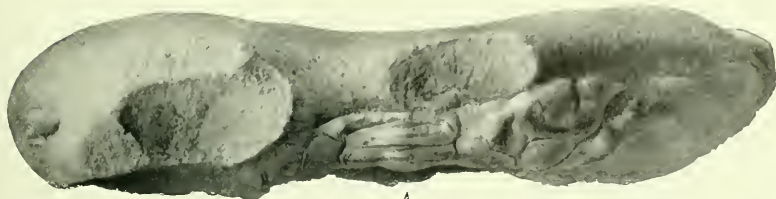
1



2



3



4

1, *CANCER FISSUS*; 2-4, *ARCHÆOPUS ANTENNATUS*.

FOR EXPLANATION OF PLATE SEE PAGE 349.

