With the compliments of
Frank Springer.

CANADA
DEPARTMENT OF MINES
GEOLOGICAL SURVEY BRANCH
Hon. W. Templeman, Minister; A. P. Low, Deputy Minister;
R. W. Brock, Director.

MEMOIR No. 15-P

ON A TRENTON ECHINODERM FAUNA

AT

KIRKFIELD, ONTARIO

BY

FRANK SPRINGER.

OTTAWA
GOVERNMENT PRINTING BUREAU
1911

No. 1150

PLATE I.

5675—4½

EXPLANATION OF THE PLATES.

All specimens figured are from the lower part of the Trenton Limestone; and, except where otherwise specified, are from Kirkfield, Ontario, and in the author's collection. All figures, unless differently indicated, are of natural size.

PLATE I.

Reteocrinus alveolatus M. and G.. .. ..page 10.

FIG.

1*a*. A mature, slightly flattened specimen with complete crown, and a few pentagonal stem ossicles; r. post. radial view, showing keel-like anal series to about the level of fourth bifurcation, and the irregular, sharply sculptured iBr plates.

1*b*. Cross-section of stem at an interpolated columnal.

2*a*. Another specimen with nearly natural contour, from r. post. interradius; showing the deep pits at sides of basal and radial plates, the strong elevation and lateral buttresses of the brachial series, and depressed iBr areas filled with small plates.

2*b*. Cross-section of stem at a projecting columnal.

3. Large crown with long stem attached, anterior view; showing the prominent and rounded radial angles of the stem.

4. Infrabasal plates of very large specimen with part of stem attached, the sides becoming broadly concave.
(Following the terminology of Pentacrinine stems proposed by Dr. Bather in his recent beautiful Memoir on Triassic Echinoderms of Bakony, p. 24, the stem in this and the foregoing specimens would be more accurately called 'subconcavistellate'; but the work was received too late to enable me to adopt his terms in the text).

5. A rather young specimen, with stem pentagonal in proximal part and becoming rounded below.

Reteocrinus stellaris Billings.. .. ..page 10.

FIG.

6. One of the types, original of Dec. IV, Pl. IX, fig. 4*b*, post. view, after removal of the matrix by further cleaning. It shows the stem to be perfectly round; the crook appearing in the original figure was due to unequal exposure in the matrix, and it was also much exaggerated in the drawing. Ottawa; Coll. Geological Survey, Canada.

7. Cross-section of stem of another type, Dec. IV, Pl. IX, fig. 4*d*; to show that the form of the axial canal is substantially the same in both species, the exterior form of the stem being due to secondary growth.

Cupulocrinus humilis (Billings).. .. ..page 28.

FIG.

8. Complete specimen with stem tapering to a fine point; r. ant. view. Note the bell-like shape of the projecting columnals.

