

ward about a fourth of an inch, and ends in a transverse truncate border, which in the entire sternum would measure two inches in width. The position of the ento-sternal plate, of the usual form, at the suture of the episternal and hyo-sternal plates would measure 22 lines in breadth. The depth of the episternal to the ento-sternal is 11 lines; the breadth at the posterior suture 14 lines. In the specimen near the median suture there exists a groove, apparently indicating a long narrow scute intervening between the gular scutes, but not reaching the anterior border of the sternum within four lines. This last mark may perhaps be an anomalous one.

##### 5. CROCODYLUS APTUS.

Dr. A. R. Rocssler, in charge of the Geological Cabinet of the General Land Office, Washington, has submitted to my inspection a specimen from the collection consisting of a cervical vertebra of a Crocodile. The specimen was found by Col. John H. Knight, U. S. A., near South Bitter Creek, where it crosses the stage route about 70 miles west of the summit of the Rocky Mountains, in western Wyoming. It is thoroughly petrified, and the bone appears to have been of mature age. It has lost the greater part of the neural arch with the dependent processes, but is otherwise perfect. It belonged to an animal about the size of the Mississippi Alligator, and the bone bears a near resemblance with the corresponding sixth or seventh cervical vertebra of that species. The hypapophysis has the same character, projecting obliquely from the fore part of the centrum, but the latter is less carinated back of the process.

Length of centrum in its axis 16 lines; height and breadth in front 14 lines. Length of hypapophysis below the anterior articular concavity of the centrum 5 lines.

Probably the vertebra may belong to the same species as less characteristic fragments of bone, found by Mr. Carter, near Fort Bridger, in the same territory.

#### Descriptions of new CRINOIDEA and ECHINOIDEA, from the Carboniferous rocks of the Western States, with a note on the Genus ONYCHASTER.

BY F. B. MEEK AND A. H. WORTHEN,

Of the Illinois State Geological Survey.

Genus SYNBATHOCRINUS, Phillips, 1836.

SYNBATHOCRINUS WACHSMUTHI, M. and W.

Body below the top of the first radial pieces nearly semi-globose, or approaching semi-oval, being about twice as wide as high, and rounding to the column below. Base forming one-third to nearly one-half the height, somewhat basin shaped, and obscurely pentagonal in outline as seen from below; basal pieces, with the two larger divisions wider than high, and hexagonal in outline, and the smaller about as wide as high, and pentagonal in form. First radial pieces two-thirds to three-fourths as high as wide, with a general quadrangular outline, but two of those on the anal side, have each one of the superior lateral angles slightly truncated to form a notch for the reception of the first anal piece, so as to give each an additional angle. Second radial pieces of nearly the same size as the first, but not tapering upward as much as the first do downward, quadrangular in outline, and generally about three-fourths as long as wide. First anal piece about half as wide as long, pentagonal in form and equaling the length of the second radial pieces; second anal piece nearly half as long as the first, on the truncated upper end of which it rests; trigonal in outline, the upper angle being acute.

Arms very long and very gradually tapering, angular along the middle of the dorsal side, and each composed of more than thirty quadrangular pieces, 1869.]

that are somewhat wider than long, and provided with a very deep ambulacral furrow within. Minute ambulacral pieces extending up the furrows of the arms, from five to seven to each arm-piece, in each row, the two rows arching over the deep furrow. Probosciform ventral tube very long, slender, cylindrical, and composed of apparently not more than two or three vertical ranges of oblong curved pieces, about half as long as those of the arms.

Column comparatively rather stout, rounded, and composed near the base of more or less irregular pieces, gradually becoming thicker farther down, and all pierced by a small rounded or subpentagonal central canal.

Surface, when well preserved, showing under a strong magnifier minute granulations, with a tendency to run together into a kind of vermicular style of marking.

Height of body of a medium sized specimen, to the top of the first radial pieces, 0.16 inch; breadth 0.28 inch; height to top of second radial pieces, 0.30 inch. Length of arms, about 3 inches; breadth of same at the base, 0.15 inch. Thickness of column, 0.10 inch.

This species will be at once distinguished from all the others known to us, by having its body obtusely rounding under to the column below, instead of expanding upward from the same, with straight or concave sides. By this character alone of its body, exclusive of the second radials, when found detached, it can be readily distinguished from *S. dentatus*, Owen and Shumard, as well as from *S. Wortheni* and *S. papillatus*, Hall.

We have elsewhere noticed the occurrence of a long pipe-stem-like ventral tube in this genus, and a double series of minute ambulacral pieces extending up, and apparently arching over, the ambulacral furrow of each arm.\* These characters were first observed in this species, in which the ventral tube seems to be nearly as long as the arms. We have also seen indications of the same characters in *S. Wortheni*, and fragments of other undetermined species, and hence have little doubt that they occur in all the species of the genus, when well preserved. There is perhaps scarcely any other type of all the various genera of Crinoids, in which one would less expect to find such an elongated ventral tube, than in this.

*Locality and Position.* Upper division of the Burlington group, Burlington, Iowa. Lower Carboniferous. No. 235, of Mr. Wachsmuth's collection.

#### SYNBATHOCRINUS BREVIS, M. and W.

Body small, expanding rather rapidly, with nearly straight sides from the base to the top of the first radial pieces, thence contracting very slightly to the top of the second radials. Form and arrangement of the body pieces very nearly as in the last. Arms comparatively short, and tapering rather rapidly at the extremities, angular or subcarinated along the middle of the dorsal side, the carina being interrupted, or obsolete near the sutures between the arm-pieces, so as to present, as seen in outline, a subrenate appearance; arm-pieces eighteen to each arm; excepting the first one, slightly wider than long. Column slender, round and composed of alternately thinner and thicker pieces near the base; some of those 0.25 in. farther down, however, being as long as wide, all marked with strong radiating striæ on their articulating surfaces, and pierced by a small, apparently round, central canal. Surface finely granular.

Height of body to the top of the first radial pieces, 0.15 inch, to top of second do., 0.20 inch; breadth, 0.21 inch; length of arms, 1.35 inches.

This species will be readily distinguished from *S. Wortheni*, *S. dentatus* and *S. papillatus*, by its much shorter arms, which have scarcely two-thirds as many pieces as in those species. Its body is also rather less spreading, and slightly

\* Sometimes these pieces are thrown apart along the middle, as if they had been movable and articulated so as to open or close together over the ambulacral furrows. So far as we have been able to see there would appear to be no pinnulæ in this genus.

more inclined to round in to the column below, but not near so much so as in the last described species, from which it also differs in having much shorter arms.

*Locality and Position.* Lower Burlington beds, Burlington, Iowa. Lower Carboniferous. No. 336 of Mr. Wachsmuth's collection.

Genus DICHOCRINUS, Münster, 1839.

DICHOCRINUS LINEATUS, M. and W.

Body ovoid-subglobose, about as wide as long, not rounded below, but abruptly tapering to the column; widest near the middle, and but slightly contracted above. Base forming very nearly half the height, and expanding rapidly, so as nearly to equal, at the top, the greatest breadth of the body; margins faintly sinuous for the reception of the next range of pieces; sutures a little furrowed, but ankylosed. Radial pieces quadrangular, generally nearly or quite as wide as long; sinus above, for the reception of the second radials, shallow, rounded, and equaling about half the breadth of the upper margin, marked with fine radiating striæ at the outer margin. Anal piece as wide below as the first radials, but narrower above, and slightly shorter; sub-pentagonal in form, being but very obtusely angular in the middle below. (Succeeding parts unknown.)

Surface ornamented with numerous sharply elevated lines, slightly less than the furrows between. Of these lines, on the base, a part near each lateral margin run parallel to the same; while other series farther from the margins, although parallel with each other, on each side of the middle, run obliquely so as to connect with the lateral ones, and with each other, along the middle, in such a manner as to form three divaricating series on each piece: near the upper margins there are also traces of a few very fine crowded striæ running parallel to the same. On the first radial and anal plates there are also a few fine transverse striæ, near and parallel to the lower margins; while on a triangular central space, with its most acute angle terminating near the middle of the top, there are vertical or slightly converging striæ of the same size as the divaricating series on the base; and on each upper latter space, on each side, another series runs up and down, parallel to the lateral margins. Column rather small, round, and provided with a very minute central perforation.

Height of body to top of first radials, 0.65 inch; breadth, 0.66 inch; height of base about 0.30 inch.

This species seems to be somewhat intermediate in its characters between *D. ovatus* and *D. striatus*, of Owen and Shumard. From the first it differs in having distinct, sharply defined, continuous lines on the body plates, instead of merely rows of depressed granules; and these lines also run differently on the basal pieces from the rows of granules on that part of *D. ovatus*, which are described as forming a series of hexagons, one within the other, instead of forming three series of triangles, as the lines on our species show a tendency to do. The lines are also as well defined on the radial and anal pieces of our species as on the base, while the surface of these parts of *D. ovatus* is described as being merely "corrugated."

In having continuous, well defined, raised lines, it agrees more nearly with *D. striatus*, of Owen and Shumard; but it is easily distinguished from that species by having these lines very much finer and more crowded, as well as greatly more numerous, there being about ten of them in the space of 0.20 inch, which only includes four or five of those on *D. striatus*.

*Locality and Position.* Lower Burlington beds, Burlington, Iowa. Lower Carboniferous. Mr. Wachsmuth's collection.

DICHOCRINUS PISUM, M. and W.

Body small, somewhat cup-shaped, approaching sub-globose, rather depressed or flattened below, and from one-fourth to one-third longer than wide, 1869.]

slightly contracted at the top. Base nearly flat, or presenting a shallow dish-shape, sub-circular outline; facet for attachment of the column very small. First radial plates generally slightly longer than wide, and nearly quadrangular in form, comparatively moderately thick; sinus in the upper margin of each, for the reception of the second radials, very shallow, and about half as wide as the upper margin. Anal plate wider below than any of the first radials, but narrowing upward; provided with a very obscure angle at the middle of the under side, so as to present a sub-pentagonal outline. (Arms and vault unknown.)