9. Posterior view of a specimen showing full length of the anal tube, and the fine distal branches of the arms.

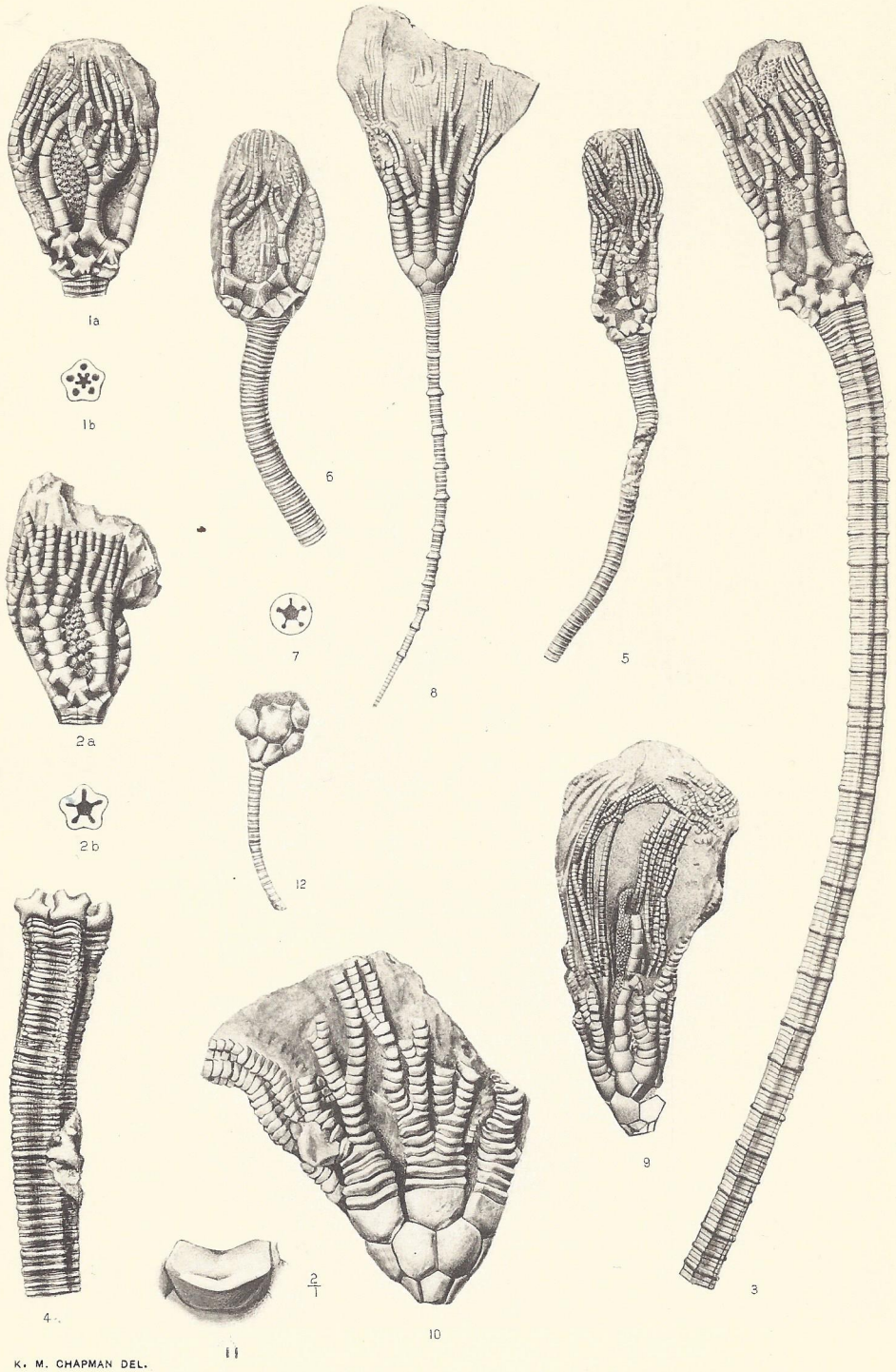
Cupulocrinus jewetti (Billings).. .. ..page 28.

FIG.

10. A mature specimen, showing the general proportions of the calyx and arms; from anterior radius. Coll. Geological Survey, Canada.

11. Distal face of a IBr., the articular markings indistinct.

12. A small specimen to show the characters of the stem; the proximal columnals alternating from the beginning, and not markedly enlarging.



K. M. CHAPMAN DEL.

KIRKFIELD ECHINODERMS SPRINGER

PLATE II.

PLATE II.

Hybocystis eldonensis Parks.. .. ..page 13.

FIG.

1. A small specimen with 4 brachials to the arm, and ambulacra recurring on the dorsal side; from r. post. ray; lateral ambulacrum not passing the radial. x 2.
2. Small specimen with stem attached, left lateral view; 4 brachials to the arm; lateral ambulacra just passing the basi-radial suture. x 2.
3. Medium specimen with 5 brachials, anterior view; dorsal ambulacra passing only short distance from top of arm. x 2.
4. Medium specimen with 5 brachials, from left anterior ray; lateral ambulacrum passing down to basals. x 2.
5. Small flattened specimen with 6 brachials, anterior view. Dorsal ambulacra are seen on the arm to the left; the other brachials in sight are displaced, the upper four having the ventral side exposed; the lateral ambulacra in this specimen do not pass the radial. x 2.
6. Large specimen with 6 brachials, right anterior view; recurrent dorsal ambulacrum passing full length of arm and down to radial, and lateral ambulacrum fully across basals. x 2.

7*a*. Large malformed specimen, from anterior radius; the arm broken off during life and replaced by calyx-ambulacrum extending down upon the stem; right lateral ambulacrum imperfectly developed. x 2.

7*b*. Central part of tegmen of same, showing side and covering ambulacral plates, and integument of small plates between water pore and anal pyramid, which is broken off. x 3.

7*c*. Detail of ambulacrum in same, showing the two sets of side pieces, and small arched covering pieces forming a median ridge. x 12.

8*a*. Posterior view of small specimen, showing crenulated anal plate. x 2.