Surface ornamented with comparatively strong, rounded costæ, wider than the furrows between. On the base these are arranged in three divaricating series, the lateral costæ being parallel to the lateral margins, and the divergence upward. On the radial and anal plates there are 7 or 8 of these costæ which run nearly vertically and parallel, the lateral ones, however, converging above, so as to leave small triangular spaces on the superior lateral corners, on which there are a few short costæ not properly connected with the others.

Height of body, 0.30 inch; breadth, 0.37 inch. Costæ on radial plates, six or seven in the space of 0.20 inch.

In the coarseness of its costæ this species is nearest like *D. striatus*, of Owen and Shumard, but it differs in having its costæ rather smaller, more rounded and separated by furrows, distinctly smaller than the costæ themselves, which are also without the numerous little asperities seen on those of *D. striatus*. It is also a smaller, shorter species, with a much more depressed or nearly flat base.

*Locality and Position.* Upper division of the Burlington group at Burlington, Iowa. Mr. Wachsmuth's collection.

#### Genus ERISOCRINUS, M. and W. 1865.

This genus was originally proposed by us for the reception of two very similar forms, one of which, from the upper part of the Coal-Measures of Illinois, we called *E. typus*, and the other, from the same horizon in Nebraska, we called *E. Nebrascensis*. The specimens then known consisted only of the body up to the summit of the first radials. This part of these forms is sub-hemispherical in outline, being rounded below, and evenly truncated above, with five minute, or very small basal pieces, surrounded by, and alternating with, somewhat larger subradials, which in their turn alternate with, and support, five larger, thick first radials, with articulating facets occupying their entire breadth above for the reception of the next range of radials. These radials being in contact with each other all around, leave no spaces for anal or interradial pieces. All the specimens then known had lost the arms, but those of other species now before us are seen to be simple from their origin on the second radial pieces, and each composed of a single series of transversely oblong pieces.

Subsequently another species was found in the same beds in Illinois, presenting an obconic form of body, with a protuberant base, and we were so much impressed with its resemblance to an East Indian Carboniferous type described by Dr. de Koninck, under the name *Philocrinus*, in 1863, that we were led to think our genus not distinct, and his name having priority of date we referred the two forms we had first described to it.\* In doing this, how-

\* Our later comparisons of other specimens have led to the conclusion that these are only varieties of one species. Good specimens of a form described by us in the Proceedings for Aug. 1865, from a number of detached plates, under the name *E. tuberculatus*, also show that it does not belong to this genus, as it has a large oblong subanal, and a true anal piece, resting on the upper truncated edge of one of the subradials. Hence, although it agrees exactly in all its other known parts with *Erisocrinus*, it cannot properly be retained in that genus, but would belong to *Cyathocrinus*, giving that group the limits generally admitted. It is not a typical *Cyathocrinus*, however, but nearer the group *Barycrinus*, and yet differs from the typical forms of that group, in having its second radials as wide as the first, and articulating by broad transversely furrowed facets, instead of merely resting in comparatively small sinuses in the upper edge of the latter.

ever, we thought it desirable to change the specific name of our species *typus*, it not being the type of the genus *Philocrinus*.

We were led to regard our species as not being generally distinct from *Philocrinus*, because they agree exactly in all their known generic characters, unless the lower range of pieces shown in the figure of *Philocrinus* really are the basal pieces, which would make that genus without subradial pieces. As the typical specimen, however, seems, from the figure, to be a little defective at the lower extremity, and the lowest range of pieces represented, if really prolonged to the bottom of the body, would have to present a very remarkably elongate cuneiform outline, we were strongly impressed with the probability of there being another smaller series of true basal pieces below the lowest range represented (but not visible in consequence of the condition of the specimen), especially as these forms appear to agree so nearly in other respects. If so, there would be no generic differences between *Philocrinus* and *Erisocrinus*, and the American species would have to stand under the former name. If *Philocrinus*, however, really has no subradial pieces, then, of course, *Erisocrinus* must be an entirely distinct genus. Until all doubts on this point, however, can be removed, we finally concluded to retain our name *Erisocrinus*.

The close similarity of the body of some species of this genus, and that of another allied form, found in the upper members of the Coal-Measures of Nebraska, to the corresponding parts of the genus *Encrinurus*, and their wide difference from all the then known Lower Carboniferous Crinoids of America, have been appealed to as facts sustaining an opinion, maintained by some, that these Nebraska beds belong to the age of the Permian of Europe, instead of to the Coal Measures. The fact, however, that we now have the species of this genus described in this paper, from the lower part of the lower Carboniferous or Mountain Limestone at Burlington, ought, we should think, to be sufficient evidence that no such conclusions can be properly based on this type of fossils.

#### ERISOCRINUS ANTIQUUS, M. and W.

Body small, much depressed, somewhat basin shaped, or very rapidly expanding from the base to the summit of the first radial pieces, at the connections of which it is very faintly sinuous around the margins, as seen from below. Base small, subpentagonal, almost entirely covered by the round, flat facet for the attachment of the column; basal pieces exposing very small pentagonal surfaces, three or four times as wide as long. Subradial pieces each about one-half to two-thirds as large as the whole base, all uniformly pentagonal (there being no visible angle at the middle of the base), and with the upper sloping sides each about twice the length of the lateral margins. First radial pieces about twice as large as the subradials, half as long as wide, and all equally pentagonal, with the lateral and inferior sloping edges of nearly equal length, and the straight, upper truncated side equaling the entire breadth; articulating upper edge very thick, deeply notched at the middle on the inner edge, and provided with the usual transverse ridge and furrows. Second radials as wide as the first, and about three-fourths as long as wide, angular in the middle on the dorsal side, and constricted on each lateral margin; pentagonal in form, and supporting on their superior sloping sides the first arm pieces, which are quadrangular, slightly constricted on each side, and a little wider than long; arms beyond these simple (as far as they can be traced in the specimen), two to each ray, or ten in the whole series, and composed of somewhat shorter quadrangular pieces, provided with a well defined ambulacral furrow within. Surface merely finely granular.

Height of body to the top of the first radials, 0.12 in.; breadth, 0.23 in.

This little species will be readily distinguished from those already known from the coal measures, by its much more depressed, rapidly expanding body, as well as by its proportionally longer and constricted second radial pieces.

1869.]

*Locality and position.* Lower division of the Burlington group, at Burlington, Iowa. Lower Carboniferous. Mr. Wachsmuth's collection.

ERISOCRINUS WHITEI, M. and W.

Body of moderate size, very much depressed, or almost dish-shape, below the top of the first radials, being about three times as wide as high. Base very small, and entirely hidden by the slender, round column, when it is attached. Subradials small, forming together a nearly flat pentagonal disc. First radials comparatively large, thick and presenting a general quadrangular outline, there being scarcely any visible angle at the middle of the under side, which is distinctly shorter than the straight transverse upper edge, and about as long as the diverging lateral margins. Second radial pieces as large as the first, which they equal in breadth; broadly rounded on the outer or dorsal side, pentagonal in form, and each supporting on its superior sloping sides two arms, thus making ten to the whole series. Arms simple from their origin, flat on the outside, and composed of quadrangular pieces, the first of which is nearly as long as wide, and the others about half as long as wide, with scarcely any tendency to assume a wedge shape. Surface merely finely granular.

Height of body to the top of first radial pieces, measuring to their inner edges, 0.14 inch; breadth, 0.40 inch; breadth of column, 0.08 inch.

This species will be distinguished from the last by its more depressed body, which has its under side between the top of the first radial pieces and the column, slightly convex in outline, instead of concave, which results from the greater prominence of the basal and subradial pieces of the latter. The species under consideration likewise has its radial pieces proportionally wider, particularly the second radials, which also differ in being broadly rounded instead of angular on the dorsal side, and not constricted on their lateral margins. Its arm pieces are also flat, instead of convex, on their outer side.

Owing to the fact that the column entirely hides the very small base of this species, and the sutures between the subradials, or first range of pieces around the summit of the column, are rather obscure, and really look as if there were only three instead of five of these pieces, we were led to suspect that these might be the basal pieces, which would remove the species entirely from the genus *Erisocrinus*. On removing the column, however, we have been able to see what we believe to be five minute basal pieces within the first series surrounding the end of the column, which would necessarily have to be succeeded by five pieces in the next range. Hence, we think we can scarcely be mistaken in supposing the appearance of only three suture lines between the plates we regard as the subradials, as merely an abnormal condition, resulting from two of the suture lines being ankylosed, or accidentally obliterated. This supposition is also strengthened by the near specific relations between this and the last described species, in which all the basal, subradial and other plates are clearly and distinctly seen.

In case our genus *Erisocrinus* is not distinct from *Philocrinus*, with which we have already suggested it may be identical, then the names of the species here described will have to be written *Philocrinus antiquus* and *P. Whitei*.

The specific name of this species is given in honor of Dr. C. A. White, the able State Geologist of Iowa.

*Locality and position.* Upper division of the Burlington Group, at Burlington, Iowa. Lower Carboniferous. Mr. Wachsmuth's collection.

Genus CALCEOCRINUS, Hall.

*Calceocrinus*, Hall, 1852. Palaeontology N. Y. Vol. 11, p. 352.

? *Cheirocrinus*, Hall, 1860. Thirteenth Report Regents University N. Y. (State Cab. N. H.), p. 122; (not *Cheirocrinus*, Eichwald 1856, Bull. Soc. des Nat. Mosc. vol. 29, p. 123, and Leth. Ross. vol. 1, p. 645, pl. xxxii, fig. 1, a. b., 1860).