8*b*. Tegmen of same, showing ambulacral plates in place—the covering pieces too small to show in this drawing—the water pore, anal pyramid, and the shape of posterior oral when not covered by small plates. x 2.

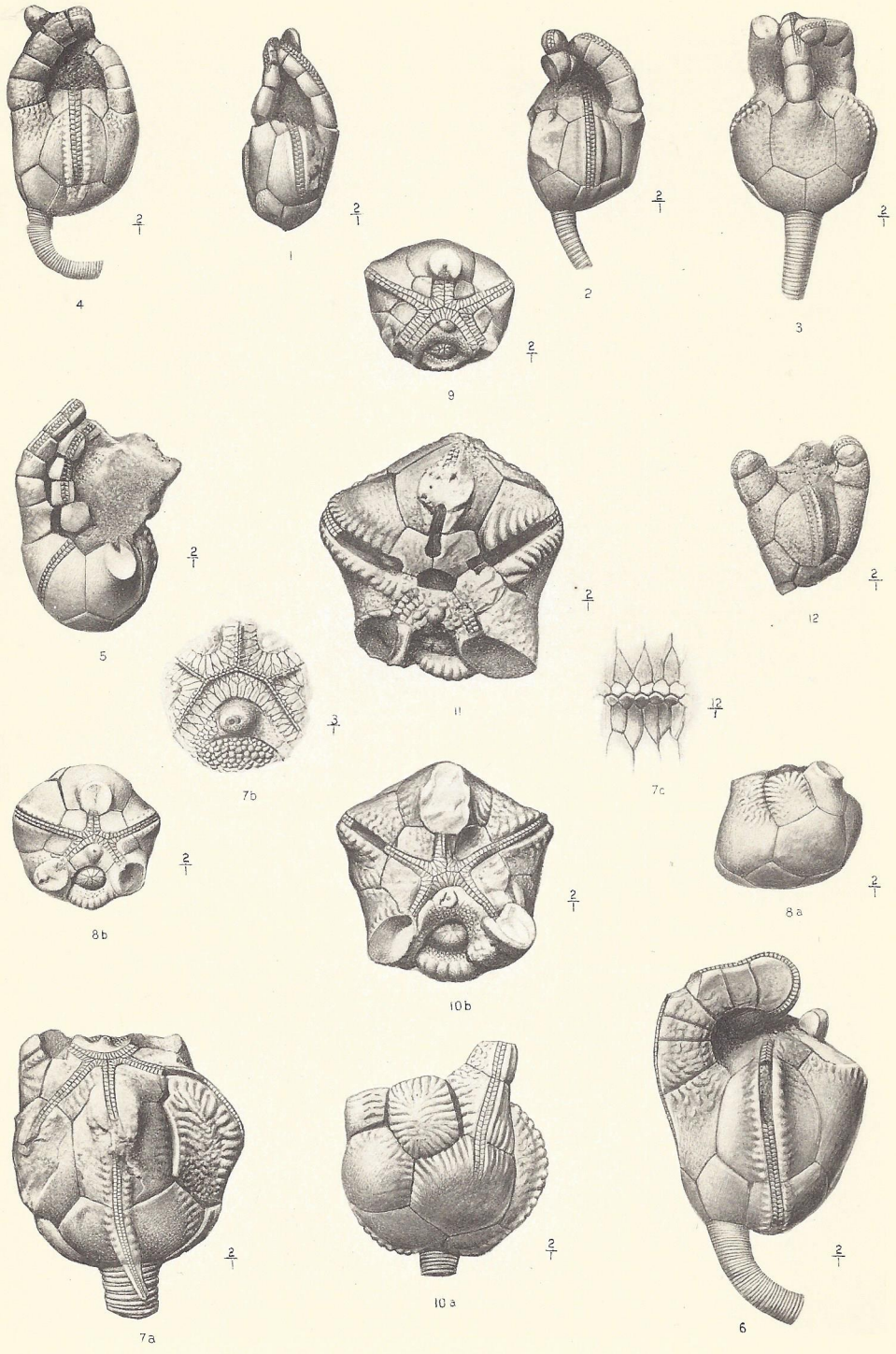
9. Tegmen of another small specimen with all structures well preserved; the integument of small plates surrounding the anal pyramid is well shown. x 2.

10*a*. Posterior view of large specimen, showing the crenulated anal plate, and grooves radiating to other plates. x 2.

10*b*. Tegmen of same; posterior oral partly covered by integument of small plates surrounding the anal pyramid. x 2.