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Dr. Shumard has suggested, in his Catalogue of North American Palæozoic *Echinodermata* (Trans. Acad. Sci. St. Louis, ii, p. 358, 1866), that the curious genus of Crinoids described by Prof. Hall, in the Report of the Regents, cited above, under the name *Cheirocrinus*, may be the same type for which Prof. Hall had previously proposed the name *Calceocrinus*, in the second volume of the Palæontology of N. Y. The name *Calceocrinus* was proposed by him for some subtrigonal pieces of a Crinoid, which, judging from his figures and description, certainly resemble *very closely* the basal piece of the subsequently proposed genus *Cheirocrinus*,—so closely indeed, that we are much inclined to adopt Dr. Shumard's suggestion that they may belong to the same type. Still it seems very improbable that Prof. Hall, with the original typical specimens of his *Calceocrinus* (of which he says many specimens, all agreeing in form, have been found) at hand for comparison, should have been less liable to understand their true relations to his subsequently described type than others, with only his figures and description of *Calceocrinus* accessible for comparison, and consequently proceeded to redescribe the same genus under another name, that he had previously called *Calceocrinus*.

The synonymy is also unfortunately still farther complicated, by the fact that Prof. Hall happened to select for one of the above mentioned genera, proposed by him, the name *Cheirocrinus*, which had been used by Eichwald in 1856 for a genus of Cystidians. Eichwald's proposed genus seems to be nearly related, as he has stated, to *Echino-encrinites*, though it is very probably distinct. If so, then the name *Cheirocrinus* would have to stand for his type, and could not be retained for that described by Prof. Hall, even if distinct from his *Calceocrinus*. In that case, to avoid confusion, the form here under consideration might be called *Eucheirocrinus*.

Until these questions of synonymy can be cleared up, however, we prefer to describe our species, provisionally, under the name *Calceocrinus*; although, if the type of that genus is distinct from *Cheirocrinus*, and the latter name can stand, they would have to be ranged under it, as they are clearly congeneric with the types for which it was proposed.

It is evident that this remarkable genus differs so widely from all the other known types, that it must be regarded as belonging to an entirely distinct and unnamed family, which might be called *Calceocrinidae*, as it is almost a certainty that *Calceocrinus*, even if generically distinct from the forms here under consideration, would at least belong to the same family, and if they are generically identical, *Calceocrinus* being the older name, would have to stand for the typical genus.

#### CALCEOCRINUS? BRADLEYI, M. and W.

Body exclusive of the base subquadrangular, with the upper lateral angles obliquely truncated, and the sides rather deeply sinuous, or constricted above the middle; compressed antero-posteriorly, and rather distinctly concave in the central region of the dorsal side below the middle. Lower dorsal plate triangular, and more than twice as wide as high. Dorso-lateral pieces twice as high as wide, presenting an irregular pentagonal outline, with sloping sides above diverging at an angle of about 90 degrees. Upper dorsal plate about half the size of the lower, subtriangular, or nearly semicircular, slightly more than half as long as wide, and scarcely more than filling the notch between the inner sloping sides of the dorso-lateral pieces. Dorsal arm slender, rounded, and composed first of five pieces, the lower of which is expanded below so as to be nearly three-fourths as large as the upper dorsal piece; while the succeeding pieces are narrow and slightly longer than wide, excepting the fifth one, which is a little wider than the others, pentagonal in form, and supports upon its superior sloping sides two equal divisions, which are slender, rounded simple, and composed of pieces about twice as long as wide. Lateral divisions of the rays (or perhaps, more properly, supports of lateral arms) composed of pieces that are wider than long, and rapidly dimin-

1869.]

ishing in size from the first to the terminal one; of these, three can be counted on one side, but there may have been one or two more; each supporting an erect arm, more slender than the dorsal one, and dividing first on the third piece, the inner division being smaller than the other and remaining simple, while the larger one bifurcates again on the fourth piece, the subdivisions being equal and of the same size as the inner branch at the first bifurcation. All the axillary pieces are expanded and more protuberant at the upper end than any of the others, though all of the other pieces are slightly projecting at the upper end. (Ventral side unknown.)

Column comparatively rather stout, or slightly thicker than the dorsal arm below its bifurcation; composed, two or three inches from the body, of round, nearly equal, moderately thick pieces, but near the body showing a slight tendency to become pentagonal, and apparently composed of more irregular, somewhat roughened pieces. Surface rather distinctly granular, particularly on the dorsal side of the body.

Length of body exclusive of the basal piece, 0.48 inch; breadth, 0.47 inch; length of dorsal arm to the first bifurcation, 0.62 inch; entire length about 1.80 inch; breadth of do., near the middle, 0.10 inch. Length of upper dorsal plate, 0.15 inch; breadth of do., 0.20 inch.

Compared with Prof. Hall's figure of the body of his *C. tunicatus*, and with specimens we have identified with that species, this form differs in having the body not narrowing upward, being as wide across, just above the constriction, as at the base of the dorso-lateral pieces; the constriction of its sides is also distinctly above, instead of at the middle; while the outer sloping sides of its dorso-lateral pieces are proportionally shorter, and directed more obliquely outward. Its dorsal side, instead of being "flattened," is also distinctly concave below the middle. Again its upper dorsal plate is proportionally smaller, being considerably less, instead of more, than half the breadth of the body above the middle, and only just large enough to fill the depression in which it rests, without projecting above; while its lower sloping margins are rounded, so as to give it a semicircular outline, instead of being straight.

Compared with *C. nodosus*, Hall, the only other described species from this horizon, it will be at once distinguished by the nodose character of the latter. It likewise differs in the details of its structure from the various other species described by Prof. Hall from other horizons.

The specific name is given in honor of Prof. Frank H. Bradley, of Hanover College, late of the Illinois Geological Survey, who discovered the typical specimens, and numerous other fossils, at the same locality.

*Locality and Position.* Crawfordsville, Indiana. Keokuk division of the Lower Carboniferous series.

#### CALCEOCRINUS? WACHSMUTHI, M. and W.

Body small, compressed antero-posteriorly; above the base approaching an oblong outline, being longer than wide, a little concave in the middle of the dorsal side, and with the lateral margins of the dorso-lateral pieces constricted in the middle, and rounded and curving inward or forward, so as to form a part of the ventral side. Basal piece subtrigonal, about twice as wide as high, truncated its entire breadth above, for connection with the succeeding piece by a widely gaping suture, evidently constructed so as to permit it to be opened out on a line with the body, though in the specimens seen, it is always folded close in against the ventral side; facet for the attachment of the column truncating the lower end, concave and equaling about half the breadth. Column comparatively rather stout, composed near the base of alternately thicker and thinner pieces; becoming more slender, and composed of longer and more uniform pieces farther down; central cavity pentagonal. Body plates closely ankylosed; lower dorsal plate triangular, about one third as large in the middle as the dorso-lateral pieces, which are between three and

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four times as long on the outer side, as wide. Upper dorsal plate subtrigonal, with the lateral angles a little truncated obliquely outward, about twice as wide as high, and truncated about three-fourths its breadth above, for the reception of the middle or dorsal arm; more than filling the broad triangular notch between the upper ends of the dorso-lateral pieces.

Dorsal arm simple, and composed, above the first piece, of oblong pieces, that are rounded on the outer side, and about one third longer than wide. Lateral divisions of the rays supported on the superior latter sloping side of each dorso-lateral piece, composed each of (as far as can be seen) five pieces in a direct range, extending out laterally and curving around toward the ventral side; of these pieces the first is very short and does not support an arm, while each of the other bears an erect arm above. Each of these lateral arms, as far as can be seen, gives off a small division on the dorsal side of the third piece above the base, while the main division of each bifurcates again on the fourth piece above, the bifurcating pieces being a little tumid. All the arms have a deep ambulacral furrow within.

Pieces of the ventral side unknown.

Length of base, 0.10 inch; length of body exclusive of base 0.35 inch: breadth do., 0.27 inch; length of arms 1 inch.

This species is related to *C. daetylus*, Hall, but differs in having its dorsal arm simple, instead of bifurcating; and its lateral arms bifurcating first on the third, instead of the fourth piece. From *C. ventricosus*, Hall, it also differs in having the dorsal arm simple, instead of bifurcating, while its upper dorsal piece is distinctly shorter in proportion to breadth than in that species.

If farther comparisons should show these forms to be generically distinct from *Calceocrinus*, and *Cheirocrinus* is found to be tenable, this and the preceding species would have to be called *Cheirocrinus Wachsmuthi* and *C. Bralleyi*.

The specific name is given in honor of Mr. Charles Wachsmuth of Burlington, Iowa, to whom we are indebted for the use of the specimens from which the description was made out.

*Locality and position.* Upper Burlington beds of Lower Carboniferous, at Burlington, Iowa. Mr. Wachsmuth's collection.

### Genus GILBERTSOCRINUS, Phillips.

Subgenus GONIASTEROIDOCRINUS, Lyon and Casseday, 1859.

Syn. *Trematocrinus*, Hall, 1860.

GONIASTEROIDOCRINUS TENUIRADIATUS, M. and W.

The only specimen of this species we have seen is too much crushed to admit of a detailed description of the structure of its body. It evidently attained a medium size, however, and has unusually long, slender, pseudo-brachial appendages, or false arms; while its subradial pieces are produced into short pointed spines. Its false arms are each composed, near the body, of a double series of alternating semi-elliptic pieces, which are joined together by their straight sides, and each pierced by a small central canal. At a distance of about three or four pairs of these pieces from the body, each series of pieces diverges from the other at an angle of about fifty degrees, thus forming two very long, slender, rounded, gradually tapering branches, composed each of a single series of round pieces, generally less than twice as wide as long, with a small central canal. These pieces have their articulating surfaces radiately striated, and could not be in any way distinguished from the joints of the column of many crinoids, if found detached.

From Prof. Hall's species *typus*\* (which also belongs to the section of the genus

\*As this species is neither the type of the genus *Gilbertsocrinus*, nor of the subgenus *Goniasteroidocrinus*, the name *typus* can only serve to confuse and mislead the student in regard to the history and synonymy of the genus, and hence ought to be changed.

with the pseudo-brachial appendages composed, near the body, of a double alternating series of pieces, and bifurcating farther out into two rounded branches, composed each of a single range of pieces pierced by a small central canal), the species under consideration will be readily distinguished by its much longer and more slender pseudo-brachial appendages, which have their pieces merely rounded and finely granular, instead of being each provided with a row of small tubercles around the middle. From *G. tuberculosus*, Hall, (sp.), which, if correctly identified among the specimens before us, has its pseudo-brachial appendages constructed, at the base at least, in the same way, it will be distinguished by having its subradial pieces produced into short pointed spines, instead of being merely tuberculiform. The same character, as well as its larger size, and more robust appearance, will also distinguish it from our *G. fuscillus* and *G. reticulatus*, Hall (sp.)

The specimen is too much crushed to afford measurements of the body, but the false arms measure 0.60 inch from the body out to the point of bifurcation, and 0.35 inch in breadth. Each of the branches near the point of bifurcation measures only 0.18 inch in thickness, while one of them can be traced to a length of 2 inches, where it is broken off, and measures 0.13 inches in thickness, the whole length of each branch being probably not less than three inches.

*Locality and Position.* Lower division of the Burlington group, Burlington Iowa. Lower Carboniferous. No. 308 of Mr. Wachsmuth's collection.

#### GONIASTEROIDOCRINUS OBOVATUS, M. and W.

Body rather large, truncato-obovate, being narrow below, with convex sides, and truncated above; height a little greater than the breadth. Base small, and very deeply concave; basal pieces entirely within the concavity of the under sides, and hidden by the column, when it is attached; apparently completely inverted by the pushing in, as it were, of the column, around which they are folded down with their outer sides inward, while their edges that join to the subradials are turned downward. Subradials of moderate size, very tumid or tuberculiform, but not pointed; curving into the concavity below and upward at the outer ends, while their tumid central part forms the base upon which the body stands when placed upon a plane surface; all heptagonal in form, if we count an obtuse angle at the middle of the base of each. First radial pieces about as large as the subradials, tumid, and of nearly equal length and breadth; all heptagonal in outline. Second radial pieces generally smaller than the first, and proportionally a little narrower, rather tumid, and all hexagonal in form. Third radial pieces of about the same size as the second, or sometimes slightly larger, equally convex, pentagonal or hexagonal in outline, and each supporting on their superior sloping sides, convex secondary radials, the second of which is sinuous above, so as to form the under side of the openings to which the pendent true arms connect, while on their outer sloping sides they connect with a series of small pieces, which unite with others coming in the same way from the adjacent ray, so as to form the under side of the base of the false arms over each interradial and anal space.

Anal and interradial areas of an oval outline, and scarcely distinguishable from each other, each occupied by twelve to fourteen more or less convex, or tumid pieces, the first of which is hexagonal, about as large as the second radials, and rests as usual on the upper truncated side of a subradial; above these there are usually three arching ranges of three each, and three or four other pieces still farther up, more or less irregularly arranged.

Vault flat, not quite equaling the greater breadth of the body below, and composed of irregular tumid pieces, generally of rather small but unequal sizes, with a more or less marked depression opposite each false arm; opening apparently nearly central. False arms composed at their bases of four rows of small pieces above and two below, arranged so as to inclose two distinct canals which do not pierce any of the pieces themselves.

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Surface very finely granular. Impressions at the corners of the plates also sometimes cause the appearance of a tendency to form a short obtuse radiating rib at each side of some of the plates, but this character is too faintly marked to attract attention.

Height of body about 1.70 inch, breadth, 1.60 inch.

The most marked feature of this species is its rather obovate form, produced by the narrowness of its lower part and its convex sides, and slight contraction near the top. The narrowness of its lower part results from the small size of its basal, subradial, and first radial pieces. The deeply sunken character of its base also contributes to the same result, as it is not near so wide as it would be if its pieces extended out horizontally from the column, instead of being folded down with their backs against it. It seems to resemble *G. tuberculatus*, Hall (sp.), more nearly in general appearance than any other species known to us, but will be readily distinguished, not only by its different form, but by the proportionally smaller size of its basal, subradial, and first radial pieces, but more particularly by the structure of its false arms, which are each composed at the base of six ranges of pieces, instead of only two.

*Locality and Position.* Upper division Burlington Group, Burlington, Iowa. Lower Carboniferous. No. 379 of Mr. Wachsmuth's collection.

#### Genus LEPIDOCENTRUS, Müller (?) 1856.

Entire form unknown. Interambulacral plates rather thin, very irregular in size and form, all strongly imbricating apparently from below, and toward the lateral margins of the areas; arranged in five or more rows, only the outer two of which seem to be continued to the extremities of the areas, all occupied with generally obscure secondary granules, and most of those on the lower (?) side of the body also provided with large primary central tubercles and spines; primary tubercles sometimes showing a small pit in the top, surrounded by two smooth rings, separated by an annular furrow, and all without any ring, depression or prominence around the base; on the upper (?) side of the body, only the marginal rows provided with primary tubercles. Ambulacral areas wide, and occupied by six or more irregular rows of unequal, irregular pieces, some of which are as large as the smaller interambulacral plates, and all strongly imbricating in the opposite direction from the interambulacral series; each pierced by two pores, and the larger ones usually marked with one or two additional pits, which, with the pores, are surrounded by a large circular impression, while some of them sometimes show a tubercle intermediate in size between the primary and secondary series. Apical disc unknown, but a single rather large plate believed to belong to it is seen to have six or seven pores circling around near its outer margin, and a small tubercle in the middle.

This type is related to several of the other palæozoic genera, but cannot be properly referred to any of them. In the great irregularity of its interambulacral plates, both in size and form, as well as in the absence of primary spines, excepting on the marginal rows (at least on the upper (?) side of the body) it seems to be very similar to *Perischodomus* of McCoy. It differs, however, clearly from that group in the much greater breadth of its ambulacral areas, the greater number of ranges of ambulacral pieces and their greater irregularity, as well as in the much larger sizes of some of them, and their peculiar circular impression around the two pores. If *Perischodomus* has its plates not imbricating, that would also be another important difference, but although that character is not mentioned in the description, we suspect it may really exist, because we find it to occur in all the analogous types in this country.

From *Lepidechinus* it is also readily distinguished, by the much greater breadth of its ambulacral areas, and its more numerous rows of ambulacral pieces and pores, as well as by the larger size and the other peculiarities of these species.

In the breadth of its ambulacral areas, and the number of rows of pieces occupying the same, it is more nearly related to our *Lepidesthes*; but it differs 1869.]

in the great irregularity of these pieces, both in size and form, as well as in the curious circular impressions of the same: also in the possession of large primary tubercles and spines on some of the interambulacral pieces.

It is probably more nearly related to the form referred in this paper, doubtfully to *Eocidaris*, but it differs materially in the much greater breadth of its ambulacral areas, more numerous ranges of ambulacral plates, and the larger sizes, and other peculiarities of these species; as well as in not having primary spines and tubercles on all of its interambulacral plates.

NOTE.—After preparing the foregoing description, with the view of proposing a new genus for the reception of this fossil, our attention was called by Prof. Alexander Agassiz to a very similar type, that was published by Müller under the name *Lepidocentrus*, in 1856, from the Eifel Limestone (Aus den Abhandlungen der Königl. Akad. der Wissenschaften zu Berlin, p. 258, taf. iii); but which has been entirely overlooked by subsequent authors. After comparing our specimens with the figures and description in Müller's paper (a copy of which Prof. Agassiz was kind enough to loan us), we find our type agrees so nearly with his genus, in all the parts known to him, that we have concluded to refer it provisionally to the same. Müller, however, knew nothing of the nature of the ambulacral pieces of his type, and we have therefore no means of comparing these important parts. As it is already known that there are various genera of these older types, agreeing in some characters and differing in others, it is quite probable our fossil may belong to a distinct genus. If so, we would propose to call it *Pholidocidaris*.

#### LEPIDOCENTRUS IRREGULARIS, M. and W.

The specimens of this fossil that we have had an opportunity to study are too much crushed and broken to give a clear idea of its general form, or to admit of being systematically described. It seems to have attained a rather large size, however, and if of a depressed subglobose form, may even have measured as much as three and a half to four inches in its transverse diameter. Some specimens show from five to six ranges of interambulacral plates lying together, so as to indicate that there were at least that many ranges between the ambulacra at that point. These six ranges, as they lie flattened by pressure, measure about two inches across.

All of these interambulacral plates are thin and sharp at the edges, and of only moderate thickness in the central region, while they present such a variety of forms that it would scarcely be possible to give a correct idea of their outlines, without describing each individual plate. They are generally a little longer than wide, however, and on what appears to be a part of the body below the middle, most of them have the primary tubercles more or less distinctly developed, though on some they are obsolete, or not easily distinguished from the obscure secondary ones.

On what appears to be the upper side of the body, no traces of any but the small secondary tubercles covering the surface of all of these plates are visible, excepting, as already stated, on those of the marginal rows. These marginal plates on this side, are generally each as large as three or four of those adjoining them, and in some instances measure 1 inch in length, and about 0.60 inch in breadth, being of an elliptic form. The primary tubercle of each is placed about midway of the length, and between the middle and the ambulacral side. In many instances these tubercles are rounded off, as if the spines had been dropped during the life of the animal, and the tubercles partly absorbed away.