11. Tegmen of a specimen of *H. problematicus* from Woodford county, Kentucky, with ambulacra removed, and oral plates fully exposed; showing how they meet by lateral extensions around a central space—both covered by rigid ambulacra when in place. x 2.

12. Young specimen of *H. problematicus* from Mercer county, Kentucky, with lateral ambulacra not passing to basals. x 2.



K. M. CHAPMAN DEL.

KIRKFIELD ECHINODERMS SPRINGER

PLATE III.

PLATE III.

Cupulocrinus humilis (Billings).. .. ..page 28.

FIG.

1*a*. A nearly complete crown, anterior view; showing (1) small irregular plates in three interradii, and (2) 4 IBr in anterior ray, and 5 in the two lateral rays.

1*b*. Posterior view of same; showing (1) the gaping sutures in the rays; (2) the base of the anal tube with its border of small plates on either side; (3) integument of irregular plates in left posterior interradius; (4) 4 IBr in the posterior rays.

1*c*. Detail of left posterior interradius at *c*, showing the character and number of small plates in the axil; they are more regular here than usual, being largely hexagonal. x 3.

1*d*, *e*. Detail of brachial sutures, showing the articulation seen from the dorsal side, and profile of the same; this is not a mere bevelling of the edge of the plates, but the distal faces are deeply sloped, indicating great mobility in the rays, as in many Flexibilia. x 3.

2. A broken specimen, showing (1) the anal tube to nearly its full length; the distal end is lost, but the imprint of it in the matrix is seen, showing what must have been the extremity, and how the tube tapers to a small size instead of expanding into a sac; (2) the median series of plates evenly curved, without keel.

3. Broken specimen with calyx and arms to the first bifurcation, anterior view; showing (1) the small interbrachial plates with lower one well defined and fitting closely into the axil; (2) the proximal part of the stem, composed of thin, non-alternating columnals, enlarging towards the calyx. x 2.

4*a*. Small specimen of an allied form associated with '*Dendrocrinus*' *polydactylus*, in the Hudson River Group near Cincinnati, Ohio; figured for comparison of anal structures; posterior view, showing the tube curving over upon the tegman. x 2.

4*b*. The ventral side, showing the tube merging into the tegmenal structures, which are indistinctly preserved. x 2.

Cupulocrinus jewetti (Billings).. .. ..page 28.

FIG.

5*a*. Nearly complete crown, posterior view; showing (1) anal tube with keeled median series of plates and bordering structures; (2) small plates in left posterior interradius. x 2.

5*b*. Detail of left posterior interradius at *b*. Here the left anterior ray is pulled out of position, so that we see the lateral face which is usually concealed by contact with the adjoining ray; it exposes a very peculiar surface marking—as of very small plates or the imprint of them—above the interbrachial plates, extending outward between transverse keels on the brachials, and obliterating the sutures. x 4.

6. Posterior view of an injured specimen with arms partly removed, showing anal tube complete; it bends to the right at the distal end, and the exact construction there cannot be ascertained, but there is some indication of an opening.

7*a*. A very mature, flattened specimen with calyx and lower part of rays—anterior view—to show the deeply indented and waving sutures; plates almost smooth, without connecting ridges or furrows; small plates in iBr areas.

7*b*. Posterior view of same, showing base of anal tube.

7*c*. Detail of IIBr at *c* in the right posterior ray, showing the strong sinuosity of the sutures. x 3.

Cupulocrinus jewetti, var. *kentuckiensis*.. .. ..page 32.

FIG.

8. Specimen with smooth plates, posterior view, with part of arms removed; showing anal tube about complete. Woodford county, Kentucky.

9. Similar specimen from same locality with arms nearly complete, from left anterior interradius; showing (1) a large, well developed interbrachial plate in only one interradius—a sporadic occurrence, not found in other specimens; (2) proximal part of stem with alternating columnars, very different from that of Figure 3.