The ambulacral plates are apparently even more irregular in size and form than those of the interambulacral series. In one crushed specimen, showing a part of the fossil composing apparently the under side, extending an inch or more away from the supposed oral opening, portions of three of the ambulacral and two of the interambulacral series of plates are seen, apparently

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nearly in their relative positions, excepting that they are all spread almost on a plane, and more or less displaced and broken by accidental pressure. Here, near the ends of the areas, there are apparently only two rows of interambulacral plates in each series, the two ranges measuring together only about 0.40 inch in breadth; soon, however, they pass into three or four ranges. The ambulacral areas, at about one inch from the apparent position of the oral orifice, measure nearly an inch in breadth, and, as near as can be counted, there appear to be there six or more ranges of ambulacral plates. These plates appear to increase in size and decrease in number toward the end of the areas, so that some of them are there nearly as large as the adjacent interambulacral plates. They are generally wider than long, and as they lie together present more or less rhombic faces, arranged somewhat like the scars on the surface of some species of *Lepidodendron*. This similarity is also increased by the pores, and some little pits in the central region, surrounded by the circular depression. Some of the larger of these plates have the pores near one end, and a tubercle occupying the middle, nearly as large as the primary tubercles on the adjacent interradials. These probably belong to the middle ranges.

The larger primary spines attained a length of about one inch, and a thickness of 0.10 inch at the head, which is a little swollen; above this they taper rather gradually, are rounded, nearly straight, and marked by minute, crowded, longitudinal striæ. Among the ambulacral plates there are also seen lying scattered about a number of other spines, from one-fourth to one third the size of those described, and of very nearly the same form. These seem to belong to the ambulacral plates, on most of which we see a tubercle larger than the secondary tubercles of the interambulacral plates. Many much smaller spines than the latter are likewise seen, that probably belong to the secondary, or perhaps, more properly, tertiary series.

*Locality and position.* Hamilton and near Nauvoo, Illinois; in the Keokuk division of the Lower Carboniferous Series.

#### EOCIDARIS? SQUAMOSA, M. and W.

Body attaining a large size, apparently depressed-subglobose in general form. Interambulacral plates rather thick, in eight or more longitudinal rows near the middle of each area,\* but apparently only the two outer rows continued to the oral aperture; all presenting the usual hexagonal form, excepting the pentagonal marginal rows, and distinctly imbricating apparently from the lower side upward,† as well as inward toward the central row, excepting the two outer rows on each side, the lateral imbrication of which is outward, that is, the outer row laps the edge of the ambulacral series, and the next range laps the edge of the outer row, while its inner edge laps that of the next row within, and so on to the middle row, which is lapped on both sides; each with a comparatively large, smooth, saucer-shaped depression, occupying the central region, from the edges of which the surface is distinctly beveled off in every direction to the margins, the beveled edges that pass under the edges of the adjacent plates, however, being distinctly wider than those lapping the adjacent pieces, these lapping edges being as if ground off obliquely under, or in other words, beveled on the inner side; tubercles for the support of the primary spines smooth, prominent, rather large, and rising in the middle of the saucer-shaped central depression, narrowing upward to near the top, where there is a circular depression surrounding a very narrow, prominent, perforated, central process, for the immediate articulation of the primary spines; most convex part of each plate surrounding the smooth, saucer-shaped depres-

\* Eight rows are seen in the specimen at the widest part, but we are not sure this is the middle of the area, owing to the imperfection of the specimen.

† This imbricating character, as well as several others mentioned in the above description, may be of more than specific value, and they are mentioned here, along with specific characters, because we are in doubt in regard to the generic relations of the fossil.

sion, ornamented with a few very small pustules, upon which small secondary spines probably articulated. Primary spines, apparently one inch or more in length, rounded, slender and nearly or quite straight, with the articulating end perforated and a little enlarged, so as to form an undefined ring; surface ornamented with minute, crowded, longitudinal striæ, only visible by the aid of a good magnifier.

Ambulacra narrow, or only about equaling the breadth of the marginal rows of interambulacral plates on each side, slightly convex. Ambulacral pieces slightly imbricating in the opposite direction from the interambulacral series, of very unequal size and form, and irregularly arranged, most of those starting from the mesial zigzag suture, extending out so as to connect with the crenated lapping margins of the outer ranges of interambulacral plates, while many of those starting from the latter inward, wedge out more or less abruptly between the others, at various distances before reaching the mesial suture, so as to present the appearance of a strong tendency to run into two rows of pieces on each side of the mesial suture; each pierced by two pores, which, owing to the irregular arrangement of the plates, present the appearance of forming two double rows along near each lateral margin of each ambulacrum, or four rows to each of these areas. They might, however, with probably almost as much propriety, be counted as one double, strongly zigzag row on each side.

Near what appears to be the position of the oral opening, there is adhering to the specimen one half of a stout jaw, 0.60 inch in length. On its outer side it is cuneiform, a little arched, and provided with a broad, longitudinal, ex-centric furrow; its lateral margins are smooth, and near 0.30 inch in breadth at the base, and converge to a sharp edge within. We have now tolerable good evidence that all the different genera of the *Perischoechinidæ* are provided with strong jaws.

The specimen is too imperfect to give a good idea of its general form or size. As it shows one of the interambulacral areas, however, to be near two inches broad, it is probable the entire fossil was not less than four and a half inches in its transverse diameter. The largest interambulacral plates measure about 0.35 inch in length and breadth, while those of the outer rows next the ambulacra are proportionally narrower. The primary spines seem to be about one inch or more in length, though we have seen none entire. The longest fragments we have seen, are about half an inch long, 0.10 inch in thickness at the articulating end, and 0.06 inch in diameter a little above, but without any taper toward the broken end. The ambulacral areas are only about 0.26 inch in breadth at the widest place, near the middle, and about four to six of their pieces fit into the crenulations of each of the marginal interambulacral plates.

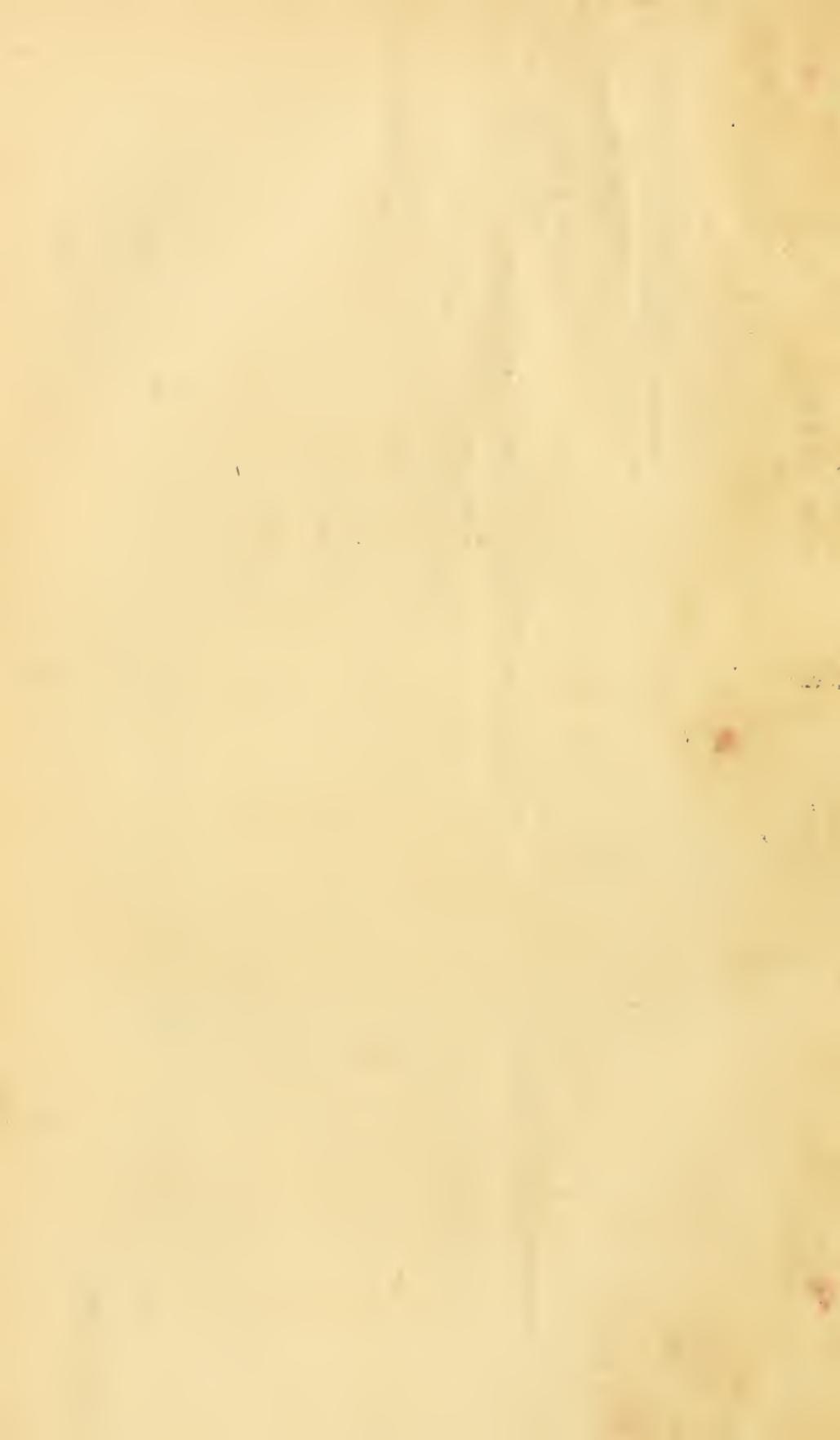
We have been somewhat puzzled in regard to the generic characters of this species. Its interambulacral plates are each provided with the large central tubercle and spine, characterizing *Archæocidaris* and *Eocidaris*, though these tubercles agree with those of *Eocidaris* in having no ring or slight projection around the base, as in *Archæocidaris*. At first we were inclined to believe it related to Prof. Hall's genus *Lepidechinus*, on account of the decidedly imbricating character of its plates; but judging from the brief published description of the type of that group (which has not yet been figured), it would seem to belong even to a different family, or sub-family, as nothing is said in the description of that type in regard to a large central tubercle for the articulation of a larger spine, on each of the interambulacral plates, the surface being, on the contrary, merely described as crowded with "irregular granules." In addition to this Prof. Hall places his group as a sub-genus under *Palechinus*, one of the distinguishing features of which is the presence of numerous small imperforate tubercles covering all the plates, without any larger central perforated tubercle.

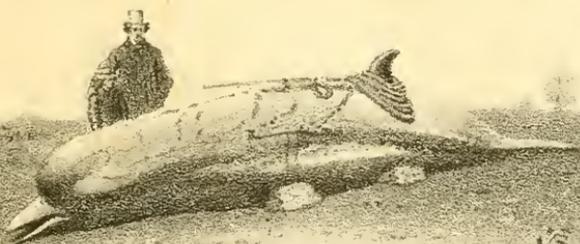
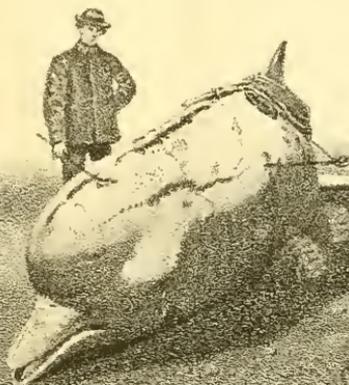
It is worthy of note, however, that Prof. Hall has since figured and described another species (*L. rarispinus*, Twentieth Rep. Regents Univ. N. Y. on State

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EXPLANATION OF THE CUTS AND OF THE LITHOGRAPH.

- Fig. 1. *Beluga rhinodon* Cope cranium, from above; from Upernavik.  
Fig. 1a. *Beluga rhinodon* teeth.  
Fig. 2. *Beluga declivis* Cope scapula.  
Fig. 3. *Beluga angustata* Cope scapula.  
Fig. 4. *Balæna cullamach* Chamisso; from north west coast; proportions approximate. (Capt. Scammon does not represent the recurved rictus figured by Chamisso.)  
Fig. 5. *Megaptera versabilis* Cope; from California coast; drawn to a scale of .25 inch to a foot. This and all the remaining cuts reduced to two-thirds of the proportions given.  
Fig. 6. *Megaptera versabilis*, from below.  
Fig. 7. *Rhachianectes glaucus*; from the Californian coast; scale .25 inch to a foot.  
Fig. 8. *Rhachianectes glaucus* Cope, from below.  
Fig. 9. *Balænoptera velifera* Cope, approximate proportions; from coast of California.  
Fig. 10. *Balænoptera velifera*, approximate proportions; from Queen Charlotte Sound, February, 1865.  
Fig. 11. *Sibbaldius sulfureus* Cope, approximate proportions; from California coast.  
Fig. 12. *Globiocephalus scammonii* Cope; coast of California; about .5 inch to the foot.  
Fig. 13. Same, from below.  
Fig. 14. "Bottle-nose Grampus;" California coast; scale near .5 inch to the foot.  
Fig. 15. *Orca rectipinna* Cope, male; approximate proportions; California coast.  
Fig. 16. *Orca rectipinna* Cope, female; same scale and locality.  
Fig. 17. *Orca ater* Cope; Juan de Fuca Straits, 1868.  
Plate I. *Hyperaodon* from the shore of Narragansett Bay, near Tiverton, Rhode Island; from photographs obtained by Samuel Powell, formerly Secretary of the Academy, at Newport, Rhode Island.





*Hyperoodon of Narragansett.*



Fig. 4

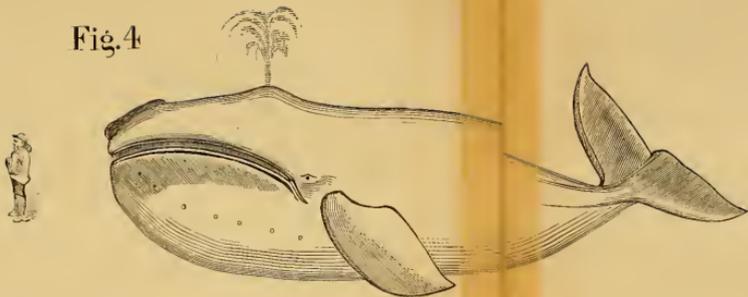
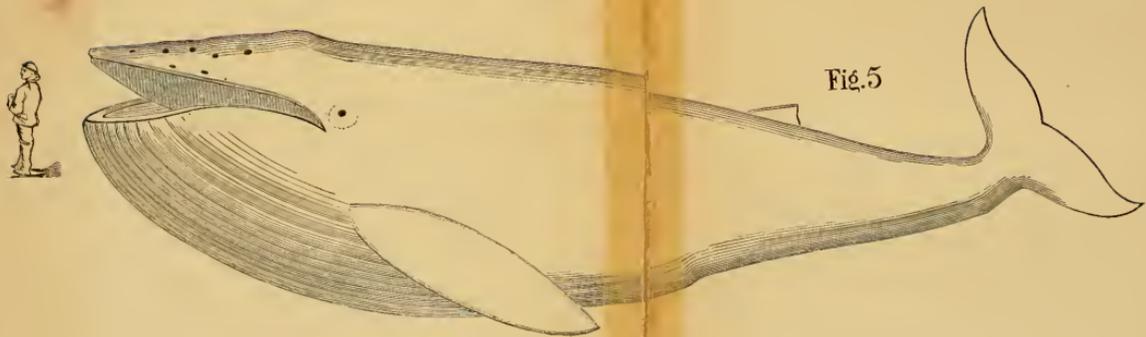