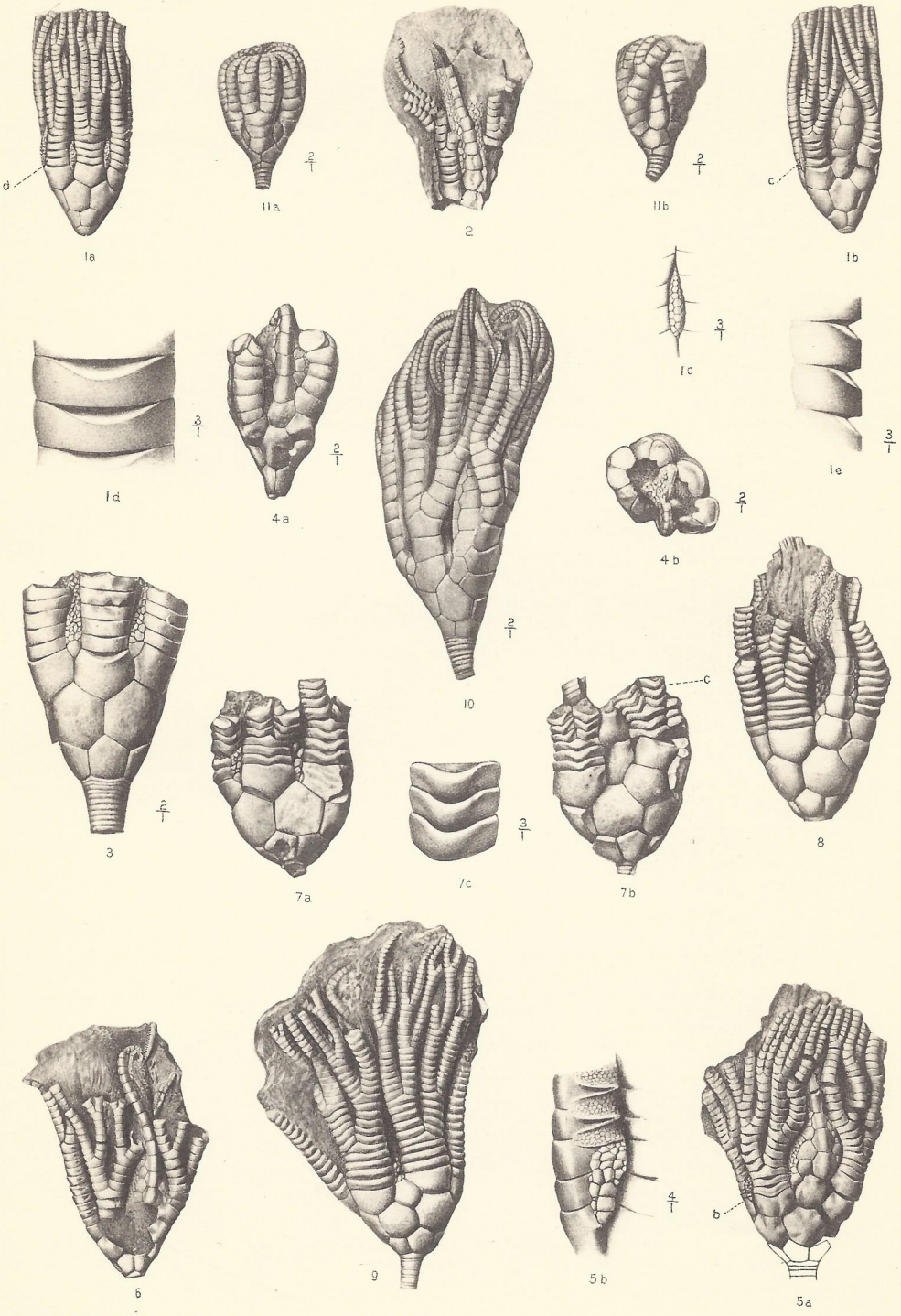
Protaxocrinus lævis (Billings).. .. ..page 11.

FIG.

10. A complete crown, posterior view; showing the anal tube, and radianal in primitive position under right posterior radial; for comparison with structures in preceding figures. x 2.

11*a*. Smaller specimen from Ottawa, anterior view; showing interbrachial plates. Coll. Geological Survey, Canada. x 2.

11*b*. Posterior view of same, showing anal tube. x 2.



K. M. CHAPMAN DEL.

KIRKFIELD ECHINODERMS SPRINGER

PLATE IV.

PLATE IV.

Ottawacrinus billingsi n. sp.. .. ..page 40.

FIG.

1*a*. A mature specimen seen from the anterior side, natural size; showing (1) the rugose ventral sac preserved to about its full length, with sharply raised stellate sculpturing on the plates; (2) the arms, in two main divisions to the ray, with ramules from alternate sides of the dichotom bearing secondary ramules from one side only. The imprints of the unilateral secondary ramules, as well as the ramules themselves, are seen at several places.

1*b*. Cross-section of stem of same, showing its division into 5 longitudinal segments.

2*a*. Enlarged view of another specimen, from left posterior radius; showing the anal side, and the sac, with details of its highly sculptured plates, and of the arms. Note the strong interbrachial plates at the left posterior interradius. x 2.

2*b*. Opposite view of calyx of same specimen, natural size; to show the iBr plates.

3. Another specimen from the anal interradius, showing the mode of succession of anal plates following posterior basal into the sac.

4*a*. Cross-section of large stem found associated with the foregoing, probably of this species, natural size.

4*b*. Side view of small portion of same, showing the extreme thinness of the columnals, and the lines of the longitudinal segments, with interarticular pores.

4*c*. The pores at a place where two segments have slightly slipped upon one another, out of the same level. x 4.

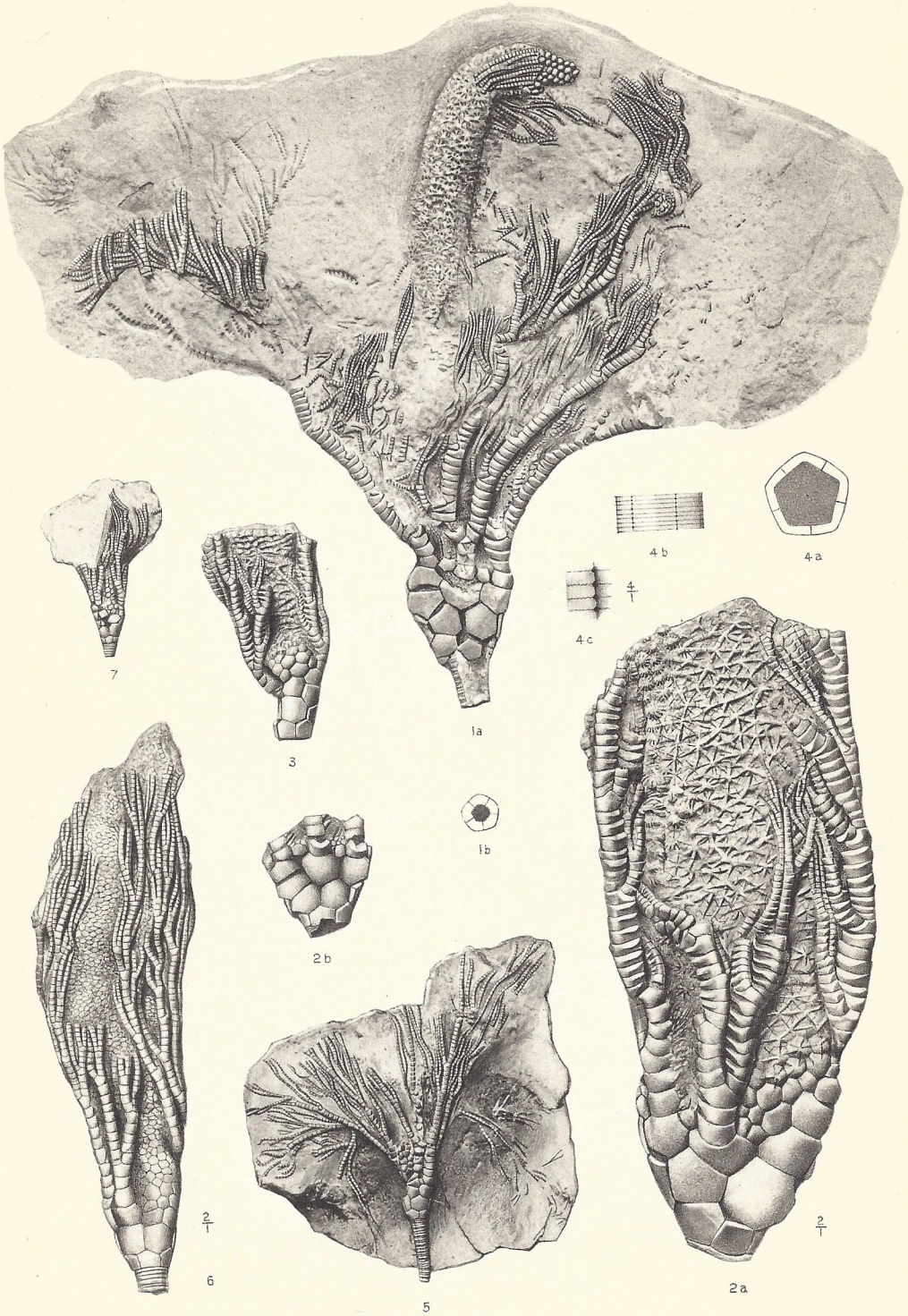
Ottawacrinus typus W. R. Billings.. .. ..page 37.