Fig. 5





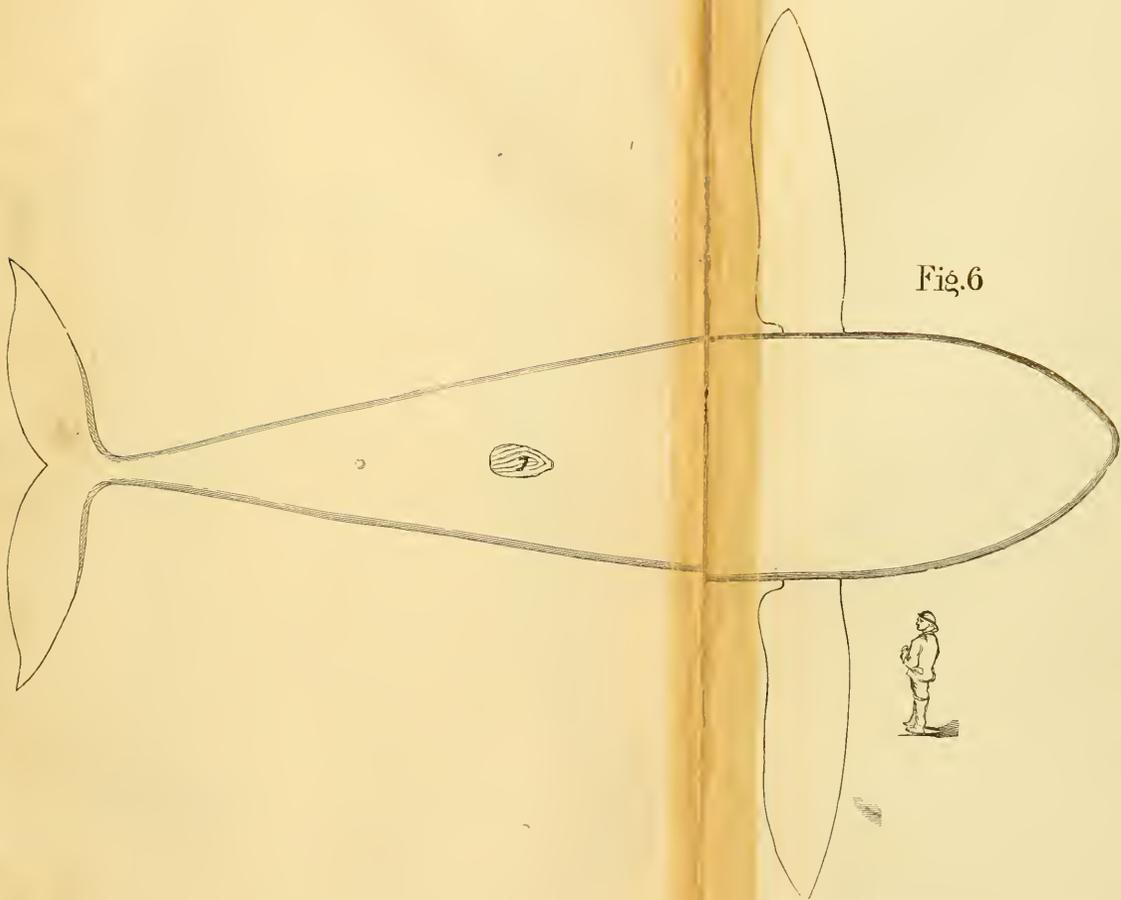


Fig. 6



Fig. 7



Fig. 8

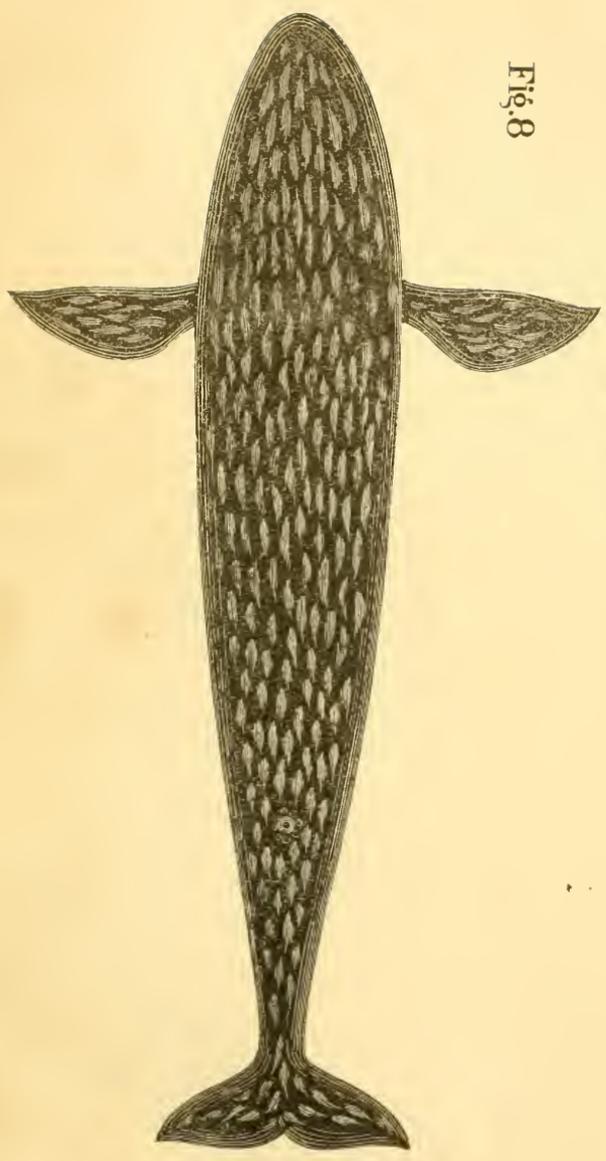




Fig.9

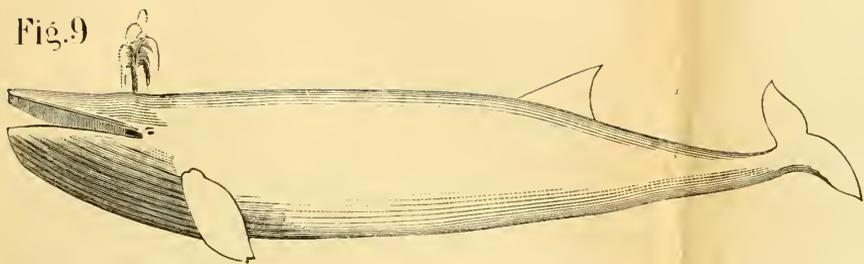


Fig.10

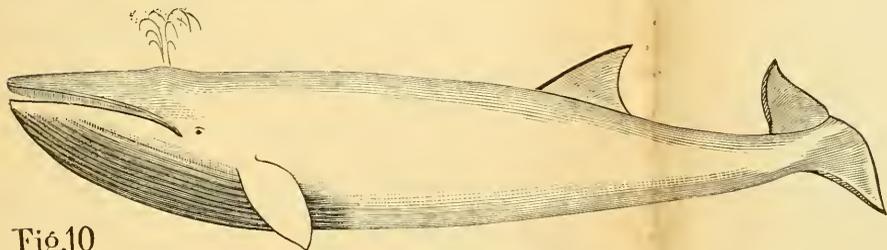


Fig.11

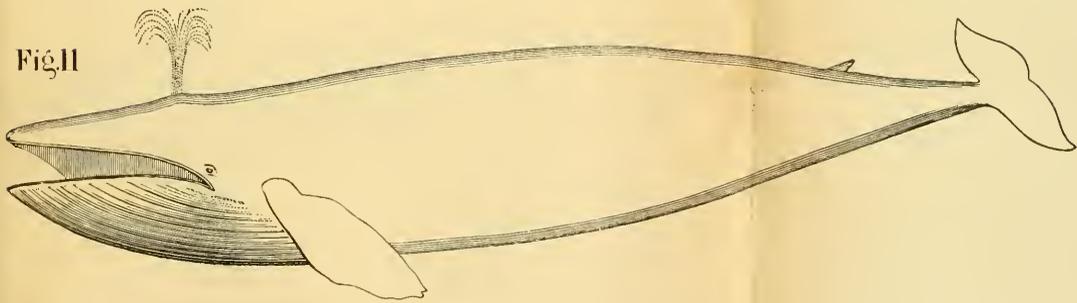




Fig.12



Fig.13

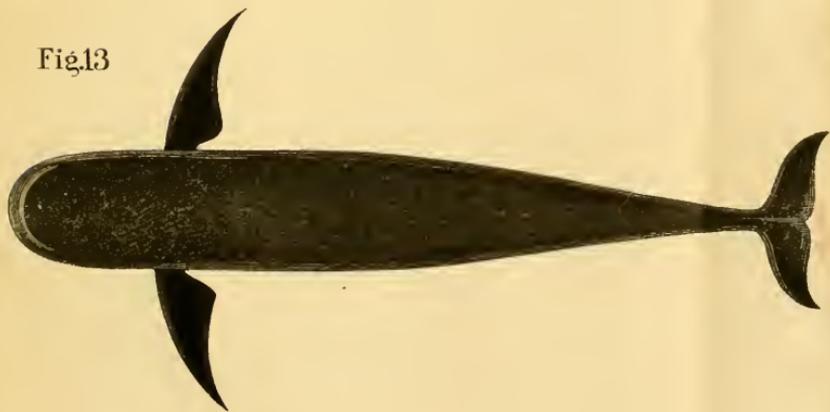




Fig.14.

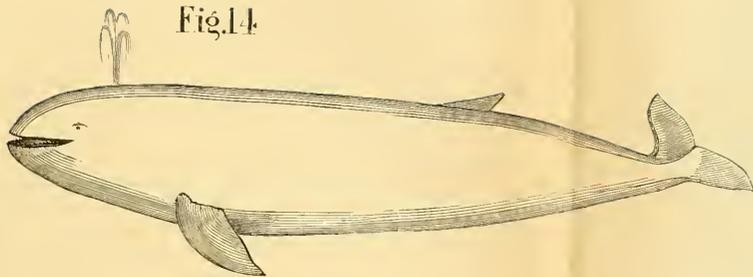


Fig.15

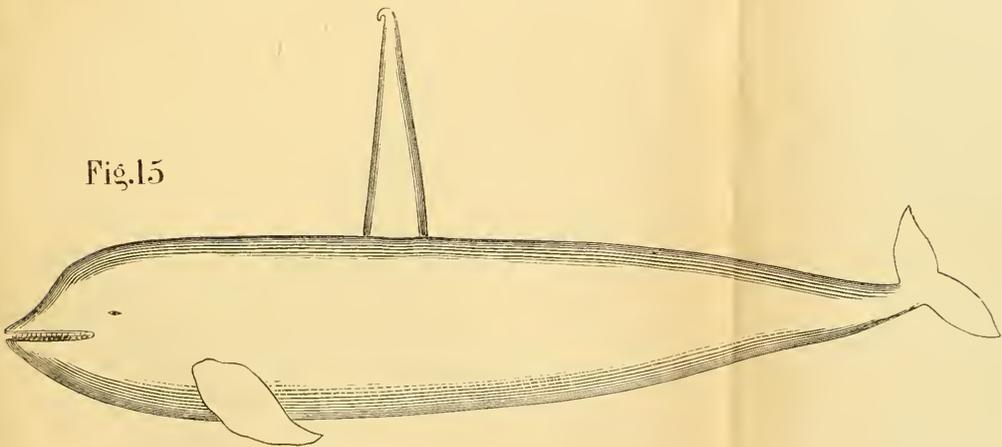




Fig.16

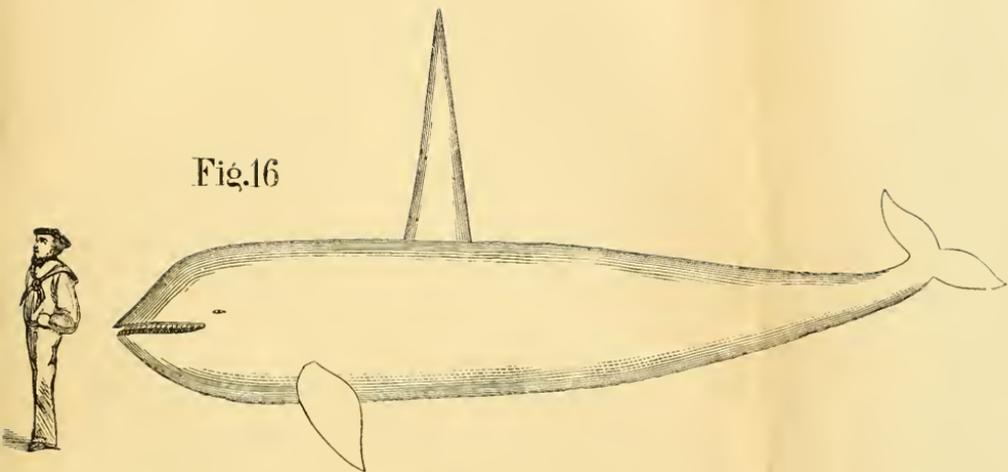
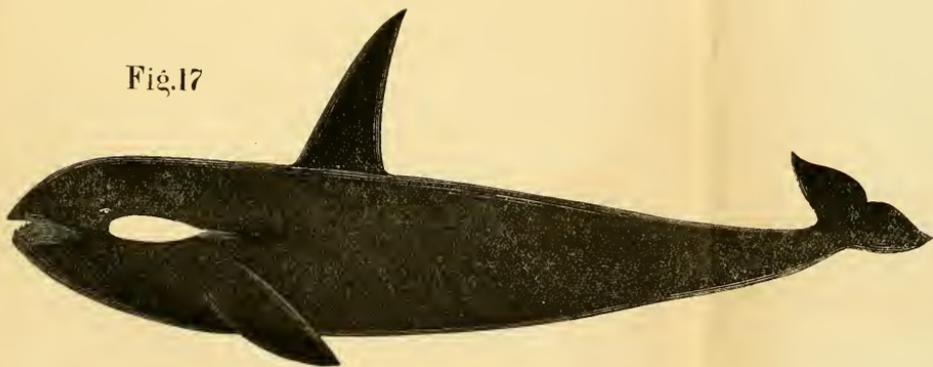


Fig.17





Cab. N. H.) in which *some* of the interambulacral plates are provided with a large central tubercle, while others apparently have none. We are not informed whether these larger tubercles are perforated at the end, as in *Archæocidaris* and *Eosidaris*, or whether they are without such perforation, as in *Palaechinus*; but if it belongs to the same family as that including *Palaechinus*, of which *Lepidechinus* is supposed to be a sub-genus, it is almost certain that its tubercles are not perforated.