FIG.

5. Specimen showing the heterotomous branching of the arms, from antero lateral interradius; the line of longitudinal division of the stem is also seen.

6. A complete crown, with ventral sac of smooth plates rising to the full height of the arms; posterior view. x 2.

7. Another specimen from posterior side, showing arm-branching and part of ventral sac.



K. M. CHAPMAN DEL.

KIRKFIELD ECHINODERMS SPRINGER

PLATE V.

PLATE V.

FIG. *Hybocrinus tumidus* Billings.. .. ..page 24.

1. Specimen from Woodford county, Kentucky, posterior view; showing the highly arched and crenulated anal plate, and lower part of arms with transverse grooves leading to ventral side.
2. Ventral side of another specimen, showing the extreme arching of the anal plate, and traces of ambulacra; same locality.
3. Another specimen from same locality with anal pyramid well preserved; drawn with posterior side up, for better view of the structures; water pore indistinctly shown.
4. Small specimen from Mercer county, Kentucky, with tegmen preserved; anal pyramid distinct, but ambulacral plates wanting.
5. One of the types, original of Dec. IV, Pl. II, fig. 1c, posterior side, after additional cleaning; showing crenulated anal plate. Ottawa. Geological Survey, Canada.

FIG. *Hybocrinus conicus* Billings.. .. ..page 24.

6*a*. Posterior view of large specimen from Ottawa, showing anal plate with smooth distal margin, followed directly by plates leading to anal opening.

6*b*. Tegmen of same, showing extreme marginal position of anal opening, directly through a cluster of small plates without any defined pyramid; also the ambulacral structures. Note the large sub-ambulacral plates.

FIG. *Cleiocrinus regius* Billings.. .. ..page 44.

7. Small specimen from Kirkfield, basal view; showing external form of the 5 large infrabasals lying within the ring of alternating basal and radial plates. To be compared with figures on Plate I of the paper on *Cleiocrinus*, Mem. Mus. Comp. Zool., XXV, No. 2.
8. Fragment of another specimen from IAx upward, showing rhombic areas with slits traversing the sutures. x 3/2.

9*a*. Exterior of an axillary plate, probably IIIBr, from another weathered fragment in which the usual median ridge is worn off; showing the rhombic areas with slits leading to a line of pores on each suture. x 3.

9*b*. Inner surface of same plate and the two next below it, showing the large pores opening to the interior at the corners of the plates, and the broad ventral grooves. x 2.

Cleiocrinus sculptus n. sp.. .. ..page 44.

FIG. Mercer county, Kentucky.

10*a*. Lower part of calyx to IIBr2, with stem detached, and free from matrix inside and out, posterior view; it has elaborate sculpturing, with rhombic areas of bars and grooves crossing the suture lines, and plates strongly elevated in the middle; the lower visible range of plates are the alternating basals and radials, the posterior basal being much higher than the others. x 2.

10*b*. Basal view of same, showing the 5 large infrabasals 'telescoped' into the ring of basals and radials, and the shallow channels at the inner edges of the plates. x 2.

10*c*. Interior of same, showing large pores opening inward at the corners of the plates, and the lip-like projections from the channels on infrabasals leading towards the interior; also the strong curvature of the inner surface of the plates generally. x 2.

10*d*. Detail of r. post. IIBr and adjoining anal plate, showing the rods, ridges, and grooves radiating from the median, keel-like elevation, and the rhombs crossing the suture lines. The sculpturing may be accentuated from replacement of cavities by infiltration of siliceous matter, and dissolving of the outer stereom, the usual granular surface being destroyed; the pores on the suture lines are obscure at the exterior. x 4.

10*e*. Distal face of the same plates, showing course of the tunnels running from the pores on the suture lines right and left, converging to form the large openings to the interior; also the inner curvature of the plates, and relative thinness of the actual sutural face; the anal plate has a peculiar central pit not seen on the others. x 4.

10*f*. Vertical section at middle of brachials, showing their median elevation. x 3.

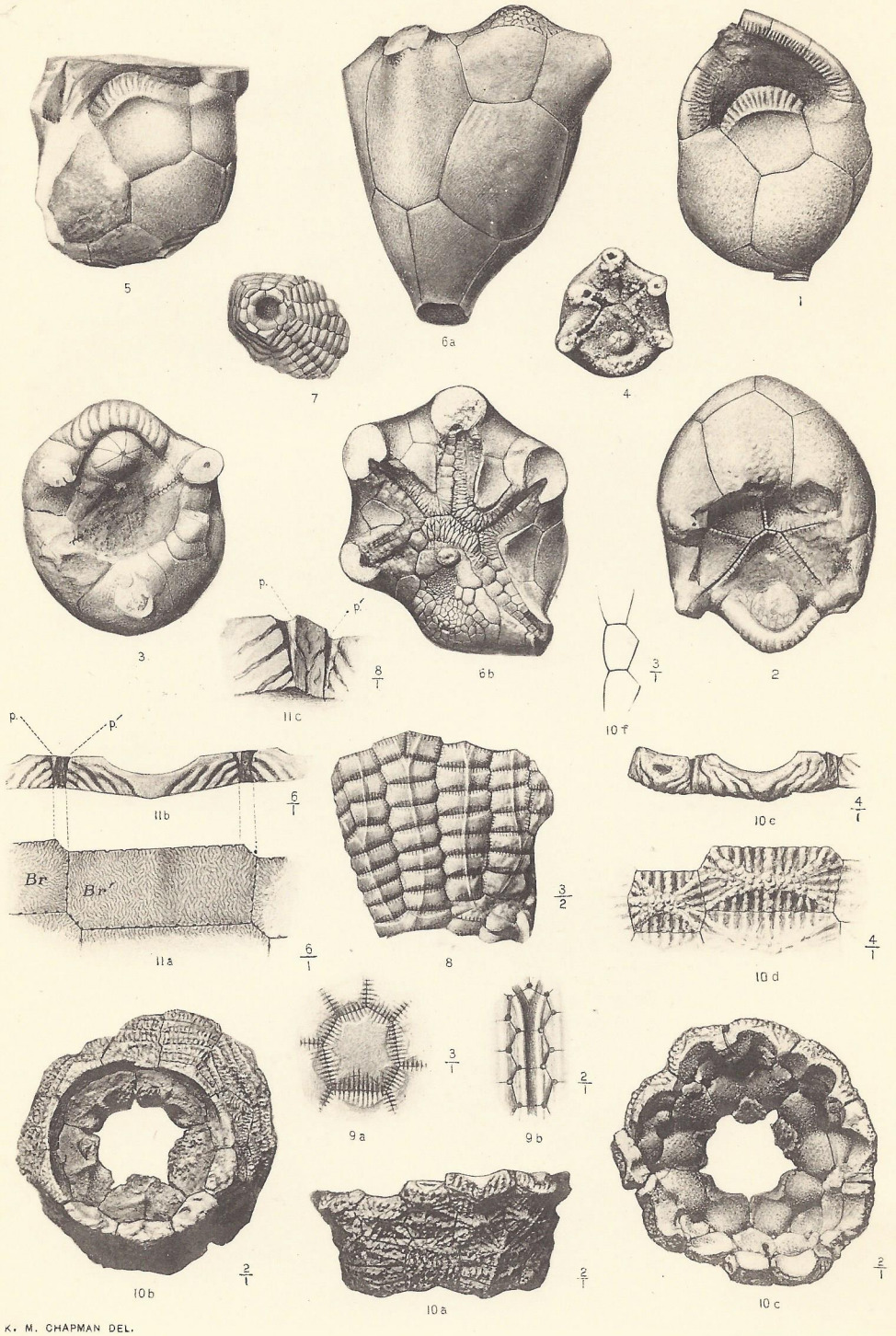
Cleiocrinus lævis n. sp... .. ..page 44.

FIG. Shelbyville, Tennessee.

11*a*. Dorsal side of a IIBr and connecting plates of the type specimen, which has the calyx preserved to about the second bifurcation; the original surface is in perfect condition, showing the meshes and folds of stereom; the plates are without sculpturing, flush with each other, having but a faint, broad median ridge, and no slits or pore-rhombs visible; but with pores along the suture line of each face. x 6.

11*b*. Distal face of same plates, showing the course of tunnels at either side discharging into large, funnel-shaped openings to the interior at the corners of the plates; the structure of these is shown in greater detail in the next figure. x 6.

11*c*. The two funnel-shaped pores, p and p^1, of the last figure; p is entirely within plate 'Br' and the apposed one above it, while p^1 is confined to plate 'Br^1' and its successor. x 8.



K. M. CHAPMAN DEL.

KIRKFIELD ECHINODERMS SPRINGER