At any rate, our fossil differs from *L. rarispinis* in the following characters, that seem to be of more than specific importance. In the first place, it differs materially in the very irregular nature of its ambulacral pieces, which show a strong tendency to pass into, and in fact do, at some places, actually pass into two rows on each side of the mesial zigzag suture, instead of having clearly but a single row on each side, with each piece extending entirely across from the mesial suture to the lateral margins. Again, it differs in having a large central tubercle and spine on *each one* of all the plate of the *entire* interambulacral series. The lateral imbrication of the plates, in our type, is also different, the direction of the imbrication being inward, excepting in the two outer rows on each side, instead of outward in the whole series, the middle row being clearly lapped on each side, instead of lapping those on each side of it.

The strongly imbricating character, especially of the interambulacral plates in our type, is a very marked feature throughout; the lapping edges being sometimes at least one-fourth the entire breadth of these pieces, and yet, owing to the accuracy with which they are beveled, they lie so evenly together that this peculiarity is scarcely apparent where the plates have not been displaced. We are not aware whether this imbricating character of the plates has been observed in any of the European types on which the genera *Eocidaris* and *Archæocidaris* were founded.\* It is certainly more or less marked, however, in several of the American forms now before us that have been referred to the latter genus. For instance, it is clearly seen in the typical specimen of *A. Agassizi*, of Hall, and less distinctly in his *A. Shumardi*. We can also see indications of it in *A. Wortheni*, of Hall, though owing to the thinness of its plates, the beveling of their edges is less apparent. All these species have the peculiar ring or prominence around the base of the tubercles supporting the primary spines, seen in the true *Archæocidaris*, and distinguishing it from *Eocidaris*. It seems therefore probable that this character *may* be more or less marked in both *Archæocidaris* and *Eocidaris*, but most apparent in species which, like that we have here described, are provided with plates of more than the usual thickness.†

So far as we are aware no European species of *Eocidaris* showing the structure and arrangement of the ambulacral series of pieces has been discovered; at least we have seen no figures or descriptions of such. Prof. Hall, however, has described a species from the Chemung group of New York (Twentieth Report Regent's Univ. p. 298), to which Vanuxem had given the name *Echinus Drydenensis*, but which is said to be an *Eocidaris*. In this the ambulacral plates are described as being in two ranges without any intercalated pieces, if we understand the description correctly.

From all that is therefore known in regard to the several types mentioned, we are much inclined to believe that our fossil will be found to belong either to a distinct subgenus under *Eocidaris*, or to an allied new genus. In either case we would propose for the group the name of *Lepidocidaris*.

*Locality and position.*—Lower beds of the Burlington group, Burlington, Iowa. Lower Carboniferous. No. 404 of Mr. Wachsmuth's collection.

\* Some of Prof. Desor's figures of the plates of *Eocidaris* appear to show indications of marginal beveling, while others do not.

† Since this was written we have been led to believe this imbricating character of the plates is more or less defined in all the *Archæocidaridæ* as well as in some of these older types, apparently not belonging to that family.

## PALÆCHINUS GRACILIS, M. and W.

Body small, and apparently oval or subglobose. Interambulacral areas a little convex. Interambulacral plates in seven rows at the middle, but apparently only the marginal rows of pentagonal pieces are continued to the upper and lower extremities of the areas, the intermediate hexagonal pieces running out at various distances between the middle and the ends of the areas; thickness of each about half the breadth of the largest; all ornamented with closely set granules, of which 25 to 30 may be counted on each of the larger pieces. Ambulacral areas slightly convex, and equaling in breadth the first and second rows of interambulacral plates on each side; composed of very short pieces, which are a little thinner than the interambulacral plates, and about three times as wide as long, the widest part of every alternate one being at the outer end, which is received into a little sinus in the adjacent marginal interambulacral plate (there being generally three of these little sinuses to each of these plates), while the intermediate pieces usually wedge out rather abruptly before quite reaching the lateral margins; the two pores at the outer end of each piece arranged so as to form two zigzag or undulating rows along the lateral margins of each ambulacral area; surface of the whole series occupied by granules of the same size as those of the interambulacral plates.

Entire dimensions unknown; greatest breadth of interambulacral areas 0.76 inch; do. of ambulacra, 0.22 inch; number of ambulacral pieces in 0.10 inch, on each side of the mesial suture, ten.

This species will be readily distinguished from our *P. Burlingtonensis* by the proportionally greater breadth of the ambulacra, and the smaller size, and greater number of its interambulacral pieces, there being seven rows of the latter pieces at the widest part of the area, at a point equaling the breadth of these areas in *P. Burlingtonensis*, where there are only four or five rows of these pieces. Again its ambulacral areas are equal in breadth to the first and second rows of interambulacral plates on each side, taken together; while those of *P. Burlingtonensis* are scarcely wider than the single marginal row on each side.

*Locality and position.*—Upper division of the Burlington group, Burlington Iowa. Lower Carboniferous. No. 407 of Mr. Wachsmuth's collection.

## Note on the Genus ONYCHASTER, M. and W.

The borrowed specimens from which we made out the outline cuts and description of this type, published in the third volume of the Illinois Geological Report, p. 526, had been, to a great extent, denuded of their outer covering in cutting away the rather hard, firmly adhering matrix, before coming into our hands. Since preparing these cuts and descriptions we have had an opportunity to examine other specimens of this fossil, in part belonging to Mr. Wachsmuth's collection, and others among the collections at Springfield, all from the original locality. From these it is evident that, in well preserved examples of this type, the granular outer covering seen on the arms, or free rays of some of the specimens first examined, actually covers the dorsal side of the small body also. We likewise observe the presence of a layer of thin small imbricating scales under the scattering granules on the dorsal side of the body; while some specimens certainly show clearly such scales under the granules on the arms. The fact that this granular covering, and this layer of thin imbricating scales, overspread the dorsal side of the body, would certainly show that the appearance of a large central, dorsal opening, which we had marked as an "anal?" aperture, could not be such. The appearance of pores in some of the pieces around the central opening is also deceptive, and due rather to deep pits than to actual perforations passing through these pieces.

From the specimens we have since had an opportunity to examine, we are led to think it almost certain that the parts seen around the central opening

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in the specimen illustrated by us are the oral and adjacent pieces accidentally pushed upward, and seen from the upper or inner side after the removal of the dorsal side or covering; and that the central opening is the oral aperture. At any rate we know of no other way to account for the very different appearances presented by these fossils, when examined in different conditions.

Since we have had some specimens of this type at hand which we have felt at liberty to grind and cut into, so as to reveal more clearly their structure, we find that the arm-pieces, which in the denuded specimen first examined by us presented the appearance of becoming isolated, deeply furrowed lanceolate pieces, at a little distance from the body, and of very little thickness or depth, really appear, when ground off, to extend nearly all the way down from the dorsal to the ventral sides of the arms, and to be connected and articulated together, like those nearer the body by little processes and sockets; the comparatively thin furrowed dorsal edges becoming thicker farther in.

Sometimes these arm-pieces appear as if consisting of two rows joined in pairs at their inner ends along the middle of the dorsal side, there being a rather large pore (or possibly only a deep pit) at the junction of the two pieces forming each pair. In other instances, as seen detached, these pairs of pieces are found to be firmly ankylosed so as to form single pieces, extending across the whole breadth of the arms, without, however, obliterating the appearance of a rather large mesial dorsal pore.

We have not yet had an opportunity to see the under side of the body or arms in any of the Crawfordsville specimens, but Mr. Wachsmuth has a specimen from the Burlington division of the Lower Carboniferous beds of Burlington, which would seem to belong to this genus, though specifically distinct.\* This is the form Prof. Hall has described in some preliminary notices of fossils (issued at Albany, N. Y., in 1861), under the name *Protaster? Barrisi*. This fossil has, so far as we have been able to see, essentially the same structure, and shows along the under side of the arms a broad shallow depression in the arm-pieces, somewhat like an ambulacral furrow. None of the specimens of either species we have seen show any indications of any proper extended disc, the body being comparatively small. It also evidently differs in several points of structure from *Protaster*.

So far as its structure is yet known, it seems to be a true *Ophiurian*. We only know the species, *Onychaster flexilis*.

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#### Remarks on the BLASTOIDEA, with Descriptions of New Species.

BY F. B. MEEK AND A. H. WORTHEN,

Of the Illinois State Geological Survey.

In regard to the nature of the functions for the performance of which the openings in the summit of this group of fossils, as the specimens are usually found, were designed, authors do not entirely agree. The central opening has been most generally regarded as the mouth, and the others surrounding this (excepting one that is always larger than the others) as ovarian apertures; while the larger one is usually supposed to be the anal aperture, with, in some types, two of the supposed ovarian apertures opening into it, one on each side.†

\* We have not yet, however, seen any of the little articulating knobs on the scales of this Burlington species. These impart the granular appearance to the surface of our typical species, in which each scale has one of these little knobs articulated in its middle. If the Burlington species did not have these, it may belong to another, but allied genus.

† In the genus *Pentremites*, as specimens are usually found, there are five of these openings of the summit, surrounding a central pentagonal aperture. Of these five surrounding openings, four are known to be divided within into two each, and the fifth one into three, the middle one of these three being generally supposed to be the anal opening